

# Vaccinations in prisons: A shot in the arm for community health

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**Abbreviations:** HIPP, Health in Prisons Program; WHO, World Health Organization; IDU, injecting drug users; LGBT, lesbian, gay, bisexual and transgender; HIV, human immunodeficiency virus; HAV, hepatitis A virus; HBV, hepatitis B virus; HCV, hepatitis C virus; HTLV, human T-lymphotropic virus; MSM, men who have sex with men

From the first day of imprisonment, prisoners are exposed to and expose other prisoners to various communicable diseases, many of which are vaccine-preventable. The risk of acquiring these diseases during the prison sentence exceeds that of the general population. This excess risk may be explained by various causes; some due to the structural and logistical problems of prisons and others to habitual or acquired behaviors during imprisonment. Prison is, for many inmates, an opportunity to access health care, and is therefore an ideal opportunity to update adult vaccination schedules. The traditional idea that prisons are intended to ensure public safety should be complemented by the contribution they can make in improving community health, providing a more comprehensive vision of safety that includes public health.

## Introduction

In any prison there is usually a conflict between the objectives of safety and security, control of the prison population and public health goals. Since 1995, the Health in Prisons Program (HIPP) of the World Health Organization (WHO) has attempted to lead and guide this broad discussion between prison safety and global health, using a perspective derived from the experiences and recommendations applied in the European region. This review aims to broaden and deepen this debate,

proposing and arguing why vaccination strategies should be the spearhead of the health system within the prison system.

Prisons and Health,<sup>1</sup> a recent HIPP publication, suggests various aspects that should be considered to improve the physical and mental health of prisoners and reduce the risks of imprisonment for health and the society using a comprehensive human-rights based approach. This approach, like others, presents some inconsistencies and may not be effective in the daily health care provided to prisoners, especially with respect to the control of vaccine-preventable diseases and recommendations on vaccination schedules.<sup>2</sup>

After water purification, vaccination is probably the intervention that has most helped to improve human life expectancy.<sup>3</sup> Vaccination is a very efficacious and cost-effective intervention, as it may eliminate and even eradicate some infectious diseases. For these reasons, of all the potential health interventions in prisons, those related to vaccine-preventable diseases should be a priority. Access of prisoners to vaccination has a direct impact not only on the target population, but also the wider community.

In general, vaccine administration criteria are based on age (routine vaccination schedule) and specific risk, either individual or group (e.g., specific vaccines for people with chronic illness, vaccines for health workers). The high coverages achieved by routine vaccination result in herd immunity, which can reduce or even halt the transmission of some contagious diseases. Some specific vaccination strategies go further, requiring an active search for individuals or groups that are difficult to access and represent pockets of people at high risk for vaccine-preventable diseases or their complications. These directed interventions can significantly improve vaccination coverages compared with traditional vaccination strategies. Prisons, with a population detained in a confined space, provide a paradigmatic opportunity for vaccination interventions.<sup>4</sup>

In addition to an accessible population, prisons present an opportunity to achieve enormous benefits using a good vaccination program, mainly because this population is at higher risk of contracting diseases than the rest of the population.<sup>2</sup> The many determinants of this increased risk of acquiring infectious diseases in prisons (with a corresponding impact on the community)

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include overpopulation and overcrowding, high levels of social vulnerability and prison lifestyles, the prevalence of communicable diseases and the rotational dynamics of the prison population.

There are surprisingly few thorough reports on this topic globally, and operational research on vaccination programs and coverages in prisons is limited.<sup>5</sup> A possible explanation is that prisons were designed and structured solely to ensure public safety. This, possibly limited, idea of safety, which persists today, works against the concept that prisons could offer real opportunities to access health care and play an important role in a global, integrated strategy for reducing the incidence of vaccine-preventable diseases, both inside and outside prisons. This perspective positively extends the concept of safety.

### Importance of vaccination in prisons

From the perspective of vaccinology, prisons should be considered a public health priority for 4 main reasons (Table 1):

#### *Access to vulnerable social groups*

The prison population is mainly composed of young men from the most disadvantaged social classes and educational levels. Marginal populations are often overrepresented in prison populations.<sup>6</sup> Most prisoners make little use of national health services when at liberty.<sup>6-8</sup> Today's global mobility has increased the number of foreign prisoners. Immigrants, depending on their origin, may have different health needs from the autochthonous population, including the need for vaccination. In Spain, for example, the foreign population is 9.7% of the total, but it nevertheless represents about a third of the prison population.<sup>9</sup> Other minorities in prison, such as lesbian, gay, bisexual and transgender (LGBT) persons are particularly vulnerable groups.<sup>1</sup> Most

female prisoners are of childbearing age and 3–5% are in the gestation period, and therefore require specific care.<sup>10,11</sup>

As in the general population, the proportion of prisoners aged  $\geq 65$  y is progressively increasing and, in some cases, the increase is even higher inside than outside prison.<sup>12</sup> The aging process is accelerated in prison, i.e., chronic diseases and disabilities develop between 10–15 y earlier than in the rest of the population.<sup>1,13</sup> As a result, some criminal justice systems consider the equivalent to the medical cutoff of 65 y to be 55 or even 50 y in prisoners,<sup>14,15</sup> with the corresponding implications for vaccination policies, such as influenza vaccination.

Reports on injecting drug users (IDU) before prison admission show a high use (5% to 38%) compared with the general population.<sup>16</sup> Proportionally, 3 times as many prisoners smoke compared with the general population,<sup>17</sup> and prisoners have a higher rate of alcohol abuse.<sup>18</sup> A study from the US showed that prisoners had a higher prevalence of hypertension, diabetes, myocardial infarction and asthma than age- and sex-matched people outside prison.<sup>19,20</sup> The prevalence of female prisoners with abnormal cervical cytology is much higher than in the general population.<sup>11,21</sup> Deaths from lung cancer, non-Hodgkin lymphoma and liver cancer are more common in inmates compared to the general population.<sup>22,23</sup>

Unsurprisingly, rates of tuberculosis in prisons may exceed rates in the community by 5 to 70 times.<sup>2,24,25</sup> US studies suggest that 25% of HIV-infected individuals<sup>26,27</sup> and 40% of chronic carriers of viral hepatitis have been incarcerated.<sup>27</sup> Studies show the prevalence of hepatitis C virus (HCV) infection in prisoners is more than 10 times higher than that of the general population.<sup>28-33</sup> The prevalence of hepatitis B virus (HBV) infection is between 1.8 and 62%, and is higher than that of the general reference population in all studies (Fig. 1).<sup>30,31,34-42</sup>

These clinical and social factors describe a population that could benefit from various vaccination strategies: prisoners whose lifestyle before imprisonment makes them more susceptible to acquiring vaccine-preventable diseases with potentially severe complications and even death.

#### *Prisoners are at high risk of vaccine-preventable diseases during imprisonment*

It is estimated that approximately 30% of prisoners are sexually active in prison, and most will not use methods that minimize the risk of the sexual transmission of diseases.<sup>43,44</sup> Surveys in Welsh prisons show 14% of prisoners were men who have sex with men (MSM) and, of these, 20% had sex with men only during their period of incarceration.<sup>45</sup> In addition, a considerable proportion of sex in prison is non-consensual and, therefore, violent. US studies have shown a rate of rape of 3–5% in male prisoners.<sup>46</sup> The true figures are probably higher, and in some groups, such as LGBT, the rates are up to 10 times greater.<sup>1,47</sup> It is also estimated that the prevalence of physical violence, not necessarily sexual, is much greater in prisoners.<sup>1,48</sup>

Tattooing and piercing are prevalent in prisons and are closely linked to prison sub-cultures: 53% of UK prisoners have a tattoo, of which the tattooing occurred in prison in 11%. Due to the

**Table 1.** Importance of vaccination in prisons

#### **Access to vulnerable social groups**

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Groups with little normal access to the health system
Prisoners come from disadvantaged social strata (educational and socioeconomic level)
Greater history of illicit drug use before entering prison
Greater history of alcohol abuse
High prevalence of carriers of communicable diseases and other morbidities
Overrepresentation of especially-vulnerable groups: LGTB, sex workers, immigrants
Progressively greater proportion of elderly adults
High risk of acquiring infections in prison
Sexual activity, often unprotected, in prisons
High rate of starting or returning to illicit drug use (injectable and non-injectable)
Tattoos / piercings
Physical violence (injuries, rapes)
Permanent contact with the community
High rotation rates in prison (short sentences, transfers)
Visits/ staff/ temporary release
High risk of extreme behavior in the first weeks after release (drug abuse)
Prison population is known and concentrated in one place
Population identified and easily located

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LGBT: gay, lesbian, transgender, bisexual.

scarcity of sterile equipment, inadequate instruments, with an increased risk of disease transmission (guitar strings, clips, nails), are often used.<sup>49-51</sup> According to studies analyzing self-reported attitudes, the prevalence of illicit drug use in prisons varies between 22 and 48% worldwide, and IDU is between 6 and 26%, with 25% of IDU being initiated in prison.<sup>40,52-54</sup>

The structural and logistical instability of many prisons worldwide, an increasingly precautionary penal system with progressive overpopulation and overcrowding, poor ventilation in cells, the lack of sanitation and hygiene, poor food quality, limited availability of health care, etc.,<sup>55</sup> are additional risk factors for greater transmission of vaccine-preventable diseases. In addition, these conditions often violate fundamental human rights.<sup>1</sup>

Of the high incidence of new cases of vaccine-preventable diseases in prison, a significant fraction should be considered attributable to the persistence of endemic diseases or the development of epidemics in the community.<sup>24</sup> (Fig. 2).

#### *Prisoners are in constant contact with the rest of the community*

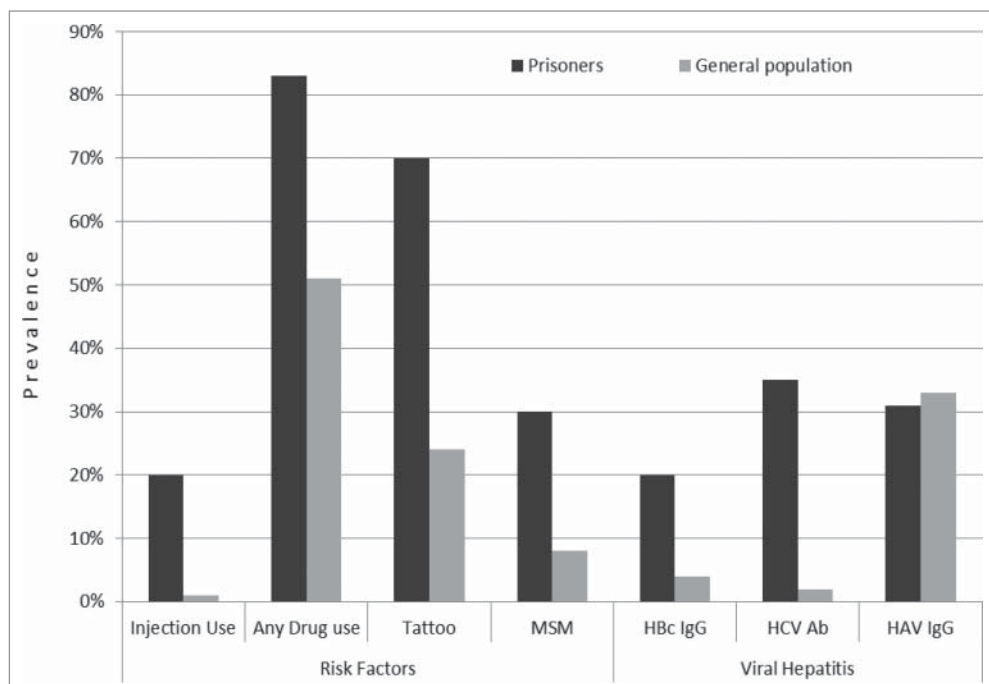
Although prisons are closed institutions, inmates are in frequent contact with the community. Prison staff, visitation rights, day leave and other “privileges” allow inmates access to the rest of the community, with which it interacts. In addition, many sentences are relatively short and almost all the prison population will, at some point, be reintegrated into society. The annual flow or rotation of prisoners can be 5 times higher than the total permanent prison population,<sup>56,57</sup> which is an indirect indicator of the close interaction between prisoners and the rest of society. Moreover, the highest frequency of risk behaviors such as drug abuse are reported in the first 3–4 weeks after release.<sup>58</sup>

#### *Prisoners are accessible and susceptible to vaccination*

Theoretically, prisoners’ access to vaccination should be simple. Prisoners are an identified, recorded, defined and easily-accessible population and this should ensure high vaccination coverages with satisfactory health outcomes in prisons.<sup>4,59</sup>

#### **Biological risks in prison and recommended vaccines**

Despite regional epidemiological characteristics (e.g., higher seroprevalence of HTLV I/II or *Trypanosoma cruzi* in Brazilian prisons,<sup>60</sup> and a higher prevalence of intestinal parasites in



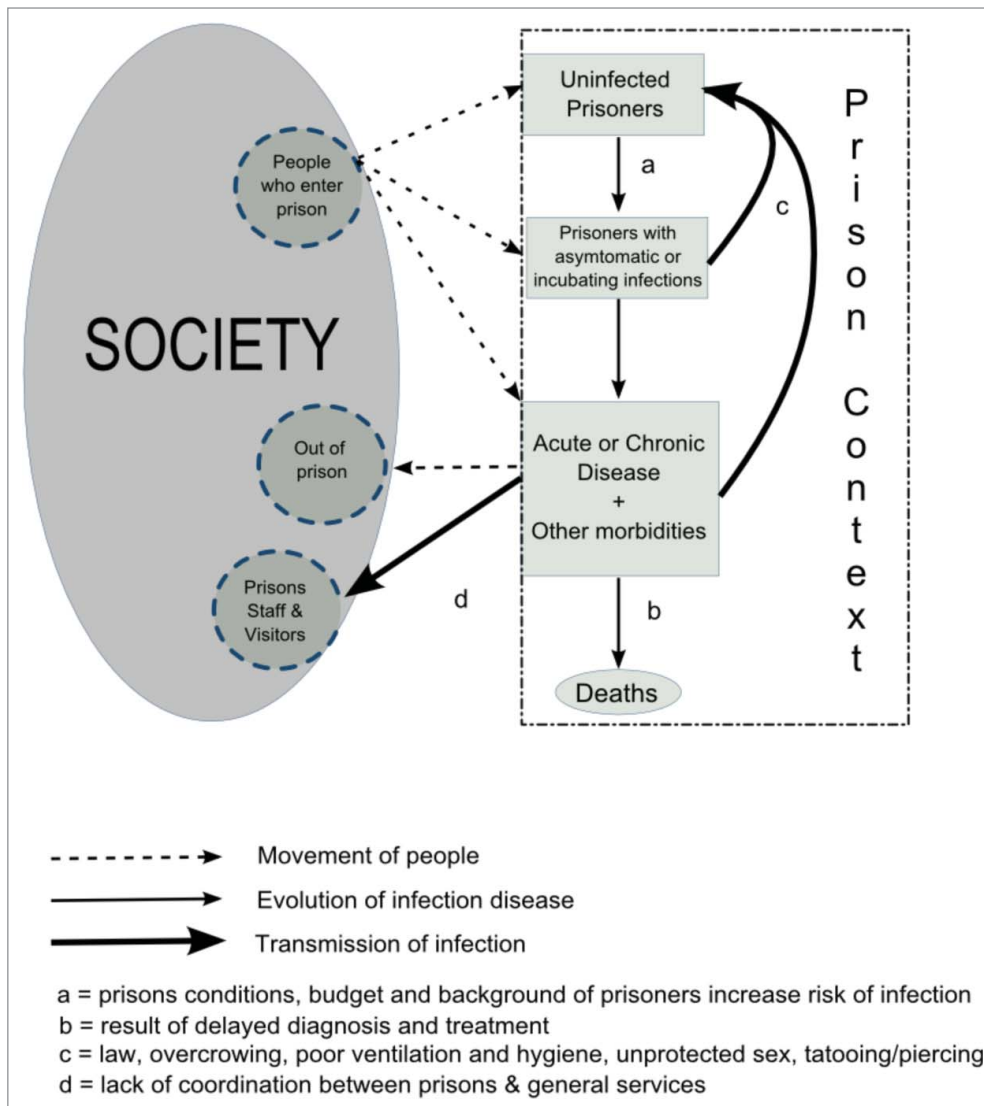
**Figure 1.** Comparison of US estimates of lifetime prevalence (%) of viral hepatitis risk factors and seroprevalence of hepatitis A, B and C virus exposure in inmates vs. the overall population 2009. HbC IgG, IgG antibody to hepatitis B core antigen; HCV Ab, antibody to hepatitis C Total virus. HAV IgG, IgG antibody to hepatitis A. MSM, men who have sex with men. Figure modified from “Viral hepatitis in incarcerated adults: a medical and public health concern,” by Hunt, DR & Saab S.<sup>44</sup>

Ethiopian prisoners<sup>61</sup>) most of the biological risks to which prisoners and prison staff are exposed are quite similar throughout the world (Table 2). In the following paragraphs, we describe evidence on vaccination and current recommendations for prisons, accompanied by an epidemiological overview of disease inside and outside prison (Tables 3 and 4).

#### **Hepatitis B**

Currently, 240 million people worldwide suffer from chronic hepatitis B,<sup>62</sup> which caused 786,000 deaths worldwide in 2010. The prevalences documented in prisons are always higher than in the general reference population,<sup>19,63</sup> with IDUs having the highest risk. Data on the prevalence of HBsAg vary by region (Table 3).<sup>31,34,35,42,64-71</sup> Whether due to the progressive introduction of routine vaccination of younger cohorts or to the longer exposure time, the disease prevalence is usually greater in older adults.<sup>40</sup>

Although HBV vaccination has been recommended since 1982 in prisons, the proportion of susceptible individuals is still higher than is acceptable and, in countries like France and the US, barriers to the correct implementation of recommendations have only been overcome in the last decade.<sup>72,73</sup> In middle- and low-income countries, HBV vaccination is far from routine. It has been shown that, for every dollar invested in HBV vaccination, \$2.13 is saved in later treatment and care costs.<sup>74</sup> Current recommendations may vary and should be adapted to the capabilities of the prison; ideally, all new prisoners who are not immune or whose serology



**Figure 2.** Transmission of communicable diseases inside and beyond prisons. Figure modified from Guidelines for the Control of Tuberculosis in Prisons, WHO 1998.<sup>153</sup>

is unknown should be vaccinated.<sup>1,75</sup> HBV serology testing is recommended since the identification of chronic carriers is another determining factor in controlling the disease. If all prisoners cannot be vaccinated, priority should be given to those with known risk factors, such as IDUs, prisoners with chronic diseases, and risk populations such as immigrants or indigenous people, among others. The rapid (0, 1 and 2 m) and extra-rapid (0, 7 and 21 days) schedules facilitate adherence and compliance, and have been shown to provide optimal seroprotection.<sup>76,77</sup>

### Hepatitis A

According to global estimates, there were 126 million acute cases of hepatitis A, and 35,245 deaths in 2005.<sup>78,79</sup> Few outbreaks have been described in prisons, although outbreaks are increasing in IDUs and MSM.<sup>52,80-85</sup> In Italy, Rapietta et al<sup>81</sup> observed a prevalence of HAV antibodies in 86.4% of prisoners, which was higher in foreign prisoners (92.1%), of whom none

reported being vaccinated. In the US, the reported prevalence of past HAV infection was 22% to 39%, comparable to the general population.<sup>86,87</sup> The prevalence of HAV antibodies in Luxemburg was 57.1% and 65.9% in IDUs versus non-IDUs, respectively.<sup>85</sup>

HAV vaccination is recommended for all new prisoners with an unknown immune status and those who are unvaccinated.<sup>1,2</sup> Previous serology testing is less important because HAV infection is a self-limiting disease without chronic carriers. If all susceptible prisoners cannot be vaccinated, they should be prioritized according to age, origin and risk factors (IDUs, MSM and hepatic risk factors).<sup>87,88</sup> For HAV vaccination alone, the recommended schedule is 0 and 6 months, although the accelerated (0, 1, 2 m) and rapidly-accelerated (0, 7, 21 and 1 year) HAV/HBV schedules have also been used.<sup>89,90</sup> If accelerated schedules are used, it is important to administer as many doses as possible, as one dose of HAV vaccine (> 90% of immunogenicity) alone gives more protection than one dose of the combined HAV/HAB vaccine. The administration of combined schedules is also more complex.<sup>86,91</sup>

### Tetanus/diphtheria/pertussis

Globally, the 1989 WHO neonatal tetanus elimination program resulted in a reduction in new cases of 92% by 2008.<sup>92</sup> A total of 4,680 (2013) cases and 2,500 deaths due to *C. diphtheria* were reported in 2011.<sup>93</sup> A total of 136,000 cases of pertussis were reported in 2013, and 89,000 deaths were reported in 2008.<sup>94</sup> There is little data on the coverage of the combined vaccine in prisons. A seroprevalence study in a Canadian prison found 49% of inmates were incompletely vaccinated.<sup>95</sup>

The recommendations are similar to those for the general population: people in whom prior vaccination cannot be proven should be vaccinated at 0, 1 and 6–12 months, and people not vaccinated for 10 y should receive a booster dose.<sup>75,96</sup>

### Pneumococcal disease

In 2005, 1.6 million people died from pneumococcal disease.<sup>97</sup> The prevalence in prisons is unknown and few outbreaks have been reported.<sup>98,99</sup> Despite this lack of data, the high



**Table 2.** Biological Hazards Prison

Transmission by serum
HIV
Hepatitis B*
Hepatitis C
Respiratory transmission
Tuberculosis*
Influenza*
Measles*
Mumps*
Rubella*
Meningococcal infection*
Pneumococcal infection*
Enteric transmission
Hepatitis A*
Transmission by contact
Herpes simplex
Varicella Zoster*
Scabies
Viral conjunctivitis
HPV*
Diphtheria*
Tetanus*

\*Vaccine available.

burden of non-communicable diseases — of which chronic lung disease is one of the most frequent — is an important risk factor for invasive pneumococcal disease (IPD).<sup>1,100</sup> The risk of IDP in some prisoners, such as those infected with HIV or splenectomized is about 100 times higher than in healthy prisoners, and therefore pneumococcal vaccination should be routine in prisons.<sup>101</sup> The current recommendation is that prisoners aged  $\geq 65$  y and those with risk factors should be vaccinated.<sup>1,75</sup> The recent availability of the 13-valent pneumococcal conjugate

vaccine (PCV13) in adults is an option that provides more-efficient protection.<sup>102,103</sup>

### Seasonal influenza

Global estimates suggest annual seasonal influenza epidemics result in approximately 3 to 5 million cases of severe illness and 250,000 to 500,000 deaths. Many seasonal influenza outbreaks have been reported in prisons.<sup>104-109</sup> James et al.<sup>110</sup> studied influenza outbreaks in 43 closed institutions (8 prisons) in the last 120 y in the UK, and found an attack rate of 3% to 69%. Seasonal influenza vaccination in prisons has long been rejected, although it has often been used for secondary prevention in the event of outbreaks.<sup>111,112</sup> The influenza A (H1N1) pandemic in 2009 may have acted as an important stimulus for organizations like the CDC and the UK Health Protection Agency to introduce vaccination for primary prevention in prisons, as coverages in US prisons were  $<50\%$  in 2009.<sup>113</sup>

All prisoners and staff should receive the seasonal influenza vaccine before the virus becomes active in the community, instead of just vaccinating people aged  $>65$  y.<sup>1,2</sup>

### Mumps, measles and rubella

The disease burden of these 3 diseases is higher in children, although it is more severe in adults.<sup>114</sup> Larney et al. studied the susceptibility of new prisoners in 7 Australian prisons; 41% were susceptible to mumps, 16% to rubella, 13% to measles and 10% to varicella, similar to the general population.<sup>37</sup> In Switzerland, susceptibility to mumps was low (6%) in immigrant prisoners.<sup>115</sup> In a Canadian correctional facility, 2% of young people were susceptible to one of the 3 viruses.<sup>95</sup>

Outbreaks have been described in prisons,<sup>116,117</sup> but have declined significantly since the introduction of routine vaccination.

**Table 3.** Prevalence of Hepatitis B in prison

Country (reference)	City, State or Region	Survey year	Prisons	Population	Seroprevalence (%)
Australia (35)	New South Wales, Queensland, Tasmania and Western Australia	2004, 2007, 2010	29	1388 914(IDUs)	2.3% 3.1%(IDUs)
Brazil (68)	Goiás (State)	2007–08	1	150	0.7% – 1.3%
Brazil (69)	Sao Pablo (State)	2003	1	333	2.4% – 1.2%
Croatia (65)	All country	2005–2007	20	3290	1.3%
England and Wales (66)	Different regions	1997 – 98	8	3930 775 (IDUs)	8% 20%(IDUs)
Ghana (70)	Different regions	2004–05	8	1366	25.5%
Hungary (41)	All country	2007–09	20	4894	1.5%
Iran (64)	Isfahan	2009	2	970 (IDUs)	3,3% (IDUs) 13,9% (IDUs)
Mexico (67)	West central Mexico	2007	1	30	20%
Nigeria (71)	Nasarawa (State)	2007	4	300	23%
Pakistan (34)	Karachi	2007–08	1	357	5.9%
Spain (31)	All country	2008	18	342	2.6%
USA (42)	Different States	Studies between 1975 and 2005	25	nd / meta-analysis 23 studies	0,9% – 8% 6,5% – 42%

EEUU: United States of America. IDUs: prevalence among injecting drug users. HbsAg=hepatitis B surface antigen; Hbc IgG=IgG antibody to hepatitis B core antigen.

\* = hepatitis B surface antigen (HbsAg).

\*\* = IgG antibody to hepatitis B core antigen (Hbc IgG).

\*\*\* = HbsAg plus Hbc IgG positives. nd = no data.

**Table 4.** Summary of Strategies and Recommended Guidelines

Vaccine	Recommendations/Strategies	Schedules	Comments
Hepatitis B	All new inmates with negative or unknown serology. New inmates with risk factors: IDUs, chronic disease, MSM, mental illness.	Normal: 0, 1 and 6 months Accelerated: 0, 1, 2 and 12 m Rapidly-accelerated: 0, 7, 21 d and 12 m	Previous serology recommended.
Hepatitis A	All new inmates with negative or unknown serology. New inmates with risk factors: IDUs (pre-serology not necessary), MSM and hepatic risk factors.	HA: 0 – 6 months HAV/HAVB: 0, 1, 2 and 12m HAV/HBV: 0, 7, 21 and 12 m	Evaluate age and place of origin.
Tetanus/diphtheria	Prisoners without demonstrated history of vaccination.	0, 1 and 6–12 months (Td)	Evaluate vaccination if there are lesions.
PCV13* and PPSV23**	All new inmates with last dose > 10 y ago. Prisoners aged more than 65 y* Prisoners aged more than 18 y with baseline pathology included in recommendations***	1 booster dose (Td) 0 (PCV13) and 6–12 months (PPSV23). If previous PPSV23, PCV13 > = 1 y* 0 (PCV13), PPSV23 minimum of 8 weeks later**	Two doses of VP23 recommended in specific risk groups**
Seasonal influenza	All new inmates	One annual dose during influenza season.	
Mumps, measles and rubella	Risk groups: > 65 years, pregnancy, chronic medical condition or immunosuppression All new inmates with negative or unknown serology.	History of childhood vaccination: 1 dose. No history of vaccination: 0, 1 month.	
Human papilloma virus	Women of child-bearing age. Women with no history of vaccination or incomplete vaccination.	0, 1–2 and 6 months	Prioritize persons aged less than 26 y Upper limits vary by country***
Meningococcal C	Inmates aged less than 26 y	1 doses	
Varicella	Prisoners with proven history of vaccination. Prisoners who remember receiving one dose.	0–4,8 weeks One booster dose	

IDUs: injecting drug users. **MSM**: Men who have sex with men. **HAV**: Hepatitis A virus. **HBV**: Hepatitis B virus. **PCV13**: 13-valent pneumococcal conjugate vaccine. **PPSV23**: 23-valent pneumococcal polysaccharide vaccine.

\*CDC 2014 recommendations.<sup>102</sup>

\*\*See risk groups: CDC 2012.<sup>103</sup>

\*\*\*WHO 2014: recommends an upper age limit of age of 26 y.<sup>122</sup>

Susceptibility studies in prisoners provide similar results to those of the general population, and there is limited knowledge of the history of vaccination in prisoners who have suffered these diseases. These records are critical because true herd immunity requires high coverages (95% for mumps).<sup>118</sup> The ideal recommendation would be to vaccinate all new prisoners who are susceptible or whose immune status is unknown.<sup>175</sup> If selective vaccination is the option chosen, women of childbearing age, the country of origin and age according to the dates of routine introduction of the vaccine in different countries could serve to select priorities. The regimen is 2 doses at 0 and 1 months. If childhood vaccination without information on the current immune status is reported, one dose of vaccine should be administered.<sup>75</sup>

### Human papillomavirus

Globally, in 2010, the estimated prevalence of human papillomavirus (HPV) infection in women with normal cytological findings, was 11.7%, with a peak in women aged < 25 y (21.7%).<sup>119</sup> The prevalence of HPV in males is less homogeneous, varying from 49.4% (HIV-) and 78.2% (HIV + 78.2%) in sub-Saharan Africa<sup>120</sup> to 1% to 84% in the EU and 2% to 93% in the US in groups at low and high risk of HPV, respectively.<sup>121,122</sup> A study of 190 female prisoners in the Amazon region of Brazil found a prevalence of 10.5%.<sup>123</sup> In Taiwan, the prevalence in 150 female prisoners was 55.4% (47.4% in HIV- and 63.9% in HIV + ).<sup>124</sup> In Mexico, the prevalence was 20.7% in 82 prisoners.<sup>125</sup> In Spain, a prevalence of HPV of between 27.4% and 46% of female prisoners was recorded.<sup>126,127</sup> These prevalences are higher than in the general population of the respective countries.

Since its approval, the HPV vaccine has been used in some juvenile detention centers in the UK and USA.<sup>128,129</sup> Henderson et al.<sup>128</sup> described its use in US prisons, and found that lack of knowledge about the vaccine and the short period in prison were the main barriers to successful vaccination. New female prisoners are at high risk for HPV and cervical cancer,<sup>130</sup> and vaccination should be initiated or completed, although the recommended upper age limits for vaccination vary between countries. Prioritization of immunocompromised subjects may be appropriate. For male prisoners, vaccination is not a priority,<sup>122</sup> but MSM and immunocompromised subjects should receive special attention.<sup>131</sup> The normal schedule of 0, 1–2 and 6 months is recommended.

### Meningococcal meningitis

There is no reliable estimate of the global disease burden. The greatest age-adjusted incidence rate is found in the African meningitis belt.<sup>132</sup> Of the 12 serogroups identified, 6 can cause outbreaks (A, B, C, W, X and Y), and these have a very-specific geographical distribution. Some outbreaks have been reported in prisons.<sup>133–135</sup> In the UK, one dose of meningococcal C conjugate vaccine is administered to prisoners aged <25 years,<sup>75</sup> identical to the policy in the general population.

### Varicella

The global disease burden is about 4.2 million severe complications and 4,200 deaths annually.<sup>136</sup> There is a high risk of transmission and outbreaks in prisons,<sup>2,75</sup> even when the percentage of susceptible inmates is low. In an outbreak in a California prison, 2% of exposed prisoners were susceptible.<sup>137</sup> In Switzerland, 12.7% of prisoners were susceptible, with immigrants having a risk nearly 6-fold greater than the general population.<sup>138</sup> In an Italian prison, the susceptibility was 14.5%.<sup>139</sup> In a global seroprevalence study in an Australian prison, 10% of prisoners were susceptible.<sup>37</sup>

There are few recommendations on the use of the varicella vaccine in prisons: some indicate serological screening and vaccination of all non-immune prisoners, in order to reduce the potential risk of outbreaks.<sup>2,140</sup> General vaccination is also recommended for new prisoners if an outbreak is suspected.<sup>141</sup>

### Tuberculosis

The overall prevalence of tuberculosis (TB) in 2013 was 159 cases per 100,000 population, with an incidence of 126/100,000 and a mortality of 16/100,000.<sup>142</sup> More than one million incident cases had HIV. In some countries, the incidence in prisons is up to 100-fold that of the general population.<sup>143</sup> A systematic review by Baussano et al.<sup>24</sup> estimated a mean annual incidence in prisons of 237.6 (interquartile range (IQR): 156–639) cases per 100,000 people and 1,942 (IQR: 1,045–2,778) per 100,000 in high and medium-low income countries, respectively. In a WHO literature review, prisons from Russia (4,560 per 100,000) and Georgia (5,995 per 100,000) had the highest prevalence rates, followed by some African countries.<sup>144</sup> The BCG vaccine is currently only recommended in children born in countries with a high disease burden and medical personnel in close contact with cases of TB, especially multi-resistant bacilli.<sup>145</sup> The vaccine is not indicated in specific prevention programs in prisons due to its lack of efficacy in preventing TB in adults.<sup>1,146</sup>

### Concluding remarks

The vast majority of epidemiological data on vaccine-preventable diseases and the use of vaccines in prisons comes from studies in high-income countries, where prison health programs are more developed and recommendations take into account the particularities of the respective population. Prison conditions in medium-low income countries are generally worse, the risk for vaccine-preventable diseases is much higher, and the scarcity of resources makes the application of new vaccines, such as conjugate vaccines, which are usually more expensive, more difficult. The prison population and the proportion of elderly persons within it are increasing worldwide, pushing up global incarceration costs. The case of the US is the prototype of this problem; the American penal system costs more than 74 billion dollars per year, eclipsing the GDP of more than 130 countries.<sup>147</sup> Addressing these high costs with a model of healthy prison initiatives such as vaccination — although this would involve further investment — would generate indirect savings for the health system and have a positive impact on overall welfare. However, there are few available studies on the cost-effectiveness of vaccination in

prisons and the performance of their health systems. No study has evaluated the introduction of an integrated prison vaccination program. This is an important research gap that could potentially aid decision making. Most studies focus on a single vaccine, mainly hepatitis B vaccine.<sup>74,91,115</sup> Jacobs et al.<sup>91</sup> examined the cost effectiveness of substituting bivalent hepatitis A/B for the hepatitis B vaccine in US prison inmates, and state rates of hepatitis A. In states with high rates of hepatitis A (200% the national average) introduction of hepatitis A/B vaccination would prevent 466 hepatitis A infections, 60 hospitalizations, 1.6 premature deaths, and the loss of 28 life-years (\$ 22,819 per life-year saved). In states with lower rates (100–200 and <100%) the cost-effectiveness would be \$ < 0 and \$ 2,131 per life-year saved, respectively. This could help reduce morbidity and mortality, therefore reducing costs. A study in a Swiss prison calculated the reduction in costs due to measles vaccination in accordance with origin and age. It was estimated that 35 % of inmates were susceptible to measles and required vaccination. This approach achieved a reduction of 62% in vaccinations in 3,000 prisoners yearly, resulting in annual cost savings of € 72, 000. The high cost of potential outbreaks was an important issue also taken into account.<sup>115</sup> Likewise, there are few studies of the situation of female, elderly or mentally-ill inmates. In the context of prisons, it is imperative to agree on whether vaccination strategies should lower the age cut-off for considering a patient as “older” from the normal 65 y to 50 or 55 years, and to integrate current vaccination recommendations to this effect in the specific case of prisoners (Table 5).

The complexity of the prison context in countries or regions makes it impossible to make general “one-size-fits-all” recommendations. The first major step recommended is that the prison system delegates the responsibility and authority for prisoner’s health care to the health system, because this is part of public health.<sup>148,149</sup> This would guarantee the right to primary health care for every prisoner: in many cases this might be a first contact with the health system. Providing healthcare access to prisoners helps reduce inequalities outside prison and facilitates reintegration. Vaccines should be the spearhead of a comprehensive approach based on primary care. First, updating of the vaccination of healthy adults should be ensured (Table 6). Secondly, access to other vaccines according to individual risk should also be ensured. Thirdly, vaccines should be offered

**Table 5.** Research gaps: improving the introduction of prison vaccination programs

1	Cost-effectiveness assessments of integrated vaccine program introduction
2	Health technology assessment of prison vaccine program introduction Promotion of reports on prison vaccination with a focus on developing countries
4	Promotion of studies on the implementation of vaccination in female prisons
5	Gender studies on vaccination in prisons
6	Research on elderly prisoners and the impact of vaccines in this group
7	Research on the impact of vaccines on mentally-ill inmates

**Table 6.** Recommended steps to ensure vaccination schedules in prisons

Integration of health services with the prison system	1	The authority and responsibility for health care in prison lies with the health system
	2	Ensure the integration of prisons with other community health services
Application of a vaccination schedule	3	Ensure compliance with the vaccination schedule for healthy adults
	4	Ensure access to vaccination of persons with specific risk factors (HIV, HCV, MSM)
	5	Establish vaccination priorities for each prison according to identified epidemiological factors and local resources
	6	Evaluate strategies (coverage, adherence, follow up outside prison)

according to agreed criteria based on local epidemiological data and the availability of funds. Prison staff should receive the same treatment. Thereafter, it is essential to evaluate the quality of the strategies introduced. In the UK, one indicator of the quality of care in prisons is that 80% of prisoners should be vaccinated against hepatitis B during the first 3 months of imprisonment.<sup>150</sup> It is debatable whether offering vaccination immediately upon imprisonment is the best strategy, since the psychological burden felt by new inmates might not provide the optimum frame of mind, could be an obstacle to compliance with the recommended immunization schedule, and might lead to rejection of the first dose or result in incomplete vaccination. Prisoners may be less likely to reject vaccination if this is offered within an integrated health care policy. Therefore, ideally, vaccination of prisoners should not be automatic, but should be integrated into an approach that shows respect for people and their rights. Moreover, refusal to vaccinate may be due to misinformation, poor knowledge of the vaccine, and fear of needles or adverse reactions. Peer educators can play a vital role in educating other prisoners about vaccine acceptance. Peers may be the only people who can speak candidly to other prisoners about ways to reduce the risk of contracting infections. Peer-led education has been shown to be beneficial for peer educators themselves: individuals who participate as peer educators report significant improvements in self-esteem.<sup>6</sup> However, as with other educational programs, preventive education between peers is difficult when prisoners have no means to adopt the changes that would lead to healthier choices. Peer support groups need to be adequately funded and supported by staff and prison authorities, and have the trust of their peers, which can be difficult when the prison system appoints prisoners as peer educators because it trusts them, rather than because the prisoners trust them. However, the main reported barrier to achieving complete vaccination schedules remains the high turnover and dynamics of prisoners.<sup>151,152</sup> The full integration of the prison health system should strengthen infection control in prisons and



facilitate monitoring of vaccinations and other treatments after the prisoner is released.

Such policies would make it easier to prevent vaccine-preventable diseases in prisoners, prison staff, families and the community in general, and offer benefits to national health systems,<sup>153</sup> as they would ensure that the prisoners would no longer be a pocket with a high burden of communicable diseases. Therefore, locally-agreed vaccination programs in prisons, based on reported evidence, are essential. Prisoners may suffer the loss of liberty but should not be punished by disease. Healthy prisons result in healthier communities, and vaccines are an essential tool in achieving this goal.

### Article search criteria

We searched Medline/Pubmed for articles from the last 10 years, except for diseases where little data is available, where no time limits were set. The search terms included the MeSH terms (\*correctional OR prison\* OR jail\*) and, for

each vaccine-preventable disease of interest (infection OR infections/epidemiology OR infection OR infections/prevention and control). The references of publications located were scrutinized and relevant articles included. The gray literature, guidelines and reports of public health agencies included were identified through the Google advanced search engine. English, Spanish and Portuguese language texts were included. In the text, the term “prison” refers to all types of institution authorized by a country in which detainees are held.

### Disclosure of Potential Conflicts of Interest

JMB has collaborated in educational activities supported by GlaxoSmithKline and Sanofi Pasteur MSD, Novartis and Pfizer, and has participated as an investigator in clinical trials sponsored by GlaxoSmithKline and Sanofi Pasteur MSD. The remaining authors report no conflict of interest.

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