Criminalization of HIV Transmission

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Despite the best of the scientific community's efforts, HIV is incurable. Its life-threatening symptoms can be successfully managed with a panoply of antiretroviral drugs, but the infection itself remains irrevocable. Furthermore, the available arsenal of antiretroviral drugs represents a luxury that the world's poorer patients can scarcely afford. Moreover, it is difficult to accurately predict the future effectiveness of those drugs, since HIV is constantly evolving toward drug resistance.[1] Accordingly, the current HIV global pandemic has prompted jurists, public health experts, and government officials to grapple with the dilemma of whether or not HIV transmission should be criminalized.[2] Proponents of criminalization argue

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1 At the same time, HIV research is also constantly evolving, as newer antiretroviral agents are being developed by microbiologists. Thus, there is essentially a life-and-death race in progress between the HIV virus and scientists who seek to thwart HIV. Presently, scientists possess the upper hand (at least insofar as wealthier patients who are capable of affording the drugs are concerned), but it is impossible to offer guarantees for the future. Cf. *Iggerot Mosheh, Even ha-Ezer* IV no. 10, where R. Moshe Feinstein explains that even though a Jew is commanded by Deuteronomy 18:3 to trust that the Creator will take care of the future, this does not exempt the Jew from paying responsible attention to the dangers that medical science has positively identified. [This is because the achievements of medical science are themselves the merciful manifestations of Providence. See R. J. David Bleich's *Bioethical Dilemmas* I (KTAV Publishing, 1998), pp. 11-12, 72–74, and *idem* II (Targum Press, 2006), pp. 1-2, 9–15, 99-100, 103–105, 134–139.] Although, in context, *Iggerot Mosheh* speaks of the Tay Sachs gene, it seems obvious to these writers that the selfsame considerations apply to the HIV genome.

2 See S. Burris and E. Cameron, "The case against criminalization of HIV transmission," *Journal of the American Medical Association* 2008, 300:578–581; M.A. Wainberg, "Criminalizing HIV transmission may be a mistake," *Canadian Medical*

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that justice demands that the vehicles of an intractable and potentially lethal infection be held accountable. Opponents counter that criminalization would lead to unfair stigmatization of HIV carriers and would discourage the citizenry at large from voluntarily being screened for HIV, thereby jeopardizing public health efforts to curb the pandemic. As such, the following article will explore how Halakhah might provide guidance regarding this vexing societal problem.

In essence, two separate halakhic spheres address the question of HIV transmission criminalization: (a) The obligation to impose tort law as it is defined by the Torah, seeing as infecting another human being may be construed as a form of damage, and (b) the rights of members of a society to compel one another to erect fortifications against a future enemy invasion (as per the *gemara* in *Bava Batra* 7b), seeing as the spread of an epidemic is a form of enemy invasion.[3] Each of these spheres is relevant for Jews as well as for Noahides.

A. HIV Contagion as a Tort

The divine law does not normally take cognisance of subvisual phenomena, since "the Torah was not given to ministering angels," as per the *gemara* in *Berakhot* 25b. A typical ramification of this principle is that microorganisms may be permissibly imbibed by a Jew.[4] Accordingly, since infectious disease pathogens (such as HIV particles) are microscopic in nature, one may justifiably inquire whether contaminating another individual constitutes a bona fide tort.

Association Journal 2009, 180:688; P.G. Berger, "Prosecuting for knowingly transmitting HIV is warranted," *Canadian Medical Association Journal* 2009, 180:1368; and J. Csete and R. Elliott, "Criminalization of HIV transmission and exposure: in search of rights-based public health alternatives to criminal law," *Future Virology* 2011, 6:941–950.

3 For sources on the equation between enemy invasion and infectious disease spread, as well as pertinent applications to the Noahide Code, see the discussion by these writers in "HIV Vaccine Triage," (scheduled for publication in *Jewish Law Annual*, Vol. 20), notes 78-82, with accompanying text.

4 See *Bioethical Dilemmas* II, pp. 211–215, as well as *Contemporary Halakhic Problems* VI (KTAV Publishing, 2012), pp. 268–276, by R. Bleich. The same author similarly argues in *Contemporary Halakhic Problems* V (Targum Press, 2005), pp. 101–103 that Halakhah does not take cognisance of Einstein's relativistic conception of time, since relativity is a notion—while empirically true—that transcends human perception, and Halakhah is addressed to human beings with human perception.

Actually, R. Zvi Spitz, in his *Mishpetei ha-Torah* I (Jerusalem, 5758), no. 87, unhesitatingly rules in the affirmative, pursuant to the analysis of R. Jacob Israel Kanievsky in the latter's *Kehillot Ya'akov*, *Bava Kamma*, no. 39.[5] R. Kanievsky proves from *Tosafot* to *Bava Kamma* 100a (s.v. *tiher*) that insofar as damages are concerned, one is most assuredly responsible for executing them even via imperceptible agents of harm. *Tosafot* declare a judge who wrongfully condemns a litigant to be effectuating direct damage through his speech alone. Apparently, infers R. Kanievsky, the vibrating air molecules emanating from his vocalized words may be intangible, but their ultimate effect in depriving the litigant of money is quite real. R. Spitz extrapolates that the same holds true for transmission of communicable disease.

In a separate but parallel work entitled *Mishpetei ha-Torah Al Mesekhet Bava Kamma*, no. 67, R. Spitz renders the same point regarding culpability for the dispatch of computer viruses by way of electronic mail. Although a computer virus is simply a series of invisible binary code data that is launched with the click of a mouse, the sender is fully liable for resulting damage to the recipient's computer, based on the aforementioned *Kehillot Ya'akov*.

Both in the case of infectious disease and in that of computer viruses, R. Spitz carefully distinguishes between scenarios in which the victim is directly harmed and ones in which the victim inflicts the harm upon himself. In the former situation (e.g., the tortfeasor injected the victim with an HIV-tainted drug syringe), the tortfeasor must pay full damages. In the latter fact pattern (e.g., the tortfeasor supplied the victim with an HIV-tainted drug syringe without informing the victim, who proceeded to inject himself), the governing precedent is the *gemara* in *Bava Kamma* 47b, which condemns an individual who places poisoned food in front of someone else's animal [which subsequently eats the food and is harmed] to liability at the Hands of Heaven. Although such a tort—being orchestrated indirectly (*gerama*)—is not actionable in a human court, the miscreant must nevertheless volunteer to compensate his victim if his conscience is to be cleared. Moreover, all causation of damage—even when indirect and not punishable—is forbidden, as per the *gemara* in *Bava Batra* 22b.[6] Halakhically speaking, then, infecting others with disease is both

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5 In the newer edition of *Kehillot Ya'akov* for *Bava Kamma*, R. Kanievsky's composition is transposed to no. 44.

6 For a digest of various explanations for what precise *mitzvah* is transgressed when damaging someone else's property, see *Contemporary Halakhic Problems* V, p. 291. The case of damaging someone else's health through infectious disease

forbidden and, to an extent that differentially hinges upon the circumstances, subject to restitution.

Even if the miscreant does not realize that he is infecting another person by his actions, the miscreant is guilty, pursuant to the rule "a person is always [considered] forewarned [regarding damages he personally executes], whether inadvertent or intentional, whether awake or asleep" (*Bava Kamma* 26a). As the *gemara* there elucidates, this automatic liability translates into responsibility to pay *nezek* (the depreciation of the victim on a hypothetical slave market), although not the other four battery payments of *tza'ar* (pain), *ripui* (medical expenses), *shevet* (actual unemployment) and *boshet* (humiliation).

However, there may be grounds to question whether the tortfeasor is liable to pay even so much as *nezek* when he infected a victim with the tortfeasor's own corporeal fluid (e.g. he shared a drug injection needle with the victim), not realizing that he was HIV seropositive in the first place. Such self-ignorance may give rise to identify any consequential transmission of disease as an "accident"—which in contradistinction to "inadvertent" damage is halakhically exculpable for *nezek* according to some authorities.[7] As such, a tortfeasor accused of accidentally infecting

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transmission is even more weighty, since a person cannot grant advance forgiveness for his own wounding [and, *a fortiori*, his own death], as per the analysis of R. Shlomo Yosef Zevin in *Le-Or ha-Halakhah* (2nd edition, Tel Aviv, 5717), pp. 318–335.

Actually, one might question the applicability of R. Zevin's disquisition when the infectious malady being transmitted will neither wound [in the official sense of bloodletting] nor kill the victim, but merely render him ill. It seems to these writers that causation of pain to another human being—even if not accompanied by wounding or killing—is encompassed under the rubric of R. Zevin's non-advance-forgiveness principle, based on the analysis of R. Bleich in *Bioethical Dilemmas* II, pp. 166–168, which equates the experience of unnecessary pathophysiological pain with a form of quasi-suicide. [Additionally, as referenced on p. 77 of that same volume, R. Samuel Halevi Wosner understands the *gemara* in *Gittin* 57b to equate nociception with quasi-death.] If the experience of such pain is "quasi-suicide," then causation of such pain in another individual—including through such means as infectious disease transmission—would constitute "quasi-homicide." And just as one cannot grant consent to be killed, one cannot grant consent to become HIV-infected.

7 See *Contemporary Halakhic Problems* VI, p. 121; as well as *Mishpetei ha-Torah* I, no. 3, for a catalogue of conflicting opinions in this regard.

In addition to those sources, it may be observed that *Or Zaru'a* (*Hilkhot Yibbum ve-Kiddushin* no. 637) exonerates from all sacrificial liability a gentleman who waited the statutory three months of clarification after his (apparently) childless brother died to wed the widow through levirate marriage, and then some time

a victim could successfully excuse himself from financial liability by appealing to the "*kim li*" principle, which shields a defendant from monetary payment when he can invoke a legitimate halakhic opinion (which has not been refuted) that favors his stance.[8]

The foregoing represents R. Spitz' approach to tortious contagion. By contradistinction, R. J. David Bleich does not regard pathophysiological contagion as ever generating actionable liability. This is because he cites an actual dispute among halakhic authorities as to whether lethal injection of a victim with a cytotoxic agent is considered direct proximate cause or a mere *gerama*, seeing as "the drug works its way through the body and produces various chemical reactions. A chain of multiple causes and effects is set in motion that ultimately culminates in the death of the patient but the act of administering poison is [arguably (*-ed.*)] not the direct and immediate cause of death."[9] Evidently, the principle of "*kim li*" would

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after it is discovered that the widow had been pregnant from her original husband all along, but that the fetus had still been concealed even three months after the husband's death. Since the brother acted in good faith, he does not have to bring a *ḥatat* sacrifice for what has now been discovered to be an unlawful act of incest, seeing as "his heart commandeered him," apropos Leviticus 5:4 as it is expounded by the *gemara* in *Shevu'ot* 26a. Although the Talmud, in context, presents a new category of duress as it applies to false oaths, *Or Zaru'a* evidently understands it to apply even in non-oath contexts. Arguably, then, *Or Zaru'a* might exculpate a tortfeasor who orchestrated damage by pure accident on the grounds that "his heart commandeered him."

8 R. Spitz, *ad. loc.*, and in *Mishpetei ha-Torah* III (Jerusalem 5758), nos. 16-17.

9 *Bioethical Dilemmas* II, pp. 332-333. See *Contemporary Halakhic Problems* VI, pp. 143–145 and 162–165, for an elaboration of the *poskim* on both sides of the dispute.

Intriguingly, this halakhic controversy appears to be symmetrically reflected in the contemporary debate regarding the interdiction against moving a *gossess* (pursuant to the prohibition canonized by *Shulḥan Arukh Yoreh De'ah* 339:1). R. Moshe David Tendler rules that one may permissibly inject a radio-labelled substance into an intravenous line already inserted into the *gossess*, as injecting a substance into the patient's bloodstream is not considered to be direct manipulation of the *gossess*. See his *Responsa of Rav Moshe Feinstein* (KTAV Publishing, 1996), p. 94. By contradistinction, R. Shlomo Zalman Auerbach forbids such an injection as a direct manipulation of the *gossess*. See his disciple R. Simchah Bunim Lazerson's *Shulḥan Shelomoh*, *Erkei Refu'ah* II (Jerusalem 5766), pp. 28, 32, 40, 49. Evidently, R. Auerbach subscribes to R. Spitz' position, whereas R. Tendler subscribes to the countervailing camp outlined by R. Bleich (regarding what constitutes proximate cause).

True to form, this controversy is further mirrored in the additional conflict between R. Tendler and R. Auerbach as to whether the ongoing secretions of a

serve to exculpate the murderer before a human court. *Mutatis mutandis*, a tortfeasor who transmits an infectious disease to his victim could never be judicially compelled to pay, since the initial introduction of infectious matter (e.g., HIV particles) into the victim's body does not immediately harm the victim. The HIV particles must undergo many replication cycles and must kill many immune cells within the newly infected host before such time as they will actually endanger the host. In light of the unresolved dispute regarding the actionability of such a proximate cause, the infecting tortfeasor could not be sued in Beth Din, but will instead be responsible before the Heavenly court, as would be the consequence for any *gerama*. It stands to reason that, although R. Spitz and R. Bleich have penned their respective analyses independently, R. Spitz would probably concede to R. Bleich, simply because it is difficult to envisage a compelling refutation of all the countervailing authorities cited by R. Bleich. And so a person could never be held responsible by a court to pay for infecting another individual with HIV under the conventional Torah principles of torts. The miscreant will instead bear a supererogatory obligation to voluntarily offer restitution to his victim.

Admittedly, even if the miscreant is judicially exculpable according to Torah law, some *poskim* will allow Noahide legislatures to formulate their own civil laws at variance with Torah law, in order to render a miscreant financially liable, if the government sees this as a necessity for the sake of preserving society.[10] Furthermore, some *poskim* grant Noahide legislatures the prerogative to criminalize activities that are not technically criminal according to Torah law, once again if the government determines this as being necessary to uphold the citizenry's collective welfare. Such crimi-

brain dead patient's hypothalamus into his own bloodstream constitute the legally significant motion of the patient's own limbs [which might then constitute a halakhic sign of life (although this itself is subject to dispute, per the exchange between Dr. Joshua Kunin and R. Edward Reichman in *Tradition* 38:4 [Winter 2004], pp. 48–69)]. R. Auerbach, obviously following R. Spitz, believes that the hypothalamic secretions do (or at least doubtfully do) constitute legally significant motion (*loc. cit.*, pp. 29, 30-31, 49-50); whereas R. Tendler, obviously following the countervailing camp outlined by R. Bleich (regarding what constitutes proximate cause), believes that the hypothalamic secretions do not constitute legally significant motion (*loc. cit.*, pp. 96-97).

10 See R. Bleich's *Be-Netivot ha-Halakhah* I (KTAV Publishing, 1996), p. 98 and *Be-Netivot ha-Halakhah* II (KTAV Publishing, 1998), p. 154.

nalization—by definition—would entail consequential punishment by incarceration, corporal or perhaps even capital punishment.[11] Most importantly, R. Chaim Ozer Grodzinsky demonstrates that Noahides may indeed be culpable for causation of torts orchestrated even through *gerama*,[12] in which case Noahide courts would be obligated to prosecute anyone who transmits HIV (at least as a matter of civil litigation, and possibly even with the option of criminalization).

It seems to these writers that the foregoing considerations necessarily authorize Noahide society to criminalize all cases of demonstrably violent transmission of HIV. Thus, for instance, a perpetrator who perniciously jabs his fellow with a needle (against the will of the victim) should certainly face criminal prosecution—not only for the act of assault that independently represents a criminal action, but also for the aggravated fact that the assault included transmission of HIV. Considerations of law and order demand that any violence that includes HIV transmission be punished commensurate to the gravity of the harm that has been inflicted upon the victim.

All the same, in reality, the vast majority of HIV transmission occurs through non-violent pathways. In such scenarios (e.g., thoughtless or even deceitful sharing of a needle without informing the victim that the needle is infected, etc.), it appears questionable whether criminalization is appropriate. In light of the dictum that "the burden of proof devolves upon he who seeks to exact from his fellow" (as per the *gemara* in *Bava Kamma* 46b), prosecution for HIV transmission under such circumstances could be successful only where it is demonstrable beyond cavil that the tortfeasor was conscious of his own seropositive status, as explained before.

B. Societal Fortifications Against HIV Contagion

Bava Batra 7b authorizes members of society to compel one another to erect fortifications against future dangers, including the danger of contagion. Thus, if government legislation can be generated to direct human behavior in such a manner as to curb the spread of the HIV global pandemic without offending pre-existing halakhic duties [of Jews to the Mosaic Code and of Noahides to the Noahide Code], it is indeed the obligation of government to act accordingly when so requested by so much as even a single citizen.

Criminalization of HIV transmission may be a tool at the disposal of governments in their attempt to contain the HIV pandemic. However, as

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11 See R. Bleich's *Be-Netivot ha-Halakhah* I, pp. 85–105 and *idem* II, pp. 153–168.

12 *Teshuvot Ahi'ezer* II, no. 5, sec. 6 and *idem* III, no. 37. See *Be-Netivot ha-Halakhah* II, pp. 147–149 for analysis.

noted in the previous section, criminalization is fraught with difficulty because—even according to those *poskim* who grant Noahide governments the power of criminalization—the prosecution must prove that the transmitter was aware of his own seropositive status. Criminalization is therefore uncertain to work in the majority of cases, *viz.* cases of non-violent transmission. Moreover, a survey of pertinent literature by public health experts reveals a dispute among the cognoscenti as to whether criminalization (in non-violent situations of transmission) ameliorates or exacerbates the global pandemic. In the face of such caveats, it would be helpful if an alternate expedient were available to government in its quest to erect fortifications against contagion.

Although no guaranteed panacea exists, it seems to these writers that a potentially effective strategy does suggest itself, and one that is less drastic than criminalization: destigmatized open testing of the entire populace. Namely, rather than prosecuting seropositive citizens *post facto* for criminally transmitting HIV, society enjoys the moral prerogative—and, when requested by even so much as one of its members—the responsibility, to *ab initio* prevent its seropositive citizens from ever becoming criminals in the first place. Such prevention is accomplished by publicly identifying all HIV carriers without prejudice or stigma.

To be sure, the divine law places a high premium on the civil liberties of privacy and confidentiality. However, as R. Bleich[13] and R. Shlomo Deichowsky[14] both demonstrate—and as can independently inferred from a ruling of R. Shlomo Zalman Auerbach[15]—those considerations

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13 *Bioethical Dilemmas* I, pp. 142–159, 187–202. See also *Contemporary Halakhic Problems* V, pp. 54-55, which elaborates a list of five essential moral criteria that must be met before confidentiality is neutralized. As demonstrated by Dr. Benjamin Freedman in "An Analysis of Some Social Issues Related to HIV Disease from the Perspective of Jewish Law and Values" [published in *AIDS in Jewish Thought and Law*, ed. Gad Freudenthal (KTAV Publishing, 1998), pp. 93–104], all five of those prerequisites are readily surpassed in the context of the current HIV global pandemic. [N.B. These writers would note that the specific case adjudicated in *Contemporary Halakhic Problems* V redounds to the credit of all the parties involved, since they merited to precipitate the expansion of Torah study. Cf. Rashi to Numbers 27:5.]

14 "Compulsory Testing and Treatment for AIDS," published in Freudenthal (*op. cit.*), pp. 105–112.

15 *Shulḥan Shelomoh*, *Erkei Refu'ah* I (Jerusalem 5766), p. 222. R. Auerbach is asked whether the privacy of a child or mentally incompetent patient (neither of whom can grant meaningful consent) may be violated by testing urine, feces or blood samples that have previously (and legitimately) been withdrawn from them for

are halakhically overridden for the sake of protecting the public from contagion. It is human life, and not human privacy, that is the superior moral value. Thus, an argument can be advanced that it would be entirely proper to publicize the HIV status of all seropositive carriers, if this is the approach that would save the most lives. Not only could uninfected citizens benefit from the public identification of HIV carriers (in the sense that it affords them the opportunity to exercise better vigilance against contracting the virus), but—even more importantly—the infected citizens would benefit as well, because there would be a greater proportion of medical resources available to treat them with lifesaving antiretroviral drugs, obviating the need for triage decisions,[16] and because the seropositive patients would be able to access those drugs very early after infection, before HIV-induced damage to the immune system has occurred. In this context, publicity of the seropositive makes good sense because it represents a proposition that is mutually beneficial to all citizens, as distinct from criminalization, which is an adversarial process pitting one citizen against another. It is a time-honored truism of the human experience that citizens working together in pursuit of the common good will always produce

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what is now an experimental medical purpose. R. Auerbach permits such experimental medical testing, even against the wishes of the patient's next of kin (e.g., the parents of the child). Evidently, the benefits that accrue to society from the advancement of medical science override matters of personal privacy, once the biorheological product has already been withdrawn from the patient. One may cogently infer from this that, *mutatis mutandis*, a patient's privacy may be violated (by testing an already withdrawn biorheological product) to protect others from contracting infectious disease. Preventing the spread of contagion is at least as great a necessity for society (*à la* the construction of urban fortifications) as the advancement of medical science; indeed, both are encompassed under the rubric of *Bava Batra* 7b, as per the reference cited *supra* note 3.

16 Out of the estimated 7 billion human beings presently inhabiting the planet, an estimated 34 million are infected with HIV. [Source: <http://www.unaids.org/en/media/unaids/contentassets/documents/epidemiology/2012/gr2012/20121120_UNAIDS_Global_Report_2012_with_annexes_en.pdf>.] As such, there are statistically about 206 human beings (or about 200, assuming one digit of significant figures) available as caretakers to support the lifesaving administration of anti-HIV drugs to every single HIV patient. This ratio—if left frozen in place—represents a sustainable public health scenario in which every single HIV carrier's life can be saved. However, if the number of infected patients spirals further out of control, as would be anticipated in an infectious disease pandemic, then the caretaker-to-carrier ratio will be drastically skewed, dashing any realistic hope of properly caring for HIV patients. Ergo, it becomes apparent that HIV patients are themselves the greatest beneficiaries of any policy that freezes the pandemic from spreading further.

more successful results than citizens working against one another. When citizens fight one another, both sides are using human capital to destroy human capital; whereas when citizens work together, both sides are using human capital to build human capital.[17]

Publicity of the seropositive could also be helpful because of the talmudic principle *ein apotropos la-arayot,* i.e., there is no self-guarantor to prevent human conduct that potentially transmits HIV (*Ketubot* 13b). No person can reasonably be expected to guard himself against transmission of HIV; a person needs the public's assistance to do so. When the public as a whole is aware of the seropositive status of the carrier, then society will watch over the carrier to prevent him from transmitting HIV.

Obviously, such publicity would have to be accompanied by public education with an aim of destigmatization of the HIV carrier status. After all, "and you shall love your fellow as yourself" is the golden rule of the Torah, as Rabbi Akiva declares in the *Sifra* to Leviticus 19:18. Accordingly, while the public health necessitates the broadest possible dissemination of HIV carrier status information, such dissemination must be orchestrated in the most sensitive and tactful manner possible, explaining that HIV carriers deserve to be treated with dignity like all other human beings. There is no need to ostracize HIV carriers, only to avoid engaging in behavior with them that would cause disease transmission.[18]

We invite the *Ḥakirah* readership to suggest practical halakhically acceptable means of achieving destigmatized open testing of the entire populace.[19] By humanity working together cooperatively, it is possible to successfully neutralize the HIV pandemic. Such cooperation will hopefully

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17 Dr. Peter Brown, professor at McGill University's School of the Environment, in an autumn 2001 oral lecture delivered as part of that institution's "Environmental Thought" course (170-400A).

18 Cf. *Bioethical Dilemmas* II, pp. 118–125, where R. Bleich similarly urges destigmatization of genetic disease carrier status in the context of advocating disclosure.

19 A number of public health experts have calculated that mass screening for HIV is indeed cost-effective and therefore a practical strategy in addressing the global pandemic. See Elisa F. Long, Margaret L. Brandeau, and Douglas K. Owens, "The Cost-Effectiveness and Population Outcomes of Expanded HIV Screening and Antiretroviral Treatment in the United States," *Annals of Internal Medicine* 2010, 153:778–789. Admittedly, other public health experts have expressed reservations on this count. See Russell Harris, "Overview of Screening: Where We Are and Where We May Be Headed," *Epidemiologic Reviews* 2011, 33:1–6; as well as Roger Chou, "Routine Screening for Chronic Human Immunodeficiency Virus Infection: Why Don't the Guidelines Agree?," *Epidemiologic Reviews* 2011, 33:7–19. However, even according to the latter school of thought, the ostensibly

be a source of merit to earn the blessing promised by the Torah: "and I shall remove illness from your midst…" (Exodus 23:25). ☙

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insurmountable economic challenge to mass HIV screening has now been potentially solved by the development of the mChip, a simple device that can be used to accurately screen HIV at an astonishingly paltry cost (approx. one U.S. dollar per patient), within only fifteen minutes of a diagnostic finger-prick. See Curtis D Chen *et al*, "Microfluidics-based diagnostics of infectious diseases in the developing world," *Nature Medicine* 2011, 17:1015–1019. The results of this test can be immediately uploaded by cell phone in a time-stamped geo-tagged manner to a medical-records server, guaranteeing that results are accurately maintained no matter where on planet Earth the test is conducted. See Samuel Sia, "Microfluids for STD diagnostics in the developing world," oral lecture available online at <http:// www.youtube.com/watch?v=qZVOR9f5kmQ &feature=player_embedded> .