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European survey of hepatitis B vaccination policies for healthcare workers: An updated overview

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ABSTRACT

Background: The risk of transmission of bloodborne pathogens, including hepatitis B virus (HBV) to healthcare workers (HCWs) is well known. In 2005 we performed a survey on HBV prevention in HCWs in the European Union (EU). An update of the 2005 survey deemed necessary as an EU Council Directive (2010/32/EU) on sharps injuries was to be implemented into national legislation by 11 May 2013 and more countries were starting universal HBV vaccination.

Methods: We performed an electronic survey in 2016, among national representatives from the Occupational Medicine section of the European Union of Medical Specialists (UEMS), to find out how policies have been put into practice in the European Union countries (plus Norway and Switzerland). The data were updated in 2019.

Results: Answers were received from 21 countries (among them 19 EU Member States), representing 78% of the population and 60% of HCWs in the EU-28. HBV vaccination was mandatory for medical and nursing staff in 10 countries; for other paramedical staff, medical and nursing students in 9 countries; for paramedical students in 8 countries; for cleaning staff in 7 countries; and for technical staff in 5 countries; it was recommended in all but one of other countries. Serotesting before vaccination was done in 7 countries. The vaccination schedule most often used was 0, 1, 6 months (18 countries), monovalent HBV vaccine was used in 14 countries, and combined (HAV + HBV) vaccine in 11 countries. Serotesting after vaccination was done in 18 countries and boosters were recommended in 14 countries. A non-responder policy was present in 18 countries. HBV vaccination coverage (5 countries) was 70–95%. Sharps injuries were reported in 13 countries, nationwide in 7 of them; European-wide reporting was not mentioned by respondents.

Discussion: These results show the variation in the implementation of EU legislation in the participating countries. More consultation between actors at EU level, including enhancing medical surveillance in occupational medicine could help to optimise policies in European countries in order to further reduce HBV transmission to HCWs.

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1. Introduction

The occupational risk of transmission of bloodborne pathogens, including hepatitis B virus (HBV) to healthcare workers (HCWs) is well recognised [1]. The most common routes of transmission from patient to HCW are needlestick or sharps injuries, followed by mucocutaneous exposure. A range of measures and interventions

can contribute to reduce HBV transmission to HCWs, such as the adoption of standard precaution measures and the use of safety devices. The introduction of HBV vaccines in the 1980s, however, is to be considered the major achievement in terms of prevention of HBV infection. HBV vaccination of HCWs and guaranteeing optimum immunisation coverage is therefore a wise strategy [1]. Post-exposure prophylaxis (PEP) after needlestick or sharps injuries completes the picture.

Under current European Union (EU) legislation, all employers have to perform a risk assessment to identify workers exposed to HBV, to inform them about the risk and how to prevent it,

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including vaccination [2]. Moreover, vaccination should be given as soon as possible after the start of the career of HCWs in order to avoid HBV infection and its long-term consequences, particularly development of a carrier status [3].

We have published an overview of the information on HBV vaccination policies for HCWs in the different EU Member States (MS) plus Norway and Switzerland in 2011 [4]. However, an update of this overview deemed necessary i.a. in view of the introduction of universal HBV vaccination programmes making a change of vaccination policies for HCWs necessary [5] and a new European Council Directive 2010/32/EU on prevention of sharps injuries in the hospital and healthcare sector [6]. This directive focused specifically on the prevention of medical sharps injuries and the transmission of bloodborne pathogens (including HBV infection) in the healthcare sector, including specific reporting mechanisms at local, national and European-wide level. The EU MS were expected to implement this into national legislation by 11 May 2013.

2. Methods

The purpose of the current study was to provide an update, identifying analogies, differences, and gaps in policies in place between different EU MS plus Norway and Switzerland, and to report changes in legislation and practice since the previous study. Therefore, we performed a descriptive quantitative study using a structured on-line self-administered questionnaire to survey HBV vaccination policies in HCWs in EU MS ($n = 28$) plus Norway (NO) and Switzerland (CH) in 2016. The latter two countries were included because, first, they had also been included in our previous study and second, they have a trading arrangement with the EU requiring them to follow EU rules (including changes) in their own laws. The survey was conducted from June through August 2016. The questionnaire was adapted from the one used in our previous study, making questions more specific on vaccination schedules, pre- and postvaccination testing, types of vaccines used, booster and non-responders policies, providing more answer categories, adding questions on universal vaccination programmes and their impact on vaccination policies for HCWs, and on new European legislation on sharps injuries [4]. In its final version it contained 8 parts with easy-to-answer open and closed questions: the definition of a HCW, general issues, universal vaccination policy, targeted vaccination policy and pre-vaccination testing, HBV post-vaccination testing, booster policy and reporting of sharps injuries.

As a working definition, a HCW was considered as a person who has professional contacts with patients and/or is potentially exposed to contamination sources inside and outside the hospital. According to this definition, a HCW belongs to one of the following professional categories: medical staff, nursing staff, other paramedical staff, medical students, student nurses, other paramedical students, technical staff, and cleaning staff.

As the issue of mandatory vaccination for HCWs has frequently been discussed in the literature [7–12], we compared countries having mandatory policies with countries without such a policy in terms of epidemiology of HBV, geographical position in Europe, GDP per capita, and year of introduction of universal HBV vaccination [13–14]. For this we compared 10 countries having lowest HBV prevalence, highest GDP per capita and situated most north-west, to 11 countries with highest HBV prevalence, lowest GDP per capita and situated most southeast.

A non-responder to HBV vaccination was defined as a person whose serum anti-HBs concentration is lower than 10 IU/l, as measured one month after completion of a primary complete vaccination course.

Participants were questioned about non-responders policies in an open question.

The questionnaire was first circulated among vaccination specialists, who were identified through their extensive publication record, and members of the Viral Hepatitis Prevention Board (VHPB) for comments. The concept and the practical modalities of the survey were discussed and agreed upon at a meeting of the national representatives in the Occupational Medicine Specialist section of the 'Union Européenne des Médecins Spécialistes' (European Union of Medical Specialists/UEMS) [15].

The questionnaires were sent through e-mail to the UEMS national representatives in 26 EU Member States (no contact persons were identified in Cyprus and Slovakia) plus Norway and Switzerland. They were asked to send us the contact details of at least one authoritative colleague in regard to occupational HBV vaccination of HCWs in their country. If no answer was received within three weeks after the first mailing, a reminder was sent, equally by e-mail.

In December 2019, participants were asked to re-verify the submitted results of the survey.

3. Results

Answers were received from 21 countries: 19 EU MS (Austria/AT, Belgium/BE, Croatia/HR, Czech Republic/CZ, Estonia/EE, France/FR, Germany/DE, Greece/GR, Hungary/HU, Ireland/IE, Italy/IT (incomplete answers), Latvia/LV, Luxembourg/LU, the Netherlands/NL, Poland/PL, Portugal/PT, Slovenia/SI, Spain/ES and Sweden/SE) plus Norway/NO and Switzerland/CH. The participating 19 EU MS represented 77.4% of the total EU population and 60% of the total number of HCWs in the EU at the time of the survey [16–17]. In the 2019 update of the results we received answers from 11 countries and the data were adapted where necessary.

The proposed definition of a HCW was agreed upon with one exception: medical students are not considered as HCWs in Latvia.

3.1. General issues

The first aspect to explore was whether the occupational health laws and regulations in a specific country were valid for the whole country. This turned out to be the case in all participating countries.

3.2. Universal vaccination

Universal HBV vaccination programmes were present at the time of the survey in all countries except in Sweden and Norway (SE and NO) introduced their programme in 2017). They were all introduced between 1991 (IT) and 2017 (NO).

3.3. Vaccination policies

National HBV vaccination policies for employees and students are shown in Table 1 and Fig. 1. Vaccination against HBV infection is mandatory for medical and nursing staff in 10 countries (BE, CZ, FR, HU, LV, HR, NL, PL, PT, SI); and also mandatory for (other) paramedical staff in 9 of these 10 countries (not in CZ). It is recommended for medical, nursing, and other paramedical staff in all other countries. There were no penalties for refusing vaccination nor incentives for all HCW categories to be vaccinated.

For cleaning staff, HBV vaccination is mandatory in 7 countries (BE, FR, HU, HZ, LV, PT, SI), for technical staff in 5 countries (BE, EE, FR, HU, PT). It is recommended for both groups in all other countries except in Sweden.

Table 1

Hepatitis B vaccination policies for different categories of healthcare workers (including students) in European countries.

Country	Medical staff	Nursing staff	Paramedical staff	Technical staff	Cleaning staff	Medical students	Student nurses	Paramedical students
Austria (AT)	R	R	R	R	R	R	R	R
Belgium (BE)	M	M	M	M	M	M	M	M
Croatia (HR)	M	M	M	R	M	M	M	M
Czech Republic (CZ)	M	M	R	R	R	M	M	M
Estonia (EE)	R	R	R	M	R	R	R	R
France (FR)	M	M	M	M	M	M	M	M
Germany (DE)	R	R	R	R	R	R	R	R
Greece (GR)	R	R	R	R	R	R	R	R
Hungary (HU)	M	M	M	M	M	M	M	M
Ireland (IE)	R	R	R	R	R	R	R	R
Italy (IT)	R	R	R	R	R	R	R	R
Latvia (LV)	M	M	M	R	M	R	R	R
Luxembourg (LU)	R	R	R	R	R	R	R	R
Netherlands (NL)	M	M	M	R	R	M	M	R
Norway (NO)	R	R	R	R	R	R	R	R
Poland (PL)	M	M	M	R	R	M	M	M
Portugal (PT)	M	M	M	M	M	M	M	M
Slovenia (SI)	M	M	M	R	M	M	M	M
Spain (ES)	R	R	R	R	R	R	R	R
Sweden (SE)	R	R	R	N	N	R	R	R
Switzerland (CH)	R	R	R	R	R	R	R	R

M: mandatory; R: recommended; N: neither mandatory nor recommended.

Fig 1. Map indicating the countries where hepatitis B vaccination is mandatory or recommended for most groups of health workers.

The different HBV vaccination policies for students are also summarised in Table 1. Vaccination is mandatory for medical students and student nurses in 9 countries (BE, CZ, FR, HU, HR, LV, NL, PL, PT, SI); and for other paramedical students in 8 countries (BE,

CZ, FR, HU, HR, PL, PT, SI). It is recommended for these categories in all other participating countries.

Countries from the eastern and southern part of the EU have shown to have a higher prevalence of HBV infection than northern

and western parts [13]; in our study eastern and southern countries had more mandatory policies (7/11 countries) compared to northern and western countries (3/10). Countries with a lower GDP also had more mandatory policies than richer countries: of the 11 poorest 7/11 had mandatory policies while in the 10 richest only 3 had mandatory policies. The introduction year of universal vaccination programmes showed no link with mandatory or not; of 11 countries that introduced universal vaccination before 1999, 4/11 had mandatory policies; of 10 countries having done this from 1999 onwards 5/10 had mandatory policies.

3.4. Pre-vaccination testing

Serotesting before HBV vaccination is done in 7 countries (BE, CZ, EE, GR, LU, SI, SE) for nursing staff, student nurses, and paramedical students. In 6 it is done for medical staff, medical students, and other paramedical staff (not in LU). In 5 countries it is done for technical staff (BE, EE, GR, LU, SI) and in 4 countries for cleaning staff (BE, EE, GR, SI).

Among the countries performing HCW testing before HBV vaccination, anti-HBs is tested in 5 of them (BE, CZ, LU, SI, SE), anti-HBc in 3 of them (EE, GR, SI), HBsAg in four (BE, EE, LU, SI). In several countries (BE, EE, LU, SI), several tests are used together. No country reported to use HBV DNA as a pre-vaccination test.

3.5. Vaccination timing and schedule

HBV vaccination is reported to be done at the start of the involved HCW's career in 20 of the participating countries; only in Sweden this is not explicitly stated (results not shown). Medical students and student nurses are vaccinated in 20 countries, though in Sweden there is no standard moment when it will be given. Paramedical students are not routinely vaccinated in the Czech Republic, although vaccination for this group is reported to be mandatory in CZ (Table 1). The vaccination schedule most often applied (in 18 out of 21 countries) is 0, 1, 6 months. The schedule 0, 1, 2, 12 months is used in 7 countries, often (in 3 countries) as an accelerated course (GR, HU, ES). In 6 countries (HR, GR, HU, IE, PT, ES), different schedules (0, 1, 6 and 0, 1, 2, 12 months) coexist.

3.6. Type of HBV vaccine, post-vaccination testing, and booster policy

A combined (HAV + HBV) vaccine is used in 11 of the participating countries (19 answers received). A monovalent HBV vaccine is used in 14 countries, while in some countries both types of vaccine are used. Three countries (FR, GR, ES) use an adjuvanted vaccine, alone or in combination, and both Croatia and Hungary use a recombinant DNA adsorbed vaccine (Table 2).

Serological testing (anti-HBs) after HBV vaccination is reported to be performed in 18 countries (20 answers received); not in LV and PL. All staff (including students) are tested in 13 countries. Serotesting is done for selected categories of staff and/or students in 4 countries, in one country (EE) the categories were not specified (Table 2).

The time span between administration of the last vaccine dose and serological testing is between 4 and 8 weeks: 4 weeks in 11 countries, 4–6 weeks in 2 countries, and 6–8 weeks in 5 countries (data not shown).

The anti-HBs level considered protective in serological post-vaccination testing is 10 IU/l in 12 out of 18 countries. Six countries (AT, DE, IE, LU, NO, CH) preferred a threshold level of 100 IU/l.

Administration of a HBV vaccine booster dose (defined as any revaccination after a completed vaccination schedule) is recommended in 14 countries (20 answers received; see Table 3), compared to 10 in our previous study. In 11 countries only the results of serological screening determined the administration of

Table 2

Type of HBV vaccine used, post-vaccination testing, and booster policy for HBV vaccination for different categories of healthcare workers (including students) in European countries.

Country	Type of HBV vaccine	Post-vaccination testing (Y/N)	Type of staff
Austria (AT)	C	Y	all staff
Belgium (BE)	M + C	Y	all staff
Croatia (HR)	R	Y	all staff, except technical/cleaning
Czech Republic (CZ)	M + C	Y	all staff, except paramedical/technical/cleaning
Estonia (EE)	M + C	Y	–
France (FR)	A	Y	all staff
Germany (DE)	M + C	Y	all staff
Greece (GR)	A + C	Y	all staff
Hungary (HU)	R (M + C)	Y	all staff, except students
Ireland (IE)	M	Y	all staff
Italy (IT)	–	–	–
Latvia (LV)	M	N	all staff
Luxembourg (LU)	C	Y	all staff, except cleaning staff/medical students
Netherlands (NL)	M + C	Y	all staff
Norway (NO)	M	Y	all staff
Poland (PL)	M	N	–
Portugal (PT)	M	Y	all staff
Slovenia (SI)	M	Y	all staff
Spain (ES)	A + M + C	Y	all staff
Sweden (SE)	–	Y	–
Switzerland (CH)	M + C	Y	all staff

A: adjuvanted HBV vaccine; C: combined (HAV + HBV) vaccine; M: monovalent HBV vaccine; R: recombinant DNA HBV vaccine.

All staff: medical, nursing, paramedical, technical, and cleaning staff, and medical students, student nurses, and paramedical students.

a booster, one country (GR) used a time interval only, and in 2 countries (AT, IE) both factors (results of serological screening and time interval) were considered.

3.7. Policy on non-responders

We could identify 5 algorithms (see Table 3) for non-responders of which the most frequently used (8 countries) was: one booster followed by anti-HBs testing, if insufficient 2 doses at 1 and 6 months (see Table 3 for further details). Switzerland used this algorithm too, but mentioned that, after the second series of vaccines, a non-responder was to be referred to a specialist. France uses the same algorithm as Norway (one booster dose followed by anti-HBs testing after 3 months, if insufficient complete schedule at 0, 1, 6 months), but tests for anti-HBs after each dose. The type of HBV vaccine used for non-responders also varied widely between countries, the monovalent vaccine was most frequently used (11 countries), but some countries used a mix of different vaccine types (see Table 3). Non-responders were tested for carrier status in 12 countries, using different tests (see Table 3).

3.8. Vaccination coverage

Data on national HBV vaccination coverage among HCWs were published for 5 participating countries. Estimated coverage ranged from 70 to 100% (data not shown) [18–22].

3.9. Reporting of sharps injuries

Questions on reporting mechanisms, as prescribed in the EU Directive, were answered by 19 respondents. Reporting was avail-

Table 3

Booster and non-responders policy for HBV vaccination for different categories of healthcare workers (including students) in European countries.

Country	When booster recommended?	Test(s) used in non-responders to detect carrier status	Non-responders policy algorithm	Type of HBV vaccine
Austria (AT)	Serology/time interval	–	(1)	C
Belgium (BE)	Serology	anti-HBc	(4)	M
Croatia (HR)	Serology	–	(2)	R
Czech Republic (CZ)	Serology	–	(1)	A + M + C
Estonia (EE)	No booster recommended	–	(2)	–
France (FR)	Serology	anti-HBc/HBV DNA	(3)*	A
Germany (DE)	Serology	HBsAg/anti-HBc/HBV DNA	(1)	M + C
Greece (GR)	Time interval	HBsAg/anti-HBc/HBV DNA	(2)	A
Hungary (HU)	No booster recommended	HBsAg/HBV DNA	(2)	M
Ireland (IE)	Serology/time interval	HBsAg/anti-HBc	(1)	All
Italy (IT)	–	–	–	–
Latvia (LV)	No booster recommended	–	–	–
Luxembourg (LU)	Serology	HBsAg/anti-HBc	(5)	M
Netherlands (NL)	Serology	HBsAg/anti-HBc	(2)	M + C + T
Norway (NO)	Serology	HBsAg/anti-HBc	(3)	M
Poland (PL)	No booster recommended	–	–	–
Portugal (PT)	Serology	HBsAg/anti-HBc	(1)	M
Slovenia (SI)	Serology	HBsAg/anti-HBc	(1)	M
Spain (ES)	Serology	–	(1)	M
Sweden (SE)	No booster recommended	–	(5)	–
Switzerland (CH)	No booster recommended	HBsAg/anti-HBc	(1)*	–

Algorithms used for non-responders: (1) One booster followed by anti-HBs testing, if insufficient 2 doses at 1 and 6 months; (2) Complete revaccination followed by anti-HBs testing; (3) One booster dose followed by anti-HBs testing after 3 months, if insufficient complete schedule at 0, 1, 6 months; (4) Two doses at one moment, followed by two doses after 2 months; (5) One booster only. *Special algorithm for CH and France (see text).

A: adjuvanted HBV vaccine; C: combined (HAV + HBV) vaccine; M: monovalent HBV vaccine; R: recombinant DNA HBV vaccine; T: Third generation HBV vaccine.

able in 13 countries (4 respondents answered no and 2 did not know). Institutional (i.e., in hospitals, health centers, ...) reporting was available in 10 countries, local reporting (city, province, ...) in one country, and national reporting in 7. Aggregated data were publicly available in 6 countries. European-wide reporting was not mentioned.

3.10. Comparison with previous study

The most striking findings of the present study, compared to our previous study, are:

1. The vaccination policies ('mandatory', 'recommended' or 'neither mandatory nor recommended') in different countries and for different professional subgroups have remained largely unchanged.
2. Prevaccination testing is now done in 7 (instead of 6) countries.
3. Serotesting after vaccination has increased from 14 to 18 countries, but interpretation of the results differs between countries.
4. The presence of booster policies has increased from 10 to 14 countries.

4. Discussion

This survey is an update, 10 years after our previous study presenting an overview of different aspects of HBV vaccination policies in HCWs in different European countries [4].

Some of the answers we received on mandatory or recommended vaccination were somewhat different from other studies on HCW policies, although these differences were very minor [12,7–9].

There are several reasons for these differences.

First, the terms 'mandatory' and 'recommended' are actually close to one another. In our study, respondents reported that there were no penalties for refusing mandatory vaccination, which brings it very close to recommended vaccination.

Second, in the other studies mentioned, public health organisations and/or vaccine experts were used as respondents. We used experts in occupational medicine, therefore assuming that they

had a good knowledge of both the legislative and practical aspects of HBV vaccination of HCWs in their respective countries.

Third, in other studies a slightly different definition of HCWs was used. This could explain some discrepancies in the answers between the studies.

Mandatory vaccination policies were more frequent in both eastern and southern countries; they have a higher prevalence of HBV infection and are also the poorer countries. There was no link with earlier introduction of universal HBV vaccination.

Although mandatory HBV vaccination of HCWs is advisable [9–11], comparison of published HBV vaccination coverage figures in HCWs does not show much difference between countries where vaccination is mandatory (e.g., Poland) and those where it is recommended, e.g., Switzerland [19,22]. Further studies would be needed to determine exactly if (and to what extent) a variation in terms of 'mandatory' or 'recommended' implies different coverage rates for different groups of HCWs in European countries. This was however beyond the scope of the present study.

Pre-vaccination serological testing for HCWs is still not widely done (7 countries). With the introduction of universal vaccination without systematic post-vaccination testing, large cohorts of HBV vaccinated youngsters are currently entering the healthcare profession, needing protection against HBV [5,23]. To determine those (student) HCWs not immune against HBV, a prevaccination strategy must be developed for them; further research on this topic is needed [24].

Most (19/21) countries used at least the classical 0, 1, 6 months or 0, 1, 2, 12 months schedules.

The number of countries using the combined vaccine slightly increased from 10 in our previous study to 11 in the present study. A new development is the use of newer generation vaccines (recombinant DNA HBV vaccine, adjuvanted vaccine) in some countries.

The practice of serotesting after HBV vaccination in HCWs is applied in 18 countries compared to 14 in our previous study, mostly for medical, nursing, and paramedical staff.

The maximum time elapsed between giving a final dose and performing the tests was never shorter than 4 weeks and never exceeded 8 weeks, as recommended, compared to a maximum of 3 months in our previous study [3,25,26].

Recommendations on protective serum anti-HBs concentrations differ somewhat in different groups of HCWs: 10 IU/l is most often cited as a threshold, but 100 IU/l has also been proposed, particularly in HCWs performing exposure prone procedures [3,25,26].

In our study most countries (12 out of 18) had adopted 10 IU/l as a threshold, compared to 13 in our previous study, while 6 preferred 100 IU/l. Working with a 100 IU/l threshold has the advantage of being usually above the levels measured in HBV carriers with concurrent serum HBsAg and anti-HBs [3,25] and a meta-analysis concluded that available data did not allow to exclude an increased risk for infection with time since vaccination [27]. But recent research has confirmed previous studies that a level of ≥ 10 IU/l confers a long-term (10–28 years) immunity in immunocompetent individuals that have adequately responded to a primary HBV vaccination course, even in the absence of HBV exposure [28,29].

Therefore, current recommendations state that no boosters are necessary in immunocompetent individuals that have adequately responded to a primary HBV vaccination course [25].

One of the more difficult issues is the policy on non-responders. We could identify five algorithms used by the participating countries. The two most frequently used algorithms, used by 13 (8 + 5) countries are supported by the European Consensus Group recommendation and CDC.

Comparison of booster and non-responders policies with the policies described in our previous study was difficult, because the answers in that survey were rather confusing [4].

Another point of interest is the use of different vaccines for non-responders. Five countries used at least a combined vaccine; interestingly, none mentioned the use of double doses of the combined (HAV + HBV) vaccine [30]. Interesting developments comprise the use of new vaccines, such as adjuvanted vaccines in 4 countries (CZ, FR, GR, IE) and the search for newer vaccines specifically developed for non-responders, some of which seem to offer perspectives [31].

Non-responders were tested for carrier status in 12 countries, as recommended by the European Consensus Group and by CDC, using different tests. Ten countries used at least HBsAg as recommended by the European Consensus Group and CDC [3,26].

Besides the 5 countries for which respondents report HBV coverage studies, there have been few other recent studies (IT, PL, HR) [32–34]. Coverages are comparable to those reported in our previous study and most countries did not reach 90% coverage proposed by WHO [35].

Published HBV vaccination coverage figures in HCWs in Europe are somewhat higher than those presented in North American studies; a recent report showed United States HBV vaccination coverage in HCWs to amount to 63% [36]. This difference could be explained by the differences between US and EU occupational medicine systems and enhanced medical surveillance in the EU.

In the EU Directive on sharps injuries, there was a clause (clause 9) on reporting to include local, national and European-wide reporting systems, which could be instrumental in developing a harmonized approach in all EU countries.

From our survey, we conclude that in most countries reporting is available, both locally and nationally, but that there is no European-wide reporting. This is clearly a point that needs to be looked at in the future.

One of the strengths of our study is the participation of experts in occupational medicine, having a good practical knowledge of both legislative and practical aspects of HBV prevention. We conducted our survey using the same methodology as the previous one, which allowed us to study trends in HBV prevention in HCWs in Europe over the past decade. As a potential weakness, information on national policies was obtained from one person per country, while the implementation of the policy might differ among

different actors in the country. This point could only be solved through organising a series of country-wide surveys, which was beyond the scope of our study.

Our survey, wherein a large majority of European HCWs is represented, reveals considerable variation among countries in the way EU legislation regarding HBV vaccination is translated into policy, particularly concerning the practical implication details. Compared to our previous study, it seems that the way different countries deal with this matter has not been optimised drastically. The European Directive 2010/32/EU, to be implemented by 11 May 2013, has not lead to the emergence of a European-wide reporting system of sharps injuries. Also, research is urgently needed on the vaccination strategies (including serotesting) proposed for (student) HCWs already vaccinated as a child and/or adolescent. This seems particularly important because of WHO's goal to eliminate viral hepatitis by 2030 [37]. The 'Global health sector strategy on viral hepatitis' adopted by the World Health Assembly, implies a massive testing strategy for viral hepatitis, with subsequent risks for infections in HCWs performing these duties. Recent surveillance data suggest that the number of cases of HBV infection in EU countries is already increasing, at least partly due to this strategy and this makes HBV vaccination in HCWs even more important [37]. More in-depth consultation between key actors from different countries (EU MS and other) and better coordination, including more harmonization and convergence of different occupational medicine systems (e.g., by enhancing medical surveillance), could contribute to optimise the way this crucial matter is dealt with in Europe and the elimination goal is reached [38]. This remains a future challenge for the European Union.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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CRediT authorship contribution statement

Antoon De Schryver: Conceptualization, Methodology, Writing - original draft. **Tom Lambaerts:** Investigation, Validation, Formal analysis, Data curation. **Nathalie Lammertyn:** Supervision, Resources. **Guido François:** Conceptualization, Methodology, Writing - review & editing. **Simon Bulterys:** Funding acquisition, Resources. **Lode Godderis:** Conceptualization, Methodology, Writing - review & editing.

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