American Journal of Infection Control 000 (2019) 1–7

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

Compliance with immunization and a biological risk assessment of health care workers as part of an occupational health surveillance program: The experience of a university hospital in southern Italy

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Key Words:
Health care worker vaccination
Vaccination hesitancy
Occupational medical examination

Background: The active immunization of health care workers (HCWs) is a primary measure to prevent nosocomial infection; despite this, vaccine coverage among HCWs in most countries is low. To increase vaccine coverage in the health care setting, the hygiene and occupational medicine departments of Bari Policlinico General University-Hospital implemented a vaccination procedure. This operative procedure requires that during the occupational medical examination, all employees are evaluated for immunity/susceptibility to vaccine-preventable diseases, with vaccination offered to those determined to be susceptible.

Methods: The study sample comprised HCWs who attended the biological risk assessment program from December 2017 to January 2019 (n = 449).

Results: Susceptibility was higher for hepatitis B virus (23%), followed by rubella (11%), varicella (9%), mumps (8%), and measles (7%). The seroconversion rate after the administration of booster dose(s) was >80% for all vaccines. Overall, 15% of the HCWs refused the offered vaccine(s), and the main determinants of vaccination compliance were younger age ($P < .0001$) and being a physician ($P < .05$).

Discussion: Despite the several recommendations and campaigns to promote vaccinations, achieving high immunization rates among HCWs is still a challenge.

Conclusions: In this scenario, public health institutions have to choose between the enforcement of the promotion or the adoption of a mandatory policy.

According to the Occupational Health and Safety Risks in the Healthcare Sector guideline, 10% of workers in the European Union are employed in the health care industry, mostly in hospitals. In the performance of their jobs, however, health care workers (HCWs) are exposed to several workplace hazards, especially biological risks,[1] which include infectious diseases. Moreover, there is also a risk that HCWs will spread diseases to colleagues and patients. The active immunization of HCWs is a primary prevention measure able to control and reduce the transmission of vaccine-preventable diseases (VPDs), particularly to patients at high risk (eg, those with cancer or immune deficits).[2] Moreover, the immunization of susceptible HCWs is recommended because it assures health care delivery during infectious disease outbreaks[3] and reduces staff absenteeism.[4]

International and national guidelines strongly recommend the vaccination of all HCWs against hepatitis B virus (HBV) and influenza; that every susceptible health care professional receive measles, mumps, rubella (MMR), and varicella vaccines; and that a tetanus, diphtheritis, acellular pertussis (Tdap) booster dose be administered every 10 years.[2,5] The World Health Organization recommends antimeningococcal vaccination for individuals at risk of exposure to

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Conflicts of interest: None to report.

https://doi.org/10.1016/j.ajic.2019.09.024

Neisseria meningitidis, including health care personnel working in infectious disease units, the emergency room, and others.[6]

Although vaccination is one of the most successful and cost-effective measures in the prevention of infectious diseases,[7] vaccine coverage among HCWs in Italy is low.[3,8,9] In many European countries, vaccination prophylaxis is only recommended.[10] Consequently, several clusters of measles or varicella have been described in European health care facilities,[11-13] and in some of these settings the index case was an HCW.[14-16] In Italy, data on vaccination coverage among HCWs are not routinely available.[8] The few related studies found deficient vaccine coverage among Italian HCWs.[3,17,18] Among the factors that account for the suboptimal vaccination rates among HCWs[19,20] are misinformation, loss of confidence, fear of adverse effects, absence of educational campaigns, inaccurate perception of risk, unknown or uncertain vaccination status, and difficulties in access to vaccination in the workplace.

Thus, the immunization of HCWs is a current public health challenge. Although the National Vaccine Advisory Committee has developed several strategies to improve influenza vaccination rates in health care facilities,[21] there are no standardized procedures for the other vaccinations recommended for HCWs.[2,5,22] Carrico et al[23] proposed that HCWs attend training courses to improve their understanding and acceptance of vaccination. They also suggested that public health physicians should offer vaccination-related advice to HCWs during medical examinations and guarantee that vaccinations will be available to HCWs working in high-risk departments (onsite vaccination).[24] However, mandatory vaccination policies are subject to several ethical and legal concerns, such as restriction of the individual autonomy of HCWs.

To improve vaccination compliance among HCWs and increase vaccination coverage in the health care setting, the hygiene and occupational medicine departments of Bari Policlinico General University-Hospital, an approximately 1,000-bed hospital in southern Italy, planned and implemented a vaccination procedure requiring that during the occupational medical examination, all employees are evaluated for immunity/susceptibility to VPDs, with vaccination offered to those determined to be susceptible.

The aim of this retrospective study was to evaluate the immunity to VPDs of a subset of HCWs employed at Bari Policlinico and subsequent compliance with vaccination. The reasons for vaccination refusal were also evaluated to develop measures to increase vaccine compliance among HCWs. Our study was carried out in Apulia (southern Italy, approximately 4,000,000 inhabitants), where at the time of this study, there were no formal regulations regarding the vaccination of HCWs.

METHODS

This retrospective cohort study was conducted at Bari Policlinico General University-Hospital (Bari, Italy).

In November 2017, the hospital director approved the "Operative protocol for the vaccination prophylaxis of health care workers," developed by the hygiene and the occupational medicine departments of Bari Policlinico. The protocol complies with national guidelines[5,22] regarding vaccination prophylaxis in HCWs, and includes a biological risk prevention program for employees at the time of their prerecruitment medical examination and/or their scheduled routine occupational medical examination (every 2 to 3 years, as stipulated by national guidelines).[22]

The protocol was implemented beginning in December 2017 as a pilot program in Italy. It is conducted as follows: the occupational medicine department schedules occupational medical examinations for HCWs, during which time a blood sample is obtained and then examined using chemiluminescence techniques (chemiluminescent microparticle immunoassay and chemiluminescence immunoassay). The results of the blood test reveal whether the HCW is seroprotected for HBV (anti-hepatitis B surface antigen [HbSAg] titer ≥10 mIU/mL), measles (Immunoglobulin G [IgG] titer >16.5 AU/mL), mumps (IgG titer >11 AU/mL), rubella (IgG titer >165 IU/mL), and varicella (IgG titer >165 mIU/mL). The vaccination status of participating HCWs is also assessed using the Regional Immunization Database (GIAVA), a computerized vaccination registry in which the vaccination history and immunization schedule of every Apulian inhabitant is recorded. The need for a booster dose of anti-tetanus vaccine, a further dose(s) to complete baseline HBV (3 doses) and measles, mumps, rubella, varicella (MMRV) (2 doses) vaccines as well as anti-meningococcus ACYW135 and B vaccine status are also evaluated.

Susceptible HCWs are then asked to visit the hygiene department to discuss their vaccination status and the appropriate vaccination prophylaxis. All vaccination counseling activities are performed by public health physicians who are experts in vaccinology.

Seronegative HCWs without a history of HBV vaccination (≥3 doses) are invited to start a vaccination schedule (3 doses at 0, 1, and 6 months), whereas for HCWs already vaccinated with ≥3 doses of the HBV vaccine, a booster dose is administered and 30 days later another blood test is performed to determine the anti-HBs titer. If the titer is still negative, 2 more vaccine doses (1 month after the first booster dose and 5 months after the second booster dose) are administered. One month after the third dose, the anti-HBs titer is checked again. Seroconversion is defined as an anti-HBs titer ≥10 mIU/mL after 1 or 3 additional vaccine doses. HCWs who are seronegative and without an available vaccination certificate are considered and treated as never vaccinated. The adsorbed recombinant DNA vaccine (HBVAXPRO, MSD VACCINS, Lyon, France) is used as a booster dose and is administered intramuscularly in the deltoid muscle.

For MMR and Varicella zoster virus (Vzv), tested HCWs with a nonprotective IgG titer for one or more of these diseases and/or never immunized for MMR/Vzv are offered vaccination (2 doses at 0-1 months). Seronegative HCWs who have received ≥2 doses of MMR or Vzv vaccines are administered a booster dose, and a blood sample is taken 20-25 days later to retest IgG titers. If the IgG titer measured in the reevaluation exceeds the cutoff, the HCW is classified as seroconverted and no further vaccine doses are needed; if the titer is still negative, another vaccine dose (28 days after the first booster dose) is administered, and 20-25 days later IgG levels are measured again. HCWs seronegative and without an available vaccination certificate are considered and treated as never vaccinated. The live-attenuated vaccines (M-M-RVAXPRO, MSD VACCINS, Lyon, France/VARIRLIX; GlaxoSmithKline Biologicals S.A., Rixensart, Belgium) are used as booster doses and are administered subcutaneously in the deltoid muscle.

A Tdap booster dose is offered to HCWs with available vaccination certificates showing that the last anti-tetanus vaccine dose was >10 years before the vaccination counseling appointment. The tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine (BOOSTRIX, GlaxoSmithKline, Verona, Italy or TRIAXIS, Sanofi Pasteur Europe, Lyon, France) is used as the booster dose and is administered intramuscularly in the deltoid muscle.

Anti-meningococcus ACYW135 and B vaccines are offered to nonimmunized HCWs working in 8 operative units (OUs) with a higher risk of meningococcus circulation (anesthesia and intensive care, emergency room, pediatrics and neonatology, infectious disease, neurology, radiology, microbiology and virology, clinical pathology). The meningococcal (groups A, C, Y, and W-135) conjugate vaccine (MENVEO or NIMENRIX, Pfizer Limited, Kent, United Kingdom) and the serogroup B recombinant meningococcal vaccine (BEXSERO, GSK Vaccines, Siena, Italy) are used. Both are administered intramuscularly in the deltoid muscle.

Vaccination prophylaxis is not mandatory, and the HCW can refuse vaccination. Informed consent is collected at the time of vaccination. All the vaccinated HCWs undergo a 1-month follow-up to assess the development of adverse effects. Newly vaccinated HCWs are instructed to contact the hygiene department in case of any adverse reactions.

At the end of screening, the hygiene department sends the occupational medicine department a report on the immunologic status of the HCW and on any prophylaxis measures implemented. Finally, the occupational health physician formulates a judgment listing the placement options for each enrolled HCW according to the susceptibility/immunity status and the risk evaluation. For susceptible HCWs who refuse one or more vaccines, exclusion from occupational settings with patients at high infectious risk (eg, immunocompromised patients) is recommended. For example, a nurse susceptible to measles is not eligible to work on the oncology ward, where patients are highly susceptible to infections.

The population in this study comprised HCWs who attended the biological risk assessment program from December 2017 to January 2019. For every enrolled HCW, the following information was obtained: sex, age at study enrollment, history of chronic diseases (yes/no), medical specialty, professional category, available routine vaccination schedule (yes/no), HBV and MMR/Vzv IgG titers at baseline, vaccinations administered, IgG titer after booster(s), and vaccination refusal per vaccine type.

The data were entered in a database created using an Excel (Microsoft Corporation, Redmond, WA) spreadsheet and analyzed using STATA MP15 software (StataCorp, College Station, TX). Continuous variables are reported as the mean ± standard deviation and range, and categorical variables as proportions, with the 95% confidence interval (95% CI) when appropriate. To assess the determinants of vaccination refusal, both overall and per vaccine type (HBV, MMR, Vzv, Tdap, antimeningococcus ACYW135 and B), a multivariate logistic regression model was constructed for each outcome. The determinants were sex (male vs female), age at enrollment (years), chronic disease (yes/no), professional category, and medical specialty. The adjusted odds ratio (aOR) was calculated together with the 95% CI. The Pearson or Hosmer–Lemeshow χ^2 tests were used to evaluate the goodness-of-fit of the multivariate logistic regression models. For all statistical tests, a 2-sided *P* value <.05 was considered to indicate a significant difference.

The study was carried out in accordance with the Helsinki declaration. All HCWs who were screened provided written consent regarding the use and scientific publication of data collected for clinical purposes.

RESULTS

From December 2017 to January 2019, 449 HCWs were tested, 181 of 449 (40%) of whom were employed in high-risk OUs. The average age at enrollment of the HCWs was 38.6 ± 10.7 years (range, 24.0-66.0), and 287 of 449 (64%) were women. A history of chronic disease was reported by 76 of 449 (17%) of the enrolled HCWs.

Table 1
Vaccination coverage (% and 95% confidence interval) in health care workers for whom information on the vaccination status was available (n = 228). The data are reported per vaccine type

Vaccine	n	%	95% CI
Hepatitis B (≥3 doses)	181	79.4	73.5-84.4
Measles (≥2 doses)	44	19.3	14.4-25.0
Mumps (≥2 doses)	42	18.4	13.6-24.1
Rubella (≥2 doses)	41	18.0	13.2-23.6
Varicella (≥2 doses)	4	1.8	0.5-4.4
Tdap (≥4 doses)	222	97.4	94.4-99.0
Meningococcus ACYW135	17	7.5	4.4-11.7
Meningococcus B	0	0.0	0.0-1.6

CI, confidence interval; *Tdap*, tetanus diphtheritis acellular pertussis.

Among the 449 HCWs, 235 (52%) HCWs were nurses, 96 (21%) were physicians, 111 (25%) worked in another professional category, and for 7 of 449 (2%) the job was unknown.

The majority of HCWs were assigned to an OU associated with a medical specialty (n = 218 of 449; 49%): 99 of 449 (22%) to surgery and 95 of 449 (21%) to another specialty. For 37 of the HCWs (8%), an OU assignment had not been made at the time of screening.

Vaccination certificates were available for 228 of 449 (51%) of the HCWs. The proportion fully vaccinated according to vaccine type is described in Table 1.

All of the enrolled HCWs were tested for anti-hepatitis B surface antigen (HbSAg) and MMRV IgG; the proportion who did not have circulating antibodies for each disease is reported in Figure 1.

The mean geometric mean titers for the diseases screened in immune HCWs were as follows: anti-HBsAg IgG, 84.5 mIU/mL (95% CI, 66.3-107.6); anti-measles IgG 182.0 AU/mL (95% CI, 164.8-200.9); anti-mumps IgG 109.2 AU/mL (95% CI, 97.9-121.9); anti-rubella IgG 43.4 IU/mL (95% CI, 37.5-50.2); and anti-Vzv IgG 749.0 mIU/mL (95% CI, 671.2-835.9).

The number of HCWs offered vaccination prophylaxis, per type of vaccine, and the seroconversion rate in reevaluated HCWs are reported in Table 2.

At the time of the examination, 137 of the 228 (60%; 95% CI, 53%-67%) HCWs with an available immunization certificate had received

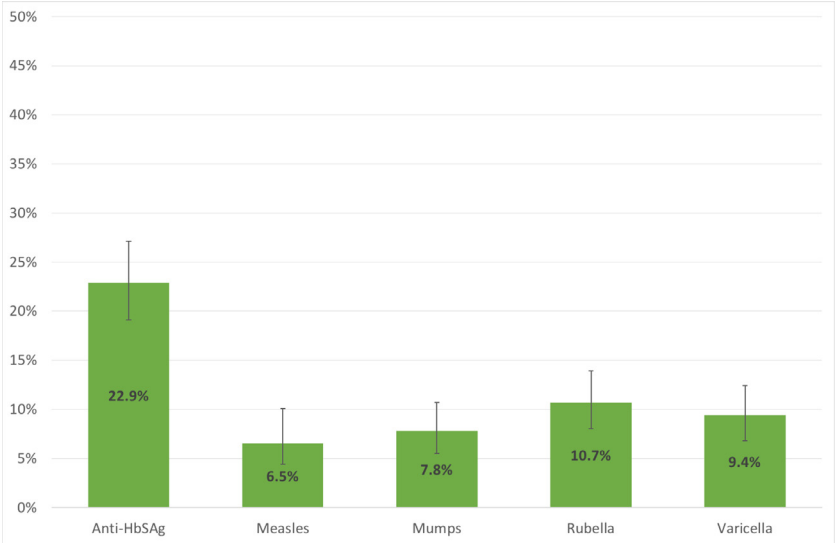

Fig 1. Proportion (%) of health care workers (n = 449) without circulating antibodies, per disease. *HbSAg*, hepatitis B surface antigen.

Table 2
Vaccination prophylaxis in susceptible health care workers per disease

Vaccine	Seronegative HCWs (n)	HCWs offered the vaccine		HCWs who accepted vaccine prophylaxis		Retitered HCWs		Seroconverted HCWs			GMT after booster(s)
		n	%	n	%	n	%	n	%	95% CI	mean (95% CI)
Hepatitis B	103	45	43.7	42	93.3	34	81.0	29	85.3	68.9-95.0	1,172.6 mIU/mL (515.2-2,669.0)
Measles	29	11	37.9	10	90.9	7	70.0	7	100.0	59.0-100.0	179.3 AU/mL (87.0-369.6)
Mumps	35	11	31.4	8	72.7	7	87.5	6	85.7	42.1-99.6	46.5 AU/mL (13.3-162.3)
Rubella	48	19	39.6	17	89.5	13	76.5	13	100.0	54.1-100.0	42.8 IU/mL (26.6-68.9)
Varicella	42	22	52.4	17	77.3	6	35.3	6	100.0	75.3-100.0	1,141.8 mIU/mL (456.6-2,855.6)

CI, confidence interval; *GMT*, geometric mean titer; HCW, health care worker.

the last dose of the tetanus vaccine >10 years earlier, and thus needed a booster dose. The Tdap vaccine booster dose was offered to 126 of 137 (92%) HCWs. The anti-meningococcus ACYW135 vaccine was offered to 71 of 164 (43%) nonimmunized HCWs from high-risk OUs. Seventeen HCWs working in high-risk OUs had been immunized for anti-meningococcus ACYW135 at the time of study enrollment. The anti-meningococcus B vaccine was offered to 81 of the 181 (45%) HCWs within this group. The MMR vaccine was offered to 45 of 133 (34%) HCWs susceptible for measles and/or mumps and/or rubella. The anti-Vzv vaccine was offered to 25 of 45 (56%) susceptible HCWs, and the HBV vaccine to 45 of 103 (44%) seronegative HCWs.

Overall, 183 of 449 (41%; 95% CI, 36%-46%) HCWs needed vaccination prophylaxis. Of these, 28 of 183 (15%; 95% CI, 10%-21%) refused at least 1 vaccine. The proportion of HCWs who refused vaccination prophylaxis are reported per vaccine type in Figure 2.

Regarding the safety of the vaccines, during the 1-month follow-up there were no serious and/or long-term adverse reactions. The most commonly reported reactions were pain at the injection site, mild fever, and, rarely for live-attenuated vaccines, laterocervical lymphadenopathy. All of these events regressed in the following days and were without sequelae.

During the study period, 17% (95% CI, 13%-20%) of the screened HCWs were still susceptible to hepatitis B, 5% (95% CI, 3%-7%) to measles, 7% (95% CI, 4%-9%) to mumps, 8% (95% CI, 6%-11%) to rubella, and 8% (95% CI, 6%-11%) to varicella. An anti-Tdap booster dose was needed by 21.2% (95% CI, 14.7%-29.0%) of the HCWs with known vaccination status. Among the HCWs working in high-risk OUs (n = 181), 55.8% (95% CI, 48.2%-63.2%) remained susceptible to meningococcus ACYW135, and 65% (95% CI, 58%-72%) to meningococcus B.

A multivariate analysis of the determinants of vaccination refusal showed a statistically significant association with older age (aOR, 1.12; 95% CI, 1.07-1.18), whereas physicians were less likely to refuse vaccination (aOR, 0.20; 95% CI, 0.04-0.87). No other factors were significantly associated with vaccination refusal ($P > .05$; Table 3). A multivariate analysis of anti-HBV vaccine refusal specifically was not possible because of the few events recorded. The results of the multivariate analyses of anti-MMR, anti-Vzv, anti-Tdap, and anti-meningococcus ACYW135+B vaccine refusals are shown in Table 4.

DISCUSSION

In this study of the immunity/susceptibility status of HCWs for VPDs, we identified a very low coverage for anti-MMRV and anti-meningococcus vaccines. Anti-meningococcus vaccines were recently included in the Italian vaccination schedule and are indicated especially for children and adolescents. Although anti-MMR/Vzv vaccines have been recommended since the 1980s to 1990s, they have been mandatory for children only since 2017. Thus, childhood vaccination was not required for the HCWs in our study. In fact, most had contracted measles and varicella during their lifetimes because both diseases were endemic in Puglia until 2006. A 2019 Italian multicentric study[18] reported similar findings, showing that coverage for anti-HBV and anti-tetanus vaccines among HCWs is >75%, whereas coverage for other vaccines is very low. A comparison of the vaccination coverage determined in that study and in our own showed a higher coverage of HCWs vaccinated with the anti-Tdap vaccine (>95% vs 77%), similar coverage for the anti-HBV (~75%) and anti-meningococcus ACYW135 (~7%) vaccines, and less coverage in the multicentric study for both the anti-MMRV (<20% vs 30%) and anti-meningococcus B (0% vs 3%) vaccines.

The proportion of HCWs without circulating antibodies differed depending on the disease. Susceptibility was higher for HBV (23%), followed by rubella (11%), varicella (9%), mumps (8%), and measles (7%). The proportion of anti-HBsAg negative HCWs was lower than determined in a 2018 study of 3,140 medical students and residents

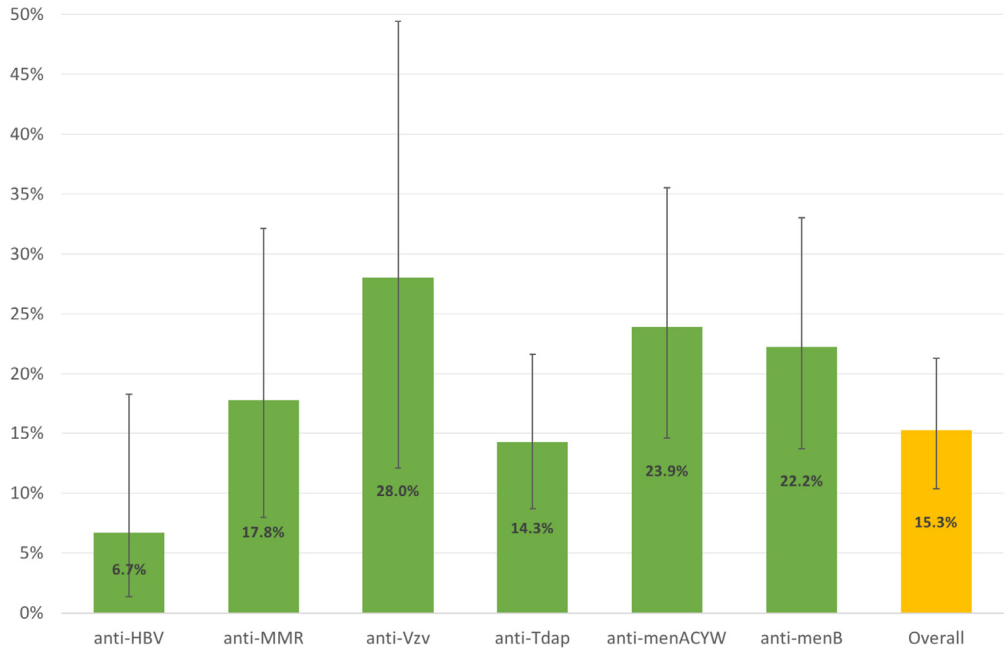

Fig 2. Proportion (%) of health care workers who refused vaccination prophylaxis among the group of susceptible health care workers offered vaccination prophylaxis, per vaccine type. *HBV*, hepatitis B; *men*, meningococcus; *MMR*, measles mumps rubella; *Tdap*, tetanus diphtheritis acellular pertussis; *Vzv*, varicella zoster virus.

Table 3
Analysis of the determinants of vaccination refusal in a multivariate logistic regression model

Determinant	aOR	95% CI	z	*P* value
Age (years)	1.12	1.07-1.18	4.4	<.001
Sex (male vs female)	0.46	0.15-1.40	1.4	.2
Professional category				
• physician vs nurse	0.20	0.04-0.87	2.2	.032
• other job vs nurse	0.52	0.18-1.52	1.2	.2
Specialty				
• surgery vs medical	0.42	0.08-2.15	1.0	.3
• service vs medical	1.69	0.44-6.51	0.8	.44
• not yet assigned vs medical	1.32	0.20-8.51	0.3	.8
Chronic disease (yes/no)	0.87	0.32-2.38	0.3	.8

$\chi^2 = 127.7$; $P = .8$.
aOR, adjusted odds ratio; *CI*, confidence interval.

conducted by our research team.[25] In that population, 38% were susceptible. This difference could be related to the difference in the mean age of the 2 study populations.

The seroprevalence of MMR susceptibility in our HCWs was similar to that reported in the literature. In a 2015 review, 6% of the HCWs in Europe were seronegative for measles.[26] A 2013 study from Spain[27] estimated that in a group of 639 HCWs, 13% were susceptible to mumps. Borràs et al[28] in a 2013 study reported the results of a rubella serosurvey of 642 HCWs; the absence of protective antibodies was determined in 13%. The susceptibility of HCWs to varicella seems to be country-dependent and ranges from 5%-50%.[26]

In our study, the seroconversion rate after the administration of booster doses was very high (>80%) for all vaccines, although the rate in HCWs receiving the anti-HBV vaccine was slightly lower than reported in the literature (85% vs >90%).[25]

Overall, 15% of the HCWs refused the offered vaccine(s), with the anti-Vzv and anti-meningococcus vaccines refused most often (>22% of the refusals), followed by the MMR vaccine (18%), whereas the anti-HBV vaccine was seldom refused (7%). The latter result can be explained by the effectiveness of previous information campaigns aimed at increasing HCW awareness about the professional biological risks of HBV infection and the efficacy of the anti-HBV vaccine in reducing that risk. The main determinants of vaccination compliance were younger age ($P < .001$) and being a physician ($P < .05$), whereas there was no association between compliance and the clinical specialty ($P > .05$). Associations between male sex and a better compliance with anti-Tdap vaccination and between a history of a chronic disease and anti-meningococcus vaccination were also determined in our study. Previous studies showed that HCWs in some professional categories, such as nurses, as well as older HCWs are less inclined to get an influenza shot, whereas physicians (especially younger ones) are more compliant.[17,29,30] Poor vaccine compliance by HCWs has been investigated in several studies, which identified several causes of vaccine hesitancy: (1) lack of or inadequate awareness campaigns, (2) insufficient health education regarding vaccine effectiveness and possible adverse reactions, (3) a perception of not being at-risk, (4) not having been previously vaccinated, (5) difficult access (because of time constraints or distance) to vaccination facilities, and (6) sociodemographic variables.[17,29,30] Of these, not having the time to be vaccinated or a lack of access to vaccination facilities was one of the most important determinants of noncompliance.[17,29,30] This finding is supported by a 2014 Italian study of 436 HCWs,[31] in which <30% of the susceptible group underwent immunization (with greater compliance in younger HCWs). One of the most commonly cited reasons for the failure to be vaccinated was the lack of an active offer of vaccination. Our operative procedure, offering biological screening during the occupational medical examination, is one approach to address this issue. The finding in the 2014 study that more than half of HCWs, including those working in intensive care units, did not consider themselves to be at risk for VPDs is consistent with our finding of a high rate of anti-meningococcus vaccine refusal by HCWs working in high-risk units. Squeri et al[4] in a 2017 study showed that a higher number of years of service is a determinant of vaccination refusal, which is also in agreement with our results. A fear concerning side effects may explain the high rate of refusal of live-attenuated vaccines. Another determinant of vaccination refusal reported in the literature is the low perception of risk related to VPDs,[32] which may account for the refusal to be vaccinated against diseases perceived as infrequent or not dangerous (eg, MMRV and meningococcus).

Table 4
Analysis of the determinants of anti-MMR, anti-Vzv, anti-Tdap, and anti-meningococcus ACYW135+B vaccine refusal according to multivariate logistic regression models

Determinants	MMR			Vzv			Tdap			Meningococcus ACYW135+B		
	aOR (95% CI)	z	*P* value	aOR (95% CI)	z	*P* value	aOR (95% CI)	z	*P* value	aOR (95% CI)	z	*P* value
Age (years)	1.39 (1.03-1.86)	2.2	.031	1.82 (0.74-4.46)	1.3	.2	1.11 (1.04-1.81)	3.0	.002	1.14 (1.05-1.23)	3.3	.001
Sex (male vs female)	0.23 (0.01-13.21)	0.7	.5	0.03 (0.00-56.61)	0.9	.4	0.06 (0.01-0.59)	2.4	.016	0.88 (0.21-3.75)	0.2	.9
Professional category												
• physician vs nurse	1	-	–	7.2 (0.0-400.1)	0.1	.9	0.22 (0.02-2.01)	1.4	.2	0.27 (0.03-2.41)	1.2	.2
• other job vs nurse	0.01 (0.00-1.81)	1.8	.1	2.62 (0.02-294.63)	0.4	.7	1.04 (0.28-3.87)	0.1	.9	0.75 (0.13-4.26)	0.3	.7
Specialty												
• surgery vs medical	1	-	-	766.5 (0.0-3,000.0)	0.3	.7	0.43 (0.07-2.46)	1.0	.3	1	-	-
• service vs medical	10.3 (0.1-801.0)	1.1	.3	217.9 (0.01-3,000.0)	1.0	.3	0.54 (0.09-3.37)	0.7	.5	2.53 (0.29-22.17)	0.8	.4
• not yet assigned vs medical	2.84 (0.03-319.4)	0.4	.7	1	-	-	3.0 (0.1-107.8)	0.6	.6	1	-	-
Chronic disease (yes/no)	0.02 (0.00-4.59)	1.4	.2	3.04 (0.03-284.50)	0.5	.6	0.89 (0.23-3.47)	0.2	.9	4.67 (1.13-19.23)	2.1	.033
	$\chi^2 = 2.1$; $P = .98$			$\chi^2 = 2.1$; $P = .98$			$\chi^2 = 3.3$; $P = .9$			$\chi^2 = 8.1$; $P = .4$		

aOR, adjusted odds ratio; *CI*, confidence interval; *MMR*, measles mumps rubella; *Tdap*, tetanus diphtheritis acellular pertussis; *Vzv*, varicella zoster virus.

A strength of our study was the large sample size (449 HCWs). In addition, to the best of our knowledge, there are no published studies assessing the biological risks for HCWs as determined in the setting of an occupational medical examination. However, a major limitation was related to the difficulty of HCWs in respecting the scheduled appointments, such that for in several cases screening activities scheduled for several months after the start of the protocol were not concluded. Furthermore, for many HCWs, especially older ones, the vaccination schedule was not available.

CONCLUSIONS

The vaccination of HCWs has been the focus of several studies, many of which noted the low vaccination coverage in this population and the need to implement effective strategies for its improvement.[33,34] An important lesson learned from our experience is that increasing vaccination coverage among HCWs requires a coordinated effort involving highly qualified physicians as well as experts in vaccinology and in occupational medicine. Another important aspect in the correct management of biological risk screening is synergy between the hygiene and occupational medicine departments.

An important responsibility of HCWs is maintenance of the health status of patients with whom they come in contact. One of the main strengths of our operative protocol is the determination by the occupational health physician about the suitability of an HCW for a specific job depending on his or her immunization status. In many cases, HCWs who refused vaccination and were thus not allowed to work in high-risk OUs reconsidered their decision and agreed to be vaccinated to become eligible for a desired job. Nonetheless, vaccination compliance among HCWs remains suboptimal, as shown by our study, in which 15% of HCWs employed at Bari Policlinico General Hospital refused the appropriate vaccines. This conclusion is consistent with reports on the general Italian population.[3,8] Strategies aimed at increasing vaccination coverage among HCWs, and thus a sense of responsibility toward patients are therefore urgently needed, is a task also recognized in national and international recommendations.[2,5,22]

The active immunization of health care personnel is an effective and safe strategy to prevent nosocomial transmission, especially to vulnerable patients, and to reduce VPD-related work absenteeism.[35] To increase vaccination compliance in Apulia, in 2018 the Apulian Regional Authority approved a regional law that makes vaccinations mandatory for health care personnel. However, implementation was prevented after the Italian Government contested the law to the Constitutional Court.[36] More recently, the Italian Ministry of Health proposed mandatory vaccination for anyone, including HCWs, working in the public sector, but the proposal is still under consideration. Our experience as well as that of other Italian hospitals suggests that, despite hospital protocols and dedicated human resources, satisfactory vaccine coverage cannot be reached without the support of federal regulations. Indeed, as also noted in other studies,[37,38] a mandatory policy may ultimately be the most effective strategy.

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