



Screening for hepatitis B virus and accelerated vaccination schedule in prison: A pilot multicenter study



Cristina Stasi^{a,b,*}, Mirko Monnini^a, Valerio Cellesi^c, Marco Salvadori^d, Daniele Marri^e, Mateo Ameglio^f, Andrea Gabbuti^g, Teresa Di Fiandra^h, Fabio Voller^a, Caterina Silvestri^a

^a Observatory of Epidemiology, Regional Health Agency of Tuscany, Florence, Italy

^b Department of Experimental and Clinical Medicine, University of Florence, Florence, Italy

^c Prison Healthcare of Volterra, Local Healthcare Tuscany North West, Volterra, Italy

^d "Sollicciano" District House, Local Healthcare Tuscany Centre, Florence, Italy

^e Infectious Diseases and Hepatology Unit, University Hospital of Siena, Siena, Italy

^f Departmental Operational Units in Prison, Local Healthcare Tuscany Southeast, Colle Val D'Elsa, Siena, Italy

^g Infectious Diseases Unit, Local Healthcare Tuscany Centre, Firenze, Italy

^h General Directorate for Health Prevention, Ministry of Health, Rome, Italy

ARTICLE INFO

Article history:

Received 4 October 2018

Received in revised form 23 January 2019

Accepted 28 January 2019

Available online 4 February 2019

Keywords:

Hepatitis B virus infection
Screening
Vaccination
Prison

ABSTRACT

Background and Aim: Vaccine against hepatitis B virus (HBV) is highly effective in preventing HBV infection. The aims of this study were to (1) increase the epidemiological knowledge on the impact of HBV in Tuscany region prisons by registering the results of serum screening on a clinical medical record and (2) increase the anti-HBV vaccination using an accelerated schedule.

Methods: Our study population was composed of all detainees present in prisons and all constrained from freedom or at institutions in the Tuscany region and not vaccinated at these facilities from 1 December 2016 to 31 May 2017.

Results: Of 17 detention facilities in the Tuscany region, 15 were enrolled in the study. On 28 February 2017, there were 3068 detainees present in these institutions. Considering the 1075 subjects screened for HBV serum markers, 730 (67.9%) were susceptible to infection and needed to be vaccinated. Five hundred and ninety-six agreed to be vaccinated (82%); 27 (2.5%) of our subjects had an isolated anti-HBc, 20 (1.9%) were HBV infected (HBsAg+), 127 (11.8%) had previous HBV infection (anti-HBs+, anti-HBc+ and HBsAg–), and 171 had been previously vaccinated. Five hundred and fifty-five inmates (95.1%) received the first vaccine dose, and 404 (83%) underwent the third dose at day 21.

Conclusion: This study showed that of a high percentage of subjects who underwent screening, more than half needed to be vaccinated. Moreover, our study reached very high levels of vaccination coverage, considering both the entire enrolled population and the new inmates.

© 2019 Elsevier Ltd. All rights reserved.

1. Introduction

The hepatitis B virus (HBV) vaccine, available since 1982, has shown high efficacy in the prevention of HBV infection (95%), as well as in the prevention of chronic liver disease, cirrhosis, and HBV-related hepatocellular carcinoma [1].

In European Union, routine childhood vaccination is carried out in 20 (74%) of the 27 countries: Belgium, Bulgaria, Czech Republic, Cyprus, Estonia, France, Germany, Hungary, Ireland, Italy, Malta,

Latvia, Lithuania, Luxembourg, Portugal, Romania, Slovakia, Slovenia, Spain, Poland. In 12 of these countries (60%) – Belgium, Cyprus, Estonia, France, Germany, Italy, Malta, Latvia, Lithuania, Romania, Poland and Luxembourg – vaccination is scheduled not only in childhood but also in adolescence. In Italy, for example, since 1991, vaccination has been provided for all new-borns and until 2003 (12 years after the mandatory vaccination), it was also provided for adolescents at age 12. Seven European countries (26%) are not included in the mandatory vaccination schedule but have a specific vaccination program for those at risk: Denmark, Finland, Iceland, the Netherlands, Norway, Sweden, and the United Kingdom [2].

* Corresponding author at: Department of Experimental and Clinical Medicine, University of Florence, Florence, Italy.

E-mail address: cristina.stasi@gmail.com (C. Stasi).

Although around 240 million people are still infected with HBV, the vaccine has significantly reduced the spread of the HBV and its socioeconomic impact in industrialised countries. According to data published by the European Centre for Disease Prevention and Control (ECDC), the prevalence of HBV in the European Union and countries of the European economic area is 0.9% [3]. HBV infection is widespread with >8% prevalence in parts of sub-Saharan Africa, in particular Burkina Faso, Ivory Coast, Gambia, Ghana, Guinea, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo-South Sudan, Angola, Uganda and Somalia. An intermediate prevalence (2–8%) is present in some Eastern Mediterranean regions (for example, Tunisia), Central Asia (eg, Kazakhstan), Southeast Asia (Thailand, Bhutan and Bangladesh), China, parts of the South America (Colombia) and in some European countries (Albania, Bulgaria, Romania and Turkey). There is a low prevalence (<2%) in some parts of North America (for example, the United States, Canada and Mexico), in some European countries (Belgium, Czech Republic, Denmark, France) and in Australia [4].

The inmates represent a population at high risk for HBV infection due to the numerous social and environmental problems that affect them – in particular, the use of intravenous drugs, unprotected sexual behaviour, execution of tattoos using non-sterile needles, in addition to specific characteristics of the prison environment, such as limited space and overcrowding.

Several studies show that HBV infection in inmates has ranged from 1.4% to 23.5% [5]. The highest prevalence of HBsAg is found in detainees in West and Central Africa (23.5%). High levels of chronic HBV infection have also been reported in Eastern and Southern Africa (5.7%), and in Eastern Europe and Central Asia (10.4%). The lowest prevalence is found in North America (1.4%).

In Italy, a cross-screening study conducted in 2012 on the evaluation of serum markers for HBV infection (in particular, for the presence of HBsAg) revealed a prevalence of HBsAg+ subjects equal to 4.4% of the total, of whom about 35% were foreign subjects [6]. Another Italian multicentre study funded by Italy's Ministry of Health within the program of the Centre for Disease Control (CCM) in 2013, extrapolated data from the medical records of 15,751 prisoners and showed a 2.0% prevalence of chronic HBV infection among inmates [7]. Moreover, the study showed that the prevalence of patients with chronic HBV infection had been strongly underestimated compared to statistics that emerged from seroprevalence studies [6].

The United States' Centers for Disease Control and Prevention (CDC) highlight the importance of screening for HBV and subsequent anti-HBV vaccination in the prison population (both adult and minor), unless there is evidence of completion of the vaccine series or serological evidence of immunity from infection [8].

In line with the CDC, Almasio and colleagues [9] have recommended HBV screening for all prisoners; moreover, due to numerous risk factors to which they are exposed, the study advocated screening for HBsAg and anti-HBs to differentiate the infection by immunity.

In Italy, these recommendations reinforce the provisions of the Ministerial Decree of 1991, which stressed the need to vaccinate against HBV for people at risk, including those held in prison. For these subjects at risk, the vaccination must be offered free of charge. The ministerial decree also emphasised that the pattern of testing with all types of vaccines begin at baseline, at 1 month, at 2 months with a reinforcement at 6 or 12 months.

The high turnover in the prison population makes it difficult to complete a vaccination schedule. For this reason, in particular population groups, an accelerated vaccination schedule can be offered to allow rapid seroconversion and short-term protection [10,11].

Several studies have shown that an accelerated schedule can lead to a faster response and an increased anti-HBs antibody levels ≥ 10 IU/L. For these schedules, a fourth dose is required in

the twelfth month. This schedule – with administration at 0, 7 and 21 days and with reinforcement at 12 months – is present in the technical sheet of Engerix B and results in a seroprotection rate of 65.2% on the twenty-eighth day, which increases to 98.6% at the thirteenth month.

Therefore, vaccination should be recommended for all prisoners as it represents an opportunity to prevent HBV infection in people at high risk. In these subjects, an accelerated immunisation program against HBV can lead to rapid seroconversion and short-term protection.

Based on these premises, the aims of this study were to (1) increase the epidemiological knowledge on the impact of HBV in prison by registering results of serum screening on a clinical medical record and (2) increase pre-exposure prophylaxis by favouring access to anti-HBV accelerated vaccination in the population present in detention facilities in the Tuscany region.

2. Methods

2.1. Screening for HBV infection

This was a prospective study with evaluation of serum markers of HBV and a subsequent vaccination in non-immune subjects.

The study population was composed of all detainees present in Tuscany region prisons and all new prisoners from freedom or other institutions who were not vaccinated at such facilities from 1 December 2016 to 31 May 2017. In the case of Italian inmates, only those born before 1991 were enrolled because compulsory vaccination of new-borns was introduced in our country in 1991, with the exception of those for whom there is a clinical suspicion of a missed vaccination.

The screening for serological markers of HBV (HBsAg, anti-HBs, anti-HBc) will distinguish between infection, immunity and susceptibility to infection [12].

The inclusion criteria were as follows: all detainees “new prisoners” from freedom or from other institutes that have not performed markers for HBV (HBsAg, anti-HBs, anti-HBc) in the previous 3 months and who remained in the facility for a period of at least 10 days; all detainees already present in the penitentiary structures of the Tuscany Region at 24 October 31, 2016 who were not evaluated for HBV markers (HBsAg, anti-HBs, anti-HBc) in the previous 3 months.

Out of 17 detention facilities in the Tuscany region, 15 were enrolled in the study. The detention facility of Arezzo did not participate because of the high inmate turnover, with an average stay of less than 15 years, making the protocol difficult to apply. On the contrary, in the detection facility of Gorgona, the application of the accelerated vaccination protocol was considered less appropriate. The Institute of Pistoia did not send data. The subjects invited to participate in the study were 1404.

Written informed consent was obtained from all subjects before we performed any study procedures in accordance with the principles of the Declaration of Helsinki (Sixth Revision, Seoul 2008).

No identifiable human data were used for this study. In accordance with the Italian law on data confidentiality, the dataset used was not openly available (decree no. 196/2003). No identifiable human data were used for this study. The demographic data of the study were appropriately encrypted in the database and the exported file (containing the “anonymized” data) was sent from the system to the Regional Health Agency of Tuscany via a secure channel.

2.2. Vaccination anti-HBV infection

The vaccination programs were conducted in all HBsAg– and anti-HBs– subjects. In the case of anti-HBc+ and HBsAg– and

anti-HBs– antibodies, the IgM antibodies have been performed: if IgM and HBsAg– and anti-HBs– (anti-HBc isolated) it was necessary to evaluate the HBeAg and antiHBe markers and detect the viremia (HBV-DNA) [12]. In the case of markers' positivity, vaccination was not indicated.

We have excluded by vaccination the following people: Italians born after 1991; anti-HBs positive subjects regardless of the antibody titre except for immunocompromised patients (eg, subjects with chronic renal failure, patients undergoing haemodialysis, HIV-positive subjects) with anti-HBs antibody values <10 IU/L. The population aged <18 years has followed the regional scheme for anti-HBV vaccination and therefore was excluded by accelerated programs.

The vaccine utilised was Engerix B (20 µg/1 ml) in subjects ≥18 years. The vaccine was administered in the left arm's deltoid muscle (or another location evaluated by the clinician) at time 0, 7, 21 days and after 12 months; after vaccination, a certification of vaccination was issued.

The design of this study evaluated the vaccination period between September 2016 and March 2017, which included the registration of the first three doses. This limited period of time was due to both the study funding period and a certain percentage of inmates' turnover. In fact, the annual turnover of inmates is of 36%, as from the data of the Department of the Penitentiary Administration, Italian Ministry of Justice.

2.3. Clinical medical records

The application, developed in Visual Basic language (vb.net), was distributed in December 2016. The instrument, in addition to the registration of the vaccination, was also used as a vaccination schedule, being equipped with a specific function able to divide the registered subjects according to the date scheduled for administration of the next dose. At the opening of the application, in fact, the operator displayed the list of prisoners to be called on the specific day and the dose to be administered.

At the end of the compilation, the program included a “print” function for the clinician to acquire a paper copy of what was done.

Respecting privacy, the tool was provided for the anonymisation of the subjects entered by an automatic coding algorithm carried out through the fields “name, surname, date of birth.” The anonymisation was necessary to make the subject traceable, albeit anonymously, in case of transfer between prisons involved in the survey, thus avoiding duplication of cases.

The demographic data were appropriately encrypted in the database. The software not only allowed the research team to include guided and controlled information using a combo-box but also to export files ready to be sent.

The exported file (containing the “anonymized” data) was sent from the system to the Regional Health Agency of Tuscany via a secure channel (SSL). After logging in and connecting to the Agency's web page, the user was then able to upload the file.

2.4. Statistical analysis

All results are expressed as mean and percentage. The chi-square statistic was used for testing relationships between categorical variables. Relative risk was used to measure the risk of contracting infection in Italian vs foreigners. The Fisher exact test was used in the analysis of contingency tables to examine the significance of the association. To avoid the potential bias related to the missing data, the analysis of the variables was conducted only on the completed fields.

Statistical analysis was obtained using statistical software SPSS v18 (SPSS Inc., Chicago, IL, USA).

3. Results

On 28 February 2017, the detainees present in these institutes numbered 3068. Of these, according to reports of medical doctors operating in the participating institutes, 1404 were potentially subject to screening for HBV (according to the data of the previous medical record) because they were unvaccinated or had not performed serologic markers of hepatitis B virus in the previous 3 months (Table 1).

3.1. Screening for serological markers of HBV

The population potentially subject to screening was 1404 people (Fig. 1), of whom 498 (35%; 284 Italians and 214 foreigners) have previously been screened for HBV serologic markers and 578 (41.2%) who have never undergone screening. 328 (23.4%) did not know whether they had previously been screened. In 227 (16.2%) subjects, screening for HBV serum markers (HBsAg, anti-HBs, anti-HBc) was not necessary – most likely already vaccinated, infected or with previous B virus infection. Thus, the subjects effectively enrolled in this study and screened were 1177, after elimination of 227 from screening. Of those, 102 refused screening (8.7%) and 1075 accepted screening (91.3%).

Of the 1075 subjects screened for HBV serum markers and when considering the single serum markers, 20 (1.9%) of the subjects were HBsAg+ (these subjects were already HBV infected and therefore were excluded from mandatory vaccination), 321 subjects were anti-HBsAg+ and 210 were anti-HBc+.

Taking these parameters into account, 730 (67.9%) subjects were neither infected nor vaccinated (HBsAg, anti-HBc and anti-HBs–), 27 (2.5%) subjects had isolated anti-HBc (occult HBV infection), 20 (1.9%) of subjects with HBV infection (HBsAg+), 127 (11.8%) of subjects had previous HBV infection (anti-HBs+ and anti-HBc+ and HBsAg–) and 171 (15.9%) of subjects were anti-HBsAg+ (Fig. 2).

3.2. Vaccination

Of the 1075 inmates screened, 730 were susceptible to vaccination (67.9%), of whom 596 agreed to be vaccinated (82%). Table 1 shows the subjects eligible to vaccination stratified by age group. However, as shown in Table 1, foreigners under the age of 36 had been susceptible to vaccination more often than the Italian citizens. This is mainly because vaccination became mandatory in Italy in 1991. The risk of contracting the HBV infection in Italians is 14% (RR:1.14P < 0.01) greater than in foreigners (Table 3). Table 2 shows the percentage and number of patients who accepted vaccination. Significant association was found between non-vaccinated people and foreign people (P < 0.01). Of the 601 prisoners likely to be vaccinated, 555 inmates (92.4%) were given the first dose of the vaccine, and as many as 83% were given the third dose by the twenty-first day. Whereas the turnover of the inmates is 36% according to the data of the Department of the Penitentiary

Table 1

Subjects susceptible to be vaccinated (N,%), divided by citizenship and stratified by age group, based on recorded data.

Age group	Italian (N,%)		Foreign (N,%)		Total
>65 years	16	5.2	1	0.4	17
56–65 years	44	14.4	7	2.8	51
46–55 years	107	13.2	26	10.2	133
35–45 years	82	35.2	69	27.2	151
26–34 years	40	27	110	43.3	150
<25 years	15	5	41	16.1	56
Total	304	100	254	100	558

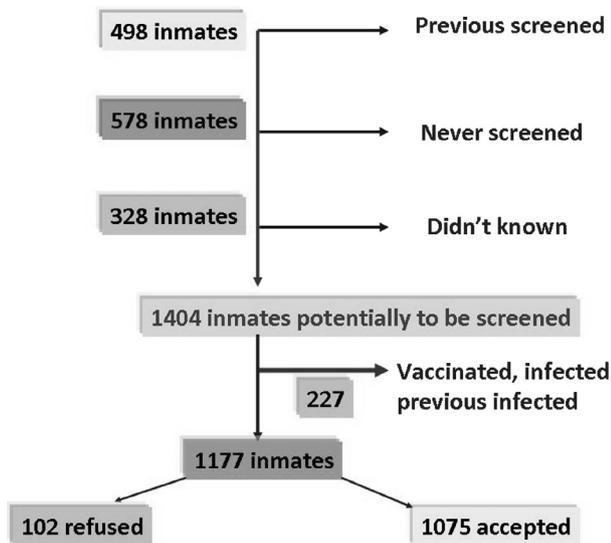


Fig. 1. Data of medical record of vaccinated, infected or previous hepatitis B-infected subjects.

administration, the fourth dose of vaccination could reach a maximum of 64%, not taking into account the refusal of the detainees to make the fourth and transfers of inmates to other institutes.

4. Discussion

To our knowledge, this is the first study that has conducted an accelerated vaccination program in Italian prisons, although several studies on screening for viral hepatitis have been conducted. In this regard, Sagnelli et al. [6] recently reported a percentage of screening adherence ranging from 37.3 to 95.2% in nine Italian custodial institutions. In our study, we found a high percentage of screening adherence (91.3%). The study showed that 67.9% of people were neither infected nor vaccinated (HBsAg, anti-HBc and anti-HBs–), 2.5% of subjects presented an isolated anti-HBc, 1.9% were HBV infected and 11.8% had a previous HBV infection (anti-HBs+ and anti-HBc+ and HBsAg–). A French prospective study [13] was conducted between June 2012 and December 2013 at the prisons of Clermont-Ferrand and Riom. During the study period, a total of 702 individuals were incarcerated, of whom 396 (56.4%) agreed to be screened.

The technical report of the European Centre for Disease Prevention and Control shows results at national levels concern-

ing the presence of guidelines on viral hepatitis. Of 21 countries that responded to the survey, 19 (90%) had indications for HBV screening at a national level and 11 countries adopted national policies for screening detainees. However, the most widespread gap in clinical practice was the ineffective surveillance of at-risk groups, in particular those who use drugs, migrants, homosexuals and inmates. Specifically, in 17 countries (81%), ineffective surveillance for HBV was reported [2]. In the prospective study from June 2012 to December 2013, conducted on adult prisoners of Puy-de-Dome, France, out of 702 prisoners, 56.4% were screened, of whom 0.6% were HBsAg+ [13]. In our study, the percentage of HBsAg+ subjects was 3 times greater. The data published by Sagnelli et al. [6] reported instead a higher prevalence (4.4% of HBsAg of 2265 subjects screened) compared to that found in our study.

Taking into account the percentage of detainees considered susceptible to vaccination, in the Puy-de-Dome study [13], this was 41.7% (149 subjects) with negative serological markers for HBV out of 357 screened, which differs substantially from results found in our study (67.9%).

Subjects with isolated positive anti-HBc are potentially at risk of transmitting HBV infection.

In a study by Shirani et al. [14] conducted in Iran on 970 male drug-dependent prisoners, the prevalence of isolated anti-HBc was found to be 4.5%. This higher prevalence is likely due to the screening being carried out in a population, such as drug addicts, already at higher risk of contracting the infection.

The global report on viral hepatitis shows a higher prevalence of HBV and HCV in prisoners than in reports on the general population. This may be justified by the increased prevalence of people born in countries with higher endemicity for HBV and by the higher frequency of subjects who have used drugs, suggesting that this population needs prevention, screening and treatment. In our study, the highest percentage of vaccination is present from 25 to 56 years, only partially due to the mandatory vaccination of newborns, which took place from 1991 and in adolescents from 1991 until 2003 and during the twelfth year.

The foreigners under the age of 36 years had been susceptible to be vaccinated more often than the Italian citizens. Moreover, the high prevalence of infection is due to screening carried out in a population, such as drug addicts, already at higher risk of having contracted the infection.

In our study, at the third vaccination dose, the percentage coverage rises to 83%. According to many studies, the use of this accelerated schedule can allow better compliance than will the standard schedule. Based on this premise, Christensen et al. [15] evaluated the effectiveness of an accelerated schedule in the field of

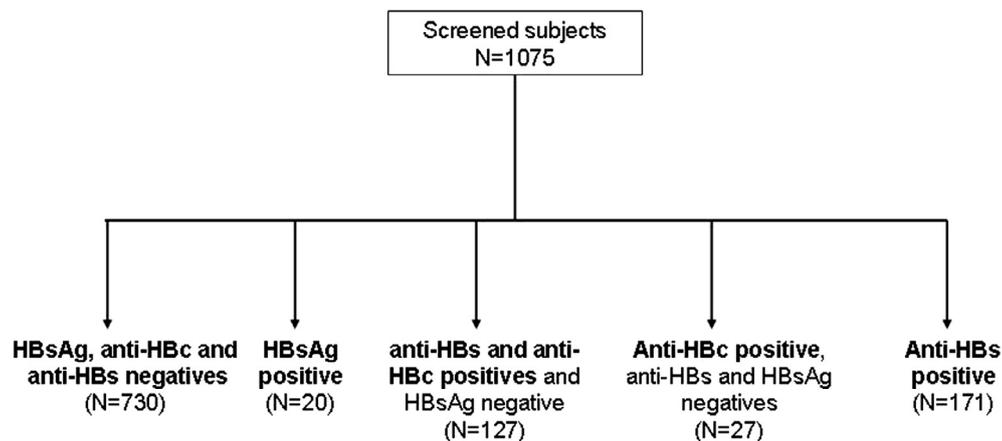


Fig. 2. Study population who underwent screening.

Table 2
Description (N,%) of the vaccination schedule for inmates susceptible to vaccination, based on recorded data.

Acceptance of vaccination	First dose (<i>Time 0</i>)		Second dose (<i>Time 7 days</i>)		Third dose (<i>Time 21 days</i>)	
	N	%	N	%	N	%
Yes	555	92.4	508	94.2	404	82.6
NO – Transferred	2	0.3	1	0.2	3	0.6
NO – Released	26	4.3	17	3.2	66	13.5
NO – Reject	1	0.2	3	0.6	4	0.8
NO – Other	17	2.8	10	1.8	12	2.5
Total	601	100	539	100	489	100

Table 3
Pearson chi-square test for subjects susceptible to vaccination.

Non-infected/non-vaccinated subjects	Total (N, %)	Italian (N, %)	Foreign (N, %)	P-value
Yes	359 (49.2%)	184 (45.9%)	172 (52.4%)	P < 0.01
No	371 (50.8%)	217 (54.1%)	157 (47.6%)	

detention (0, 1 and 3 weeks), comparing the results obtained with the application of the standard scheme (0, 1 and 6 months). Specifically, in the Institutes of Denmark, the first dose of vaccine was administered to the enrolment of subjects without any knowledge of serological markers and, only subsequently and based on the serological positivity to HBV markers, did they access the administration of the second dose of vaccine. In Estonia, out of 566 prisoners included in the accelerated schedule vaccination, 91% (516) received two doses, 80% (457) received three doses and 42% (236) received the 7-month booster dose. Therefore, in this case, 54% of the enlisted population was protected using the accelerated schedule.

Regarding the new prisoners, a study by Gilbert et al. [16] carried out in 42 prison institutions in England and Wales, accelerated vaccination was offered to all new prisoners >18 and, where possible, a fourth dose at the twelfth month was given. In this case, out of 14,163 inmates involved, the average coverage rate was 17% (range 0–94%). Despite the low levels of coverage, the authors concluded that the vaccination program in the custodial institutions reached a considerable number of young male inmates, a group that (as repeatedly emphasised) represents a high-risk population.

Another pilot vaccination program against HBV was set up in three prisons in Catalonia to assess the feasibility problem and results of accelerated vaccination in the high-risk population [17]. In this case, the vaccine was offered to all inmates who presented negativity for the serological markers of viral hepatitis and, subsequently, the antibody response was evaluated in those who received two or three doses of the vaccine. Seroprotection was obtained in 33% of the vaccinated after two doses and 76% after three doses. The overall rate of susceptible prisoners who were protected for hepatitis B was 34%. The seroconversion rate was higher when the interval between the first two doses was less than 3 weeks (91%), compared to cases with an interval of 3 to 6 weeks (79%) or longer than 6 weeks (33%).

The potential limitations of this study were the possible undiagnosed HBV infection or susceptibility to infection in the Italian citizens who are <36 years. Moreover, due to the study design that included the registration of the first three doses, the study funding period and the annual turnover of inmates, the fourth dose can be only estimated based on data of Department of the Penitentiary Administration, Italian Ministry of Justice.

In conclusion, the results of our study confirm very high levels of coverage, taking into account both the entire enrolled population and the new prisoners. The high prevalence of third-dose subjects indicates that accelerated vaccination may be a useful choice for ensuring short-term protection in most people. The accelerated anti-HBV vaccination program, activated as part of the project

action, has attracted a great deal of interest from the clinicians who work in the Tuscan custodial institutes. This means that, in these contexts, some procedures have been implemented to regulate the application of an accelerated anti-HBV vaccine schedule with the result of a vaccination practice that can reduce the spread of the HBV infection in the populations at greater risk of infection. Further studies will be able to demonstrate the serum protection reached after the end of the vaccination schedule.

Funding

Ministry of Health, Italy funded this study.

Disclosure of potential conflicts of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Data availability statement

The data used to support the findings of this study are included within the article.

Acknowledgements

We thank the Ministry of Health, Italy for funding this study and the Tuscany Region for the continued support.

We thank the medical staff involved in vaccination programme and data collection: Sergio Giacomi (Prison Healthcare of Volterra, Local Healthcare Tuscany North West), Grazzini Marcello, Elena Salomoni, Lorenza Cristiano, Nosakhare Ologhola, Claudio Calò, Licia Taras (“Sollicciano” District house, Local Healthcare Tuscany Centre), Paolo Pedicelli (District house of Grosseto, Local Healthcare Tuscany Southeast), Paolo Nannotti (District house of Siena, Local Healthcare Tuscany Southeast), Fabio Antichi (Prison house of San Gimignano, Local Healthcare Tuscany Southeast) Simone Giachi (Prison house of San Gimignano, Local Healthcare Tuscany Southeast).

We thank nursing staff for assistance in vaccination programme and data collection: Alessandro Cinci, Franco Dell’Aiuto (Prison Healthcare of Volterra, Local Healthcare Tuscany North West), Cristina Tozzi, Monica Pusceddu (“Sollicciano” District house, Local Healthcare Tuscany Centre), Loredana Micheli, Barbara Spiezia, Alberto Serzanti (District house of Grosseto, Local Healthcare Tuscany Southeast), Chiariello Elisabetta, Caroni Cinzia (District house

of Siena, Local Healthcare Tuscany Southeast), Carlo Puccioni (Prison house of San Gimignano, Local Healthcare Tuscany Southeast).

Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.vaccine.2019.01.049>.

References

- [1] Chang M-H, Chen D-S. Prevention of Hepatitis B. *Cold Spring Harb Perspect Med* 2015;5:a021493.
- [2] O'Flanagan D, Cotter S, Mereckiene J. The Health Protection Surveillance Centre European Centre for disease Control. VENICE II project. Hepatitis B vaccination in Europe. November 2008 - March 2009. Available at: <http://venice.cineca.org/Report_Hepatitis_B_Vaccination.pdf>.
- [3] ECDC Scientific Advice. Systematic review on hepatitis B and C prevalence in the EU/EEA; 2016. [Available at: <https://ecdc.europa.eu/sites/portal/files/media/en/publications/Publications/systematic-review-hepatitis-B-C-prevalence.pdf>]
- [4] Schweitzer A, Horn J, Mikolajczyk RT, Krause G, Ott JJ. Estimations of worldwide prevalence of chronic hepatitis B virus infection: a systematic review of data published between 1965 and 2013. *Lancet* 2015;386:1546–55.
- [5] Dolan K, Wirtz AL, Moazen B, Ndeffo-Mbah M, Galvani A, Kinner SA, et al. Global burden of HIV, viral hepatitis, and tuberculosis in prisoners and detainees. *Lancet* 2016;388:1089–102.
- [6] Sagnelli E, Starnini G, Sagnelli C, Monarca R, Zumbo G, Pontali E, et al. Blood born viral infections, sexually transmitted diseases and latent tuberculosis in Italian prisons: a preliminary report of a large multicenter study. *Eur Rev Med Pharmacol Sci* 2012;16:2142–6.
- [7] Stasi C, Silvestri C, Fanti E, Di Fiandra T, Voller F. Prevalence and features of chronic viral hepatitis and HIV coinfection in Italian prisons. *Eur J Intern Med* 2016;34:e21–2.
- [8] Centers for Disease Control and Prevention. Prevention and Control of Infections with Hepatitis Viruses in Correctional Settings; 2003. [Available at: <https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5201a1.htm>].
- [9] Almasio PL, Babudieri S, Barbarini G, Brunetto M, Conte D, Dentico P, et al. Recommendations for the prevention, diagnosis, and treatment of chronic hepatitis B and C in special population groups (migrants, intravenous drug users and prison inmates). *Dig Liver Dis* 2011;43:589–95.
- [10] Van Herck K, Leuridan E, Van Damme P. Schedules for hepatitis B vaccination of risk groups: balancing immunogenicity and compliance. *Sex Transm Infect* 2007;83:426–32.
- [11] Idilman R, De Maria N, Colantoni A, Nadir A, Van Thiel DH. The effect of high dose and short interval HBV vaccination in individuals with chronic hepatitis C. *Am J Gastroenterol* 2002;97:435–9.
- [12] Stasi C, Silvestri C, Voller F. Emerging trends in epidemiology of hepatitis B virus infection. *J Clin Transl Hepatol* 2017;5:272–6.
- [13] Jacomet C, Guyot-Lénat A, Bonny C, Henquell C, Rude M, Dydymski S, et al. Addressing the challenges of chronic viral infections and addiction in prisons: the PRODEPIST study. *Eur J Public Health* 2016;26:122–8.
- [14] Shirani K, Nokhodian Z, Kassaian N, Adibi P, Naeini AE, Ataei B. The prevalence of isolated hepatitis B core antibody and its related risk factors among male injected drug users in Isfahan prisons. *Adv Biomed Res* 2015;4:17. <https://doi.org/10.4103/2277-9175.148675>. eCollection 2015.
- [15] Christensen PB, Fisker N, Krarup HB, Liebert E, Jaroslavtsev N, Christensen K, et al. Hepatitis B vaccination in prison with a 3-week schedule is more efficient than the standard 6-month schedule. *Vaccine* 2004;22:3897–901.
- [16] Gilbert RL, Costella A, Piper M, Gill ON. Increasing hepatitis B vaccine coverage in prisons in England and Wales. *Commun Dis Public Health* 2004;7:306–11.
- [17] Bayas JM, Bruguera M, Martin V, Vidal J, Rodes J, Salleras LY. Hepatitis B vaccination in prisons: the Catalan experience. *Vaccine* 1993;11:1441–4.