Tuberculosis and HIV Control in Sub-Saharan African Prisons: “Thinking Outside the Prison Cell”

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Tuberculosis is one of the fastest-growing epidemics in prison populations in sub-Saharan Africa (SSA), constituting a threat to both inmates and the wider community. Various factors have contributed to the breakdown of tuberculosis control in prison facilities in SSA, including slow and insensitive diagnostics, failing prison infrastructure, inadequate funding, and weak prevention and treatment interventions for human immunodeficiency virus (HIV). In this article, we describe the challenges inherent in current approaches to tuberculosis control in prisons and consider the alternatives. We argue that although improved implementation of conventional tuberculosis control activities is necessary, considerable investment in a broader range of public health interventions, including infrastructure and staffing upgrades, cutting-edge tuberculosis diagnostics, and combination prevention for HIV, will be equally critical. This combination response to tuberculosis in prisons will be essential for tackling existing and nascent prison tuberculosis epidemics and will require high-level political support and financing.

Tuberculosis is both preventable and curable. A range of evidence-based interventions exist to prevent, treat, and mitigate exposure to the disease in general populations. These interventions include screening and early diagnosis, isolation of infected individuals, provision of directly observed therapy, and provision of information and education on infection control to reduce transmission. Despite the availability of such interventions, tuberculosis is now one of the fastest-growing epidemics in prison populations in low- and middle-income countries, including those in sub-Saharan Africa (SSA). These rising rates of tuberculosis disease, increasingly prevalent drug resistance [1], and high rates of associated mortality in prison populations suggest that the conventional suite of tuberculosis control measures, developed with general populations in mind, may be insufficient for controlling the disease in such facilities. This has implications not only for prisoners and prison staff but also for the general community [2].

BACKGROUND

Environmental Factors
Prisons worldwide are known for having high rates of communicable diseases, which affect both prisoners and prison staff; these rates exceed those in the general population [3, 4]. In prisons in low- and middle-income countries, various environmental factors have contributed to the breakdown of tuberculosis control specifically. Key among these are living conditions. Although precise information on prison conditions and the true burden of disease in prisons in SSA remains scarce, available data suggest that many facilities have outdated...
physical infrastructure, which leads to extreme overcrowding, limited access to clean water, poor nutrition, and substandard or nonexistent healthcare [5]. Exacerbating these conditions, as the World Health Organization (WHO) notes, conventional disease control measures are often poorly implemented, with limited isolation facilities, inconsistent screening, late case detection, and inadequate treatment of infectious individuals [6].

Poor living conditions such as overcrowding not only contribute to the risk of airborne infection (including tuberculosis) but also heighten tension among inmates, which can play a role in coerced and unprotected sex, rape, and unsafe injecting practices [5, 7]. These practices in turn fuel the risk of bloodborne and sexually transmitted infections (STIs) including human immunodeficiency virus (HIV). Several countries have documented high rates of HIV seroconversions within prisons [7], a scenario that dramatically increases the risk of tuberculosis.

HIV in Prison Settings

Another significant contributing factor to the presumed rising rates of tuberculosis in prisons in SSA is the absence of a comprehensive public health approach to tuberculosis control in this setting. The most obvious example of this has been in the systemic failure to address the growing burden of HIV in prison settings. HIV is a major predictor for tuberculosis, with HIV-positive individuals at an estimated 20 times higher risk of developing active tuberculosis during their lifetime [8]. In 2009 tuberculosis was responsible for 1 in every 4 HIV-related deaths globally [3]. In SSA, the region most affected by HIV, extraordinarily high rates of HIV have been documented in prison populations [9], including populations in South Africa (41%), Cote d’Ivoire (27.5%), and Zambia (27%). A 2009 report from Zimbabwe suggested that more than half of inmates in that country may be HIV infected [10]. In the same region, and despite an increasing number of HIV-infected individuals gaining access to antiretroviral therapy (ART), approximately 70% of inmates with tuberculosis are coinfected with HIV [11, 12]. In addition, Mycobacterium tuberculosis–HIV coinfection has been reported as a primary driver of high rates of inmate mortality [3].

Implications of Tuberculosis in Prisons

Tuberculosis in prisons not only threatens inmates and staff but also poses a threat to the general population [13]. The Baussano study estimated the fraction of tuberculosis in the general population attributable to transmission within prisons to be 8.5% (interquartile range, 1.9%–17.9%) and 6.3% (interquartile range, 2.7%–17.2%) in high- and middle- or low-income countries, respectively [14]. The lack of cost-effective, sensitive, and rapid tuberculosis diagnostic screening tools suitable for prison settings and the complex interplay among environmental, cultural, and biomedical factors, which has contributed to rising rates of tuberculosis, suggest that any redress must take into account the multifaceted nature of the problem. In this article, we identify the challenges inherent in current approaches to tuberculosis control in prisons and consider the alternatives. We argue that although improved implementation of conventional tuberculosis control activities is necessary, a more broad-reaching approach will be critical in order to tackle existing and nascent prison tuberculosis epidemics. Such an approach would require considerable investment in a range of rights-based and public health interventions as well as upgrades in clinical capacity. A successful approach should include improved infrastructure and staffing, combination prevention interventions for HIV, and the most up-to-date and sensitive tuberculosis diagnostics.

LIMITATIONS OF CURRENT PRISON RESPONSES TO TUBERCULOSIS AND HIV IN SSA

The basic components of tuberculosis care in prisons are well recognized internationally. Tuberculosis screening is recommended in prisons, and the WHO recommends entry screening for all inmates, self-referral for prisoners with tuberculosis symptoms, and mass screening in outbreak situations [6]. However, in prison facilities in SSA, multiple factors undermine the implementation of these best practices. These include weak tuberculosis screening tools, poorly coordinated and supervised prison health services, and inadequate financing, which stems from a lack of political interest in prison conditions and prisoner welfare (see also the article by Lee et al in this issue [15]).

Limitations of Tuberculosis Screening Tools

Early diagnosis of tuberculosis is essential to ensure effective treatment, avoid worsening morbidity and death, and disrupt the chain of respiratory transmission. In prisons, new inmates and those who self refer need to be rapidly screened and those found infectious triaged into isolation. Delayed tuberculosis diagnosis is an infection control risk because untreated inmates are infectious and interact with other inmates, including those who are immune compromised. Rapid, sensitive tuberculosis diagnostics are needed so that patients with M. tuberculosis–HIV coinfection can receive prompt initiation of treatment for both tuberculosis and HIV, which has been shown to improve overall mortality [16]. As in mainstream healthcare facilities in the region, however, most prison facilities in SSA are reliant on basic screening tools, including smear microscopy, chest radiography, and clinical screening. Although accepted as standard-of-care procedures, these tools are both slow and insensitive.
The absence of a point-of-care tuberculosis test, one capable of discriminating between active disease and latent tuberculosis infection, is one of the most fundamental and enduring problems of tuberculosis diagnostics.

These problems were highlighted during the recent rollout of a comprehensive tuberculosis screening program in 6 Zambian prisons, implemented from November 2010 to April 2011 as part of a TB REACH initiative [17]. All inmates entering and residing in 6 prisons were screened using digital x-ray and microscopy and culture. Among 1805 inmates screened, 17 (0.9%) smear-positive cases and 52 (2.9%) smear-negative–culture-positive cases were detected, with an additional 115 cases (6.4%) diagnosed based on symptoms and chest radiographic findings. HIV prevalence was 25.5%. Neither symptoms nor chest radiography were sensitive screening criteria. Among inmates with culture-confirmed cases, 34% were asymptomatic and 45% had a normal chest radiograph [18]. Of note, the prevalence of bacteriologically confirmed tuberculosis was 2.1% in inmates entering the prison, 2.4% among mass screenees, and 6.2% among inmates exiting, suggesting significant within-prison transmission.

**Effects of Prison Infrastructure, Funding, and Staffing Levels**

Beyond the limitations of existing screening technologies, prisons face significant environmental and logistical barriers to implementation of tuberculosis control activities. Infrastructure is outdated and rundown, and overcrowding is a common feature of prisons in SSA, creating high-risk environments for airborne infectious disease. In many low- and middle-income countries and most countries in SSA, finite national healthcare funding is typically prioritized to the general community [19], leaving little funding for prison healthcare. A lack of dedicated prison clinical staff means that care is provided by staff from nearby health centers who already have overloaded work schedules [20]. Existing prison infrastructure promotes poor infection control and provides minimal space for isolation facilities [21]. In Cameroon and Kenya, prison occupancy is >3 times greater than planned levels; in Zambia, 1 prison designed for 400 inmates currently houses 1731, and 1145 inmates are housed in a facility built for 200 [22]. Overcrowding and substandard living conditions promote epidemic disease, violence, and deterioration in mental health and can increase the risk of tuberculosis and HIV transmission among prisoners [23].

**Effects of Inadequate HIV Prevention and Treatment on the Tuberculosis Epidemic**

Many countries in SSA are experiencing a generalized epidemic of HIV infection. A study of prisons in 20 countries found an HIV prevalence ranging from 0% to 74% (median, 5.6%), with a particularly severe problem in the prisons of southern Africa where prevalences are commonly greater than 25% [9]. HIV is the major risk factor for tuberculosis and tuberculosis is the major cause of death for persons living with HIV [24]. Measures undertaken to prevent HIV transmission in prisons are thus critical to reducing incident tuberculosis in prisons. Additionally, there is potential for prisons to act as amplifiers of the HIV epidemic within the wider community, especially if persons cycle in and out of prisons frequently. For example, in facilities where a majority of inmates stay in prison for <2 years, it can be argued that the majority of cases resulting from “prison transmission” would occur not within the prison but in the community after the inmates’ release. Addressing prison epidemics is thus critical to mitigating the spread of HIV and tuberculosis in communities where prisoners return after release.

HIV transmission can occur through multiple modalities. High-risk behavior coupled with a lack of prevention tools and knowledge can result in rapid spread of HIV in prison populations. In fact, several countries have documented high rates of HIV, hepatitis C virus, and hepatitis B virus seroconversions within prisons [7]. All forms of sexual activity, especially violent forms of unprotected intercourse, are high-risk behaviors for HIV transmission [23]. Although difficult to quantify, consensual and nonconsensual (coerced) sexual activity, including rape, have been reported in prisons throughout SSA, often related to prison gangs [25]. Although underresearched in the region, injection drug use, needle sharing, and tattooing have also been recorded in prisons in SSA and similarly carry high risk of HIV and hepatitis B and C virus infections [26].

Despite overlapping individual, sociocultural, and structural risk factors for HIV transmission in prisons, prevention efforts in prisons in SSA are limited. Nominally, many facilities provide education and HIV testing. However, these services are often only available upon request from prisoners rather than offered routinely. Education is an important component but of little use if prisoners are not provided with the tools such as condoms to protect themselves, where possible, from exposure to HIV [27]. Access to ART is also limited, despite high HIV infection rates in prisons. Challenges to ART provision in prisons include lack of integration of HIV care into the existing healthcare system, staff shortages, lack of expertise, and structural barriers, which are undermined by the low political and financial priority of prison healthcare [5]. Despite these challenges, provision of ART in prisons has been demonstrated to be both feasible and effective in several settings [28].

**Lack of Tuberculosis Preventive Therapy**

In resource-rich prison settings with low tuberculosis prevalence, the use of tuberculin skin testing (TST) and isoniazid
preventive therapy (IPT) is recommended for both staff and prisoners, especially for those who are HIV infected and those in recent contact with patients with active tuberculosis [3]. Despite these recommendations, significant challenges to adherence have been identified [29]. Preventive therapy for tuberculosis is not part of current recommendations in prison settings in SSA where there is a high prevalence of tuberculosis and HIV. This is primarily due to the large number of patients with tuberculosis who have normal smears and chest radiographs, making it difficult to rule out active tuberculosis. The logistics of delivering IPT to large numbers of eligible inmates and the challenge of ensuring adherence to long-term treatment and monitoring side effects add to the difficulty of providing adequate treatment [2]. In addition, some have argued that efforts to implement IPT programs may divert limited resources away from controlling infectious cases. Although the WHO guidelines state that providing IPT does not increase the risk of developing isoniazid resistance, there are still concerns about the use of single-drug prophylaxis, especially in tuberculosis- and HIV-endemic areas [19].

**Weak Response to the Needs of Female Inmates**

Women are a minority in African prisons, making up between 1% and 7% of the total convicted population [30]. Nevertheless, female inmates in African prisons face the same overcrowding and unsanitary conditions that contribute to the spread of infectious disease and poor health among male inmates. In addition, female inmates experience unique health-related challenges, such as menstruation, pregnancy and childbirth, care of children inside and outside prison, and extreme violence and (often sexual) abuse by prison officers and male prisoners [31].

There are extremely limited data specific to tuberculosis and HIV among female inmates in African prisons, and the authors were not able to locate any literature reporting sex-disaggregated rates of tuberculosis in African prisons. However, in a review article by Dolan et al [9], HIV prevalence among female inmates was reported for Gabon (0%) and Rwanda (12.5%); a separate study in Malawi in 2005 reported that female inmates had a HIV prevalence of 50% [32]. Several reports and studies document the poor access to health services for female inmates. A recent study [31] of Zambian prisons, for example, demonstrated that access to ante- and postnatal care (free and universal to the general population) was limited or nonexistent for female inmates. This resulted in limited or no provision of HIV prophylaxis for prevention of mother-to-child transmission and was compounded by equally limited access to highly active ART and basic primary healthcare [33]. These same women were noted to be at extreme risk of being beaten by other female inmates and of sexual abuse by police and prison officials.

**EXPANDING THE RESPONSE TO TUBERCULOSIS CONTROL IN PRISONS**

Tuberculosis in the 21st century is not a stand-alone disease. It is fundamentally linked to a range of comorbidities and environmental and socioeconomic factors. Effectively tackling the rising rates of tuberculosis in prisons in SSA requires a suite of interventions underpinned by a rights-based approach to inmate welfare. Key among these responses must be an improvement in prison infrastructure to reduce overcrowding for both male and female inmates. Strengthened implementation of conventional tuberculosis control activities must therefore be combined with a long-term investment in a broad range of public health interventions, including more up-to-date and sensitive point-of-care tuberculosis diagnostics, combination prevention interventions for HIV, infrastructure upgrades, and improved coordination of healthcare service delivery. We propose possible interventions, which are described in the following paragraphs. Some interventions are standards of care and some are novel approaches that individual countries should phase in depending on available funding. Some of these novel approaches will be phased in as they become more widely available to the general public.

**Tuberculosis Control Through Improved Tuberculosis Diagnostics**

Prisons are enclosed, congregate settings, often with minimal infection control measures and few isolation procedures or facilities. Tuberculosis infection can originate within the prison or be introduced by newly arrived inmates. In either case, delayed tuberculosis diagnosis is an infection control risk. All inmates should have, as a minimum, tuberculosis symptom screening on admission to prison. Systems should also be in place to identify and investigate incarcerated inmates who develop new tuberculosis-related symptoms. Mass and routine screening is logistically difficult and expensive and is not routinely recommended [6]. In SSA, tuberculosis is often the first presentation of HIV infection, and delays in diagnosis typically result in a postponement of treatment for both tuberculosis and HIV infection [34]. As described above, recent studies have found that existing screening tools perform poorly in the prison environment with high rates of culture-positive inmates who are either smear negative, asymptomatic, or have normal chest radiographs. Early uptake of newly emerging diagnostics will be critical to tackling tuberculosis in the prison populations of SSA. One technology showing potential for speeding up screening and treatment initiation of inmates is Xpert MTB/RIF (Cepheid), which was recently recommended by WHO. This real-time polymerase chain reaction assay for *M. tuberculosis* simultaneously detects rifampicin resistance directly from sputum and provides results within 150 minutes,
rather than the up to 8 weeks required for traditional culture. Operationally, Xpert MTB/RIF technology has shown to be robust in various locales and can be used outside laboratory settings by lay staff with minimal training [35]. Further field evaluations in resource-limited prison settings are required to assess feasibility and cost-effectiveness.

Tools that are technically complicated and expensive are neither suitable nor sustainable for settings where prison financing is likely to remain limited. Before any test can be implemented, especially in the prison environment, a full understanding of the implementation barriers is required [36] (see also the articles by Schito et al and Palamountain et al in this issue [37, 38]).

### Tuberculosis Preventive Therapy

The WHO advises that tuberculosis preventive therapy be offered to prisoners living with HIV, regardless of their TST status, if they do not have current cough, fever, weight loss, or night sweats. A significant benefit of IPT has been found in persons, generally, who are TST positive, with a reduction in confirmed, probable or possible tuberculosis of 64% (relative risk, 0.36; 95% confidence interval, 0.22–0.61), and there is a nonsignificant benefit in those who are TST negative [39]. The adoption of tuberculosis preventive therapy in the prison setting will require thorough, systematic symptom screening to rule out active tuberculosis, as well as efficient systems to monitor toxicity and ensure adherence. Further research into the role of shorter combination regimens in the prison environment is required.

### COMBINATION HIV PREVENTION FOR TUBERCULOSIS CONTROL

In 1993 WHO issued guidelines on HIV infection and AIDS in prisons [40] that included the right “all prisoners have to receive health care, including preventive measures, equivalent to that available in the community.” Such measures include those taken to prevent the transmission of HIV in prisons and are critical to reducing incident tuberculosis and mitigating the spread of both diseases. Among global policy makers and programmers there is now growing recognition that no single HIV prevention strategy will control the spread of HIV. Rather, combination prevention is being promoted, which involves simultaneous use of a number of classes of prevention interventions (Table 1), each providing partial protection against HIV transmission and acquisition. Advantages of such an approach include reduced infectiousness of HIV-positive persons and strategies that reduce HIV susceptibility in the uninfected [41].

### Behavioral and Structural HIV Prevention

#### Counseling and Testing

Voluntary counseling and testing should be made freely available and provider-initiated counseling and testing should be offered at prison entry and exit and at every healthcare visit. This is especially important for patients who present with signs of tuberculosis or STIs. Prisoners’ awareness of their HIV status is the first step in prevention of transmission. For those found to be HIV infected, it allows them to seek ART and adopt safer sex practices; for those who are uninfected with HIV, it ensures awareness of the need to protect themselves.

#### Condom Provision

There is strong evidence that use of latex condoms reduces the risk of transmission of HIV, gonorrhea, chlamydia, and genital herpes simplex virus in both women and men [42]. Condoms have been highly recommended, when distributed freely and confidentially, and are being provided in many prison systems around the world [7, 43]. No prison to date has withdrawn condom distribution programs for security reasons and no adverse consequences (including an increase in sexual activity) have been linked to condom provision [7]. Despite this, in most prisons in SSA, prevention supplies including condoms are often not available to prisoners and sometimes are withheld on the basis of conflict with laws prohibiting men from having sex with men [22]. This practice contravenes prisoners’ right to be able to protect themselves and undermines HIV prevention education messages that advocate self-protection [44, 45].

#### Medical Male Circumcision

Medical male circumcision (MMC) has been shown to reduce male HIV acquisition by 50% [46] and is being successfully scaled up in many countries in SSA[47]. MMC program scale-up has started in Zambian and South African prisons, with 148 inmates in 1 KwaZulu-Natal prison [48] and 1247 inmates from 5 Zambian prisons having already undergone the procedure. MMC services in Zambia include HIV counseling and testing, provision of soap, and postprocedure reviews.

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**Table 1. Basic Framework for a Combination Response to Tuberculosis in Prisons**

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<td>Systematic tuberculosis screening</td>
<td>Rapid, sensitive point-of-care diagnostics</td>
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<td>Rapid screening tools for drug resistance</td>
<td>Provision of isolation facilities for patients and protective equipment for staff</td>
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<td>Tuberculosis preventive therapy</td>
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<th>Combination HIV Prevention in Prisons</th>
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<tr>
<td>Counseling and testing</td>
<td>Condom provision</td>
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<td>Medical male circumcision</td>
<td>HIV care and treatment</td>
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<td>Pre- and postexposure prophylaxis</td>
<td>Safe injecting and tattooing practices</td>
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**Abbreviation:** HIV, human immunodeficiency virus
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creasingly becoming the standard of care in the public sector between prisons and on discharge to the community [52].

PrEP has recently been shown to be efficacious between HIV reduce the tuberculosis recurrence rate [51]. ART is in-
64%–95%, reduce time to smear and culture conversion, and with tuberculosis has also been shown to reduce mortality by 
within 2 years of starting ART. A R Ti n i t i o ni n pa t i e n t s 
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Steps to enhance disease control in prisons. Source: Modified from TB control in prisons WHO, 2001

Tuberculosis Prevention Through Treatment for HIV Infection
Earlier ART initiation (CD4 T cell count, <350 cells/μL) may not only reduce HIV morbidity and mortality but also has the potential to improve tuberculosis control. Risk of incident tuberculosis doubles after HIV seroconversion and continues to increase as immune suppression advances. Combination ART has been shown to reduce tuberculosis incidence by 54%–92% in both developed and resource-limited settings [49, 50], with the maximum benefit seen within 2 years of starting ART. ART initiation in patients with tuberculosis has also been shown to reduce mortality by 64%–95%, reduce time to smear and culture conversion, and reduce the tuberculosis recurrence rate [51]. ART is increasingly becoming the standard of care in the public sector in most countries in SSA, and this “right” should be extended to the prison population whenever possible. Select prisons in Zambia have been offering ART through various partners, and similar services have been offered recently in South Africa. Special logistic precautions are required to ensure adherence and continuity of care when prisoners are transferred between prisons and on discharge to the community [52].

Tuberculosis Prevention Through Pre- and Postexposure HIV Prophylaxis
In view of the high risk of sexual violence and rape in prisons settings [25], postexposure prophylaxis (PEP) and preexposure prophylaxis (PrEP) are interventions that could be offered for the prevention of HIV acquisition among prisoners who are HIV negative. PEP has long been used in the community to reduce the risk of HIV acquisition after sexual or occupational exposure and includes short-course ART in individuals with significant exposure risk. Experience in an Australian prison shows that this approach is feasible but needs attention to risk assessment, provision of PEP drugs within 72 hours of exposure, adherence, and follow-up [53]. PrEP has recently been shown to be efficacious between HIV serodiscordant heterosexual couples in 2 clinical trials using a daily dose of tenofovir or tenofovir/emtricitabine [54, 55], and the Pre-exposure Prophylaxis Initiative (iPrEx) study showed a 44% reduction in HIV acquisition among men who have sex with men [56]. However, many logistical and ethical barriers must be overcome before these interventions can be implemented in the prison setting. Just as provision of ART is becoming the standard of care in the prison setting, so too will PEP and PrEP after guidelines and usage become established in the general public. Other important HIV prevention and harm-reduction interventions not discussed here include providing bleach or clean injection equipment for intravenous drug users, providing opioid substitution and other drug-dependence therapies, teaching safe tattooing practices, and making provision for conjugal visits.

MAKING PRISONERS A PRIORITY

Prison health is often dismissed or given low priority by policy makers and health programmers; prisoners are stigmatized and the public is often ambivalent about providing quality care to those accused or convicted, particularly in settings where public sector financing is limited [6]. But the high degree of mobility between prison and the community means that tuberculosis and HIV transmitted in prison can quickly become a community health issue as prisoners are released back into society, bringing with them the illnesses and behaviors generated or worsened by their incarceration. It is not simply a matter of human rights, it is a public health imperative for authorities to ensure that those imprisoned are kept in conditions compatible with good health. Moreover, serious illness that develops as a result of poor prison conditions or lack of access to appropriate medical treatment may be considered a violation of international human rights law [57].

All prisoners have the right to receive healthcare, including preventive measures, equivalent to that available in the community [58]. By its very nature, imprisonment involves the loss of the right to liberty; but this should not involve the loss of the right to physical and mental health. Safeguarding these rights protects not only the prisoner but also the community to
which he or she will return. Inmates who are HIV uninfected deserve the right to protect themselves from HIV. In an environment such as SSA, where condom provision in prison is proscribed because of laws that prohibit sexual intercourse between men, other approaches must be available to protect individuals from risks of HIV infection such as nonconsensual sexual activity.

Recently, early ART initiation (CD4 T cell count, 350–550 cells/µL) has been demonstrated to constitute a biomedical HIV prevention strategy by the HIV Prevention Trials Network 052 study, in which viral transmission between serodiscordant heterosexual couples was reduced by 96% [59]. Test-and-treat approaches have been suggested and modeled as a way to lower community viral load and treatment-as-prevention approaches have been proposed [60–62]. Encouraging voluntary and provider-initiated counseling and testing with early access to ART within the prison community has been shown to be feasible and would promote both individual health and reduce transmission.

**TUBERCULOSIS AND HIV PREVENTION: REFORM OF CRIMINAL JUSTICE SYSTEM AND PRISON LIVING CONDITIONS**

Minimum standards for prison living conditions are set by the United Nations [56, 57]. These standards are basic and essential prerequisites for the successful implementation and long-term efficacy of tuberculosis and HIV control strategies. Despite this, living conditions such as overcrowding, poor ventilation, and inadequate nutrition in many prisons in SSA continue to significantly affect the transmission of tuberculosis and HIV and subsequent morbidity and mortality. Infrastructure reforms are critically needed, because many African prisons have not been updated since the colonial era and are grossly inadequate for current prisoner numbers. However, expanding prison infrastructure alone will not offer a long-term, sustainable solution to the problem. Penal reform is fundamental to address overcrowding and its consequences, in order to control communicable diseases such as tuberculosis and HIV. Noncustodial measures, better legal representation, enhanced bail procedures instead of pretrial detention, and adapted sentencing policies are required. Comprehensive prison reforms based on international human rights standards would do much to improve living conditions and, ultimately, to reduce the spread of tuberculosis and HIV.

Although there has been a significant increase in national and international funding to control the tuberculosis and HIV epidemics, health services in prisons remain severely underfunded. Access to health care is therefore restricted because of a lack of equipment, transport, and staff, as well as infrastructure and consumables such as diagnostic materials and drugs. Prison health staff are often poorly motivated owing to low salaries, lack of appropriate healthcare training, and the infectious hazard and stigma of prison work. If governments in SSA are to tackle the dual epidemics of tuberculosis and HIV infection in prisons successfully, advocacy for prison funding needs to be addressed at the national level and greater financial and technical support from international donors must be secured to ensure conditions consistent with international standards [22]. In many low-and middle-income countries and most countries in SSA, finite national healthcare funding is typically prioritized to the general community [19], leaving little funding for prison healthcare. As some African countries enter lower middle-income status, the challenge for governments will be to prioritize spending to ensure the basic health needs of the general population while at the same time addressing prisoner needs. However adequate financing is unlikely to be prioritized until there is increased public awareness of the healthcare rights of prisoners that will protect both prisoners and society at large. Creating awareness among government leaders and policy makers about the needs and rights of prisoners should be the first step in this process.

**DESCRIPTIVE AND OPERATIONAL RESEARCH IN PRISONS**

The literature on prison conditions and burden of disease in SSA remains sparse. Further studies within prisons are urgently required to better document and understand disease burdens, epidemiology, and behavior dynamics. Inmate cohorts should be established to determine the prevalence of disease (eg, tuberculosis, HIV infection, hepatitis) on entry to the prison and then followed up for disease incidence. Most prison health data are from public health interventions or routine care and thus lack adequate detail on demographic and clinical characteristics, as well as risk behaviors and living conditions. Such detail would facilitate multilevel modeling of individual and structural characteristics associated with disease incidence and transmission. Finger-printing techniques are an additional tool that should be used to establish tuberculosis disease transmission patterns. Targeted behavioral, structural, and biomedical prevention interventions can be adopted based on results from such studies.

**CONCLUSIONS**

The United Nations states that prisoners worldwide are entitled to receive the highest attainable standard of physical and mental health [63] and to expect a standard of healthcare equivalent to that available in the nonprison community [5]. Despite this, tuberculosis disease control programs in prisons
in SSA are stunted by insensitive tuberculosis diagnostic tools and suboptimal implementation of existing guidelines. At the same time, HIV prevention and treatment programs are undermined by cultural taboos and lack of political interest, limiting prisoners’ access to proven biomedical and behavioral interventions. As a result, tuberculosis and HIV epidemics are reaching unmanageable proportions in many prison facilities in SSA, posing a potential public health threat to the wider community.

Addressing the rising threat of tuberculosis in prisons requires full and effective implementation of conventional tuberculosis control activities and the rapid uptake of new diagnostic and preventive strategies. But as a public health and human rights imperative, a full suite of HIV prevention, care, and treatment options must also be incorporated. Fundamentally, an integrated approach to tuberculosis and HIV programming that is designed to address not only the clinical but also the structural and environmental drivers of disease, such as overcrowding, will be essential to achieving durable solutions for both diseases in prison settings. Where not already included, this integrated approach should be incorporated into national AIDS strategic plans.

Ultimately, the optimal package of tuberculosis and HIV interventions for prisons will need to match the epidemiologic profile of each prison population and will require ongoing evaluation of safety, acceptability, coverage, and effectiveness. Essential to ensuring the implementation and sustained efficacy of this ambitious combination response to tuberculosis control in prisons will be sustained, high-level political support and financing.

Notes

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