Evaluation of Vaccination Coverages in the Health Care Workers of a University Hospital in Southern Italy

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Key words: Vaccine hesitancy, healthcare workers, coverage, vaccine
Parole chiave: Esitazione vaccinale, operatori sanitari, copertura, vaccini

Abstract

Introduction. An adequate immunization of the health care workers is essential for infection prevention and control, to avoid consequences not only for them, but for all patients that the health care workers could infect causing serious damage and/or death. Unfortunately, to date, despite the presence of international and national guidelines (Law Decree 119/2017), the vaccination coverage was low, also because of the “vaccine hesitancy” spread among the same health care workers. In light of the above, the aim of our study was to investigate the vaccination coverage of healthcare workers of all the operational units present in our hospital and to evaluate differences between sex, age, professional profile and area of work.

Materials and methods. A study was conducted from March to June 2018 to investigate the vaccination coverage of healthcare workers at the University hospital “G. Martino” of Messina; data were collected using a self-completion questionnaire based on Attachment 3 of Ministerial Circular 25233 of 18 August 2017. We verified any possible association between physicians and pediatricians and between age classes by the chi square method. Also, a logistic regression was used for each vaccination, considering the vaccination as the variable and the following covariates: type of operative unit, sex, age and area) in order to predict the probability of vaccination.

Results. We analyzed a sample of 822 health care workers (324 males and 498 females with an age of 49.5 ± 10.5 SD). The sample was made up of physicians (36%), nurses (21%) and other professional categories (43%). Analyzing the data we obtained vaccination coverages lower than the target required to guarantee “herd immunity”; higher vaccination coverages were found for females, physicians and the clinical area and - for influenza vaccination - in the older age groups and - for all the other vaccinations - in the younger groups.

Conclusions. Data analysis revealed a lax attitude towards vaccinations by health care workers and the need for measures aimed at increasing vaccination their coverage to prevent them from becoming a source of dangerous outbreaks.

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Introduction

Despite vaccines have always been considered a successful and cost-effective measure to improve health outcomes, in recent years there has been a global spread of a phenomenon known as “vaccine hesitancy”, indicating a delay in receiving vaccination or a refusal to be vaccinated despite the availability of vaccination services (1-3). It involved many factors that could influence the decision to accept some or all the vaccines in accordance with the recommended schedule, or none at all. In the end, this phenomenon resulted in a decrease of vaccination coverage, with values below the target of 95% coverage required for “herd immunity”. This decrease was partly attributable to the disinformation campaigns implemented not only by the anti-vaccination groups, but also by some healthcare workers (HCWs), who should instead represent the main stakeholders (4-6).

HCWs, in fact, do not always agree with vaccinations. The literature ascribed this to the fear of side effects, to the lack of confidence in the effectiveness of vaccinations and to organizational deficiencies in access to vaccination services (6-7).

In line with the recommendations of the Strategic Advisory Group of Experts (SAGE) on Immunization of the World Health Organization (WHO), it was necessary to evaluate vaccine coverage on both a global and local scale. Few studies have evaluated vaccine coverage of HCWs in healthcare settings and the scientific literature was therefore lacking (7).

By Law n. 119 of 31 July 2017, containing “Urgent provisions on vaccination prevention” and the connected Ministerial Circular 25233 of 16.08.2017, data collection on the vaccination status of teachers, social care workers and HCWs is requested (Annex 3). Hence, at present, HCWs are under no legal obligation to be vaccinated, but they could represent a dangerous source of transmission of vaccine preventable diseases to their patients and relatives, and so dangerous outbreak could occur in healthcare environments (8, 9). In light of the above, the aim of our study was to investigate the vaccination coverage of HCWs of all the operational units present in our hospital, AOU “G. Martino” of Messina, and to evaluate differences between age classes (20-30, 31-40, 41-50, 51-60 and 61-70 years of age) and between medical doctors and pediatricians. Also, a logistic regression was used for each vaccination, considering the vaccination variable and the following covariates: type of operative unit, sex, age and area, in order to predict the probability of vaccination.

Materials and methods

The study was conducted from March to June 2018 using a self-completion questionnaire based on Annex 3. We analyzed a sample of 822 HCWs. All the interviewees filled the questionnaire.

Summary statistics were calculated for all parameters contained in Annex 3 (sex, age, professional profile, vaccines carried out, etc.). The mean and standard deviation was calculated for the sole quantitative parameter (age) while absolute and relative frequencies were obtained for qualitative data (sex, professional profile, vaccinations carried out, etc.).

We verified possible statistical differences between vaccine coverage of physicians and pediatricians and between age classes as described above Therefore, 2x2 and 5x2 contingency tables were built and assumptions tested by the chi square method, while degrees of freedom were used to partition r x k tables.

A multiple step logistic regression with stepwise model (10) was used for each vaccination considering the vaccination variable (0 = unvaccinated and 1 =
vaccinated) and the following covariates (independent variables x): type of operative unit (clinical, surgical and services), sex, age and qualification (physicians, nurse and other healthcare workers). This method allowed verifying the weight of the single covariates in order to predict the probability of vaccination.

Using the $\beta$ parameters for measles, chickenpox and mumps vaccination, which presented all four globally significant depressors (type of operative unit, sex, age and qualification), we estimated the probability of vaccination for females and males (the only qualitative repressor) net of the other variables present in the equation $X$ area $X$ age and $X$ professional category, with the following probability estimation model:

$$p(X) = \frac{e^{(\beta_0 + \beta_1 X_1 + \cdots + \beta_p X_p)}}{1 + e^{(\beta_0 + \beta_1 X_1 + \cdots + \beta_p X_p)}}$$

The logistic model provided a smaller sample size, as the operators who answered “not remember” or had “natural immunity” were removed from the dummy variable. Significance was set at $\alpha = 0.050$; therefore p-values of less than 0.05 for two-tailed tests were considered statistically significant. The summary and inferential statistics were analyzed using the software R (11).

Results

Our sample comprised 822 HCWs (324 males and 498 females) with mean age = 49.5 ± 10.5 SD. The sample was divided into three operational areas: clinical (42%), surgery (28%) and services (30%). The clinical area included: allergology, cardiology, dermatology, metabolic diseases, geriatric, neonatology, hematology, endocrinology, infectious diseases, internal medicine, emergency room, nephrology, neurology, infantile neuropsychiatry, oncology, pediatrics, pulmonology, psychiatry and rheumatology. The surgical area included: general surgery, pediatric surgery, plastic surgery, thoracic and vascular surgery, maxilla-facial surgery, gynecology and obstetrics, neurosurgery, ophthalmology, orthopedic, urology, otolaryngology.

The service area included: Health management, Pathology, Immunological diagnostics and Virology, Clinical biochemistry, Clinical pharmacology, Physics, Occupational medicine, Hospital hygiene, Sport medicine, Forensic medicine, Nuclear medicine, Transfusion medicine, Clinical microbiology, Radiology, Radiotherapy.

The sample included: physicians (30%); doctors in training (6%); nurses (21%) and other professional categories (43%) such as biologists, pharmacologists, laboratory technicians and administrative staff. The sample was also stratified by age as follows: 20-30 (5.5%), 31-40 (12.9%), 41-50 (27.8%), 51-60 (36%), 61-70 years (16.8%).

In the sample we found the highest vaccination coverage for poliomyelitis (80%), diphtheria (72.4%), tetanus (76.8%) and hepatitis B (77.3%); lower coverages emerged for measles, mumps, rubella, varicella and pertussis vaccinations and for some recently introduced vaccinations not specifically recommended for HCWs. For some diseases the HCWs claimed to have contracted especially exanthematous diseases, in particular chickenpox. Vaccine coverage and immunization status of the sample is represented in Table 1.

Furthermore, we stratified the sample into three professional categories: physicians, nurses and other HCWs, evaluating vaccination coverage into three groups as represented in Table 2. We obtained higher coverage for physicians for all vaccines except for hepatitis B, hepatitis A and herpes zoster, whose higher coverages were detected in nurses. Higher varicella coverage was also found in other HCWs. Statistical differences were analyzed using a multivariate analysis (see table 3).
We also decided to evaluate the vaccine coverage of pediatricians within the clinical group as they were the category mainly involved in childhood vaccine promotion. We found higher rates of coverage for polio, diphtheria, tetanus and HBV; while lower coverage rates were observed for the other vaccines studied (Figure 1). Furthermore, we wanted to search for the presence of statistical differences of vaccine coverage between physicians and pediatricians: we found only differences for measles, mumps, rubella, chickenpox (p<0.05) and meningococcus C vaccine (p<0.001).

For age we stratified the sample into five groups: 20-30 years of age; 31-40 years of age; 41-50 years of age; 51-60 years of age; 61-70 years of age. From analysis of the data we found in every age classes higher vaccine coverage for mandatory vaccines. The vaccine coverage was represented
into Figure 2. The qualitative assessment revealed significant differences between the five age groups for: poliomyelitis, hepatitis A and tuberculosis (p<0.05); tetanus and HPV (p<0.01); for hepatitis B, measles, chickenpox, pertussis, rubella, H. influenzae, Influenza, meningococcus C and B (p<0.001). For others vaccines investigated no statistical differences were detected. Vaccine coverage by age is shown in Fig. 2.

We performed a multivariate analysis and in Table 3 we represented only the covariates that presented good explanatory skills selected through the stepwise method. The goodness of the various models was evaluated by calculating the G statistic, which allowed highlighting that all vaccinations have at least one regressor (variable) that adequately predicts the vaccination, except for anti tbc.
Age (always with negative $\beta$ coefficients except for polio and influenza) was among the variables with the greatest weight in the choice of vaccination. Therefore, in polio vaccination (positive $\beta$), the more the variable age increases, the more it is likely that the event will occur (vaccination); on the other hand, in the vaccination against Hepatitis B ($\beta$ negative), the more the variable age increases, the more the probability that the event (vaccination) will occur, decreases.

Sex was the second regressor studied with greater weight in the probability of vaccination (9/15 vaccinations) and we obtained a greater tendency to vaccination by the female sex for each vaccine.

The qualification was also a regressor of

Table 3 - Multivariate analysis: covariate that contribute significantly to the predictability of the individual vaccinations

<table>
<thead>
<tr>
<th></th>
<th>$\beta'$</th>
<th>$P_{value}$</th>
<th>OR</th>
<th>95% CI for OR Lower - Upper</th>
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<tr>
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<td>age</td>
<td>0.041</td>
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</tr>
<tr>
<td>HBV</td>
<td>age</td>
<td>-0.096</td>
<td>0.001</td>
<td>0.908</td>
</tr>
<tr>
<td>DT</td>
<td>age</td>
<td>-0.047</td>
<td>0.001</td>
<td>0.954</td>
</tr>
<tr>
<td>Pertussis</td>
<td>sexM</td>
<td>-0.600</td>
<td>0.003</td>
<td>0.549</td>
</tr>
<tr>
<td></td>
<td>age</td>
<td>-0.035</td>
<td>0.001</td>
<td>0.965</td>
</tr>
<tr>
<td>Measles</td>
<td>area</td>
<td>-0.290</td>
<td>0.020</td>
<td>0.749</td>
</tr>
<tr>
<td></td>
<td>sexM</td>
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<td>0.404</td>
</tr>
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<td></td>
<td>age</td>
<td>-0.044</td>
<td>0.001</td>
<td>0.957</td>
</tr>
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<td></td>
<td>category</td>
<td>0.298</td>
<td>0.011</td>
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<td>Rubella</td>
<td>età</td>
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<td></td>
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<td>sexM</td>
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<td>Age</td>
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<td>0.001</td>
<td>0.920</td>
</tr>
<tr>
<td>Pneumococcus</td>
<td>SexM</td>
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<td>0.006</td>
<td>0.238</td>
</tr>
<tr>
<td></td>
<td>Age</td>
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<td>0.052</td>
<td>0.959</td>
</tr>
<tr>
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<td>sexM</td>
<td>-1.396</td>
<td>0.001</td>
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<td>0.013</td>
<td>1.509</td>
</tr>
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<td>H. zoster</td>
<td>sexM</td>
<td>-1.446</td>
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</table>

*See $\beta$ value for results interpretation
Vaccine coverage in HCWs in a University Hospital

predicting the vaccination (6/15 vaccinations) and, finally, the area had its own weight in determining the probability of vaccination. It was noted, in particular, that the greatest compliance was found for the clinical area and for the physicians. In addition, it was noted from Table 6 that the models were globally significant (all four regressors) for immunizations of measles, chickenpox and mumps only.

We obtained from the analysis of the $\beta$ coefficients of the logistic model, and using the relative algorithm the vaccination probabilities as follows.

In the case of measles we could establish that for the clinical area for physicians (doctors in training and structured doctors) at the beginning of work we obtained a chance of getting vaccinated equal to 90.41% for females and 79.20% for males. For nurses the probability was 92.70% for females and 83.69% for males. For the last qualification examined we had the highest probability of vaccinating at the start of the career equal to 94.48% for females and 87.36% for males.

For the surgical area, for the first category we found a probability of vaccination of 81.09% for females and 68.35% for males. For nurses, on the other hand, the probability was equal to 85.42% for females and 74.69% for males. For the last qualification examined we had a probability of 91.38% for females and 84.22% for males.

If we considered the service area, the probability in the first category was 76.41% for females and 61.99% for males. For nurses, the probability was equal to 81.56% for females and 69.02% for males. For the last qualification examined we found a chance to get vaccinated equal to 85.80% for females and 75.27% for males.

So, for measles, we could observe that the highest probability of being vaccinated is up to the HCWs of the third category of females, at the beginning of the working activity, belonging to the surgical area; and the lowest probability to the physicians of the service area, first category.

In the case of varicella we could establish that for the clinical area, for those starting work in the category of medical managers (doctors in training and structured doctors) we found a chance of getting vaccinated equal to 66.55% for females and 52.77% for males. In the second category the probability was 74.23% for females and 61.70% for males. For the last qualification examined, we found the highest probability of being vaccinated at the beginning of the career equal to 80.66% for females and 69.94% for males.

Moving from the clinical area to the surgical area with the same age and qualification characteristics, the likelihood of vaccination decreases, with 59.97% for females and 45.59% for males for physicians. In the nursing category, on the other hand, the probability was equal to 68.44% for females and 54.81% for males. For the last qualification examined we had the highest probability of being vaccinated at the start of the career equal to 75.84% for females and 63.72% for males.

Evaluating the service area, the probability was - for physicians - 52.99% for females and 38.68% for males. For nurses, on the other hand, the probability was 62.01% for females and 47.72% for males. For the last qualification examined we saw that the chance to get vaccinated at the beginning of the career is equal to 70.27% for females and 56.93% for males.

For chickenpox vaccine, we could observe that the highest probability of being vaccinated is up to the female HCWs of the third category examined, at the beginning of the working activity belonging to the clinical area; and the lowest probability to the male physicians of the surgical area.

In the case of mumps we could establish that for the clinical area for the subjects at the beginning of work in the category of medical managers (doctors in training
and structured doctors) we found a chance of getting vaccinated equal to 85.03% for females and to 74.10% for males. In the nursing category the probability was 88.59% for females and 79.63% for males. For the last qualification examined we had a probability of vaccinating at the start of the career equal to 91.38% for females and 84.22% for males.

Moving from the clinical area to the surgical area with the same age and qualification characteristics, the probability of vaccination decreases for doctors, with 81.09% for females and 68.35% for males. In the nursing category, on the other hand, the probability was equal to 85.42% for females and 74.69% for males. For the last qualification examined, we had the chance to get vaccinated at the career start of 91.38% for females and 84.22% for males.

For the service area, the probability was equal in the first category for females to 76.41% and for males to 61.99%. For nurses the probability was equal to 81.56% for females and 69.02% for males. For the last qualification examined we had that the chance to get vaccinated at the beginning of the career is equal to 85.80% for females and 75.27% for males.

For this vaccine we obtained that the highest probability of being vaccinated belongs to the health care workers of the third category of females at the beginning of work belonging to the surgical area and the lowest probability for the doctors of the service area.

In conclusion, considering the three vaccinations analyzed that have all four globally representative irritants, we could observe that the highest probability of vaccination belongs to the female health care workers at the beginning of work belonging to the clinical area for measles vaccination. We obtained the lowest probability of vaccination for male physicians of services area for chickenpox.

**Discussion and conclusions**

Analysis of the data revealed vaccination coverage to fall below the level to ensure herd immunity. In particular, the rates of vaccinated HCWs for polio, hepatitis B, tetanus and diphtheria ranged between 60 and 80%, while for measles, mumps, rubella, pertussis, chickenpox and tuberculosis, the rate was 20-30%; lower vaccination coverage was found for some recently introduced vaccinations not specifically recommended yet for HCWs. However, many HCWs were unable to recall their immunization status (Fig. 1), confirming national and international data literature (2, 7, 12). HCWs are at high risk of exposure to hazardous biological agents and the WHO estimates that approximately 59 million HCWs are potentially exposed to these on a daily basis worldwide (13). It is well-known that susceptible HCWs were at greater risk of both acquiring and spreading serious infectious diseases to vulnerable patients, their colleagues and their family and friends. This was of particular concern, given the recently reported nosocomial outbreaks (13-18).

In this study, in line with the findings of other national and international studies, vaccination coverage rates were acceptable only for some diseases, but still sub-optimal. Vaccination coverage for influenza fell far short of the 75% target set for 2015 contained in the EU Council recommendation of December 2009 (2009/1019/EU). Protection against exanthematous diseases was totally inadequate to prevent disease transmission among susceptible HCWs and nosocomial outbreaks. Our findings revealed that in the majority of cases physicians have higher rates of vaccination compared to other HCWs, especially those working in the clinical area, as also reported in other studies (7, 12, 18, 19). Older workers were found to have a higher uptake for the influenza vaccine, while in younger HCWs
vaccination coverage was higher for hepatitis B, measles, mumps, rubella and varicella, in line with the literature (7, 12, 18, 19).

Higher coverage was observed for females, confirming the literature: in fact, higher rates are due to prevention of the risks correlated with some infections in pregnant women (for example rubella, HBV, measles, varicella, influenza and pertussis, etc (2)).

Also, highest coverage rates were found in pediatricians, as reported in international literature; in fact, in general, we could observe in them higher coverage and attitude towards vaccines; furthermore, pediatricians had higher coverage for measles, mumps, rubella, chickenpox and meningococcus C, perhaps because they come into contact with children that were more at risk of these infectious diseases (6, 18).

Another interesting issue from our study is the high percentage of HCWs who declared “do not recall” when asked whether they were vaccinated or not, and this probably reflects a lack of confidence in immunization. HCWs should understand that all vaccines are safe and useful; they should regard vaccinations as both a right and a duty to protect themselves and their patients.

A limitations of the study was that the HCWs self-report the vaccinations they received, so the older age groups may not recall or HCWs might tend to declare that they “do not remember” to avoid incurring legal action; we didn’t investigated the reason of such a lack of compliance.

Our results confirm that further efforts are required in Italy both to heighten awareness among HCWs and to guarantee the early recognition and prompt immunization of susceptible professionals under Healthcare Surveillance Programs. Raising awareness about the importance of vaccination among HCWs and studies on prevalence to counteract “vaccine hesitancy” were included in the main goals of the SAGE working group (1).

Protection against infectious diseases requires both economic and human resources. Investment in training healthcare staff was therefore important as the social and economic cost of non-protection may be higher.

We must remember that these HCWs are also potentially able to influence patient vaccination uptake (1, 19). Despite the availability of effective vaccines, some vaccine preventable diseases, such as measles, had recently spread in Italy and the higher number of unvaccinated immigrants might further increase the spread of infectious diseases (20-25).

Vaccines and certain practices, like handwashing, are fundamental and should be considered compulsory to prevent dangerous outbreaks of infection (23-27).

In this light, novel strategies to address “vaccine hesitancy” (i.e. promotion of vaccines via social networks and mass media, training for HCWs, provision of vaccines in the workplace) should be adopted to improve vaccination rates among HCWs (28).

The recent introduction in Italy of the law 119/2017 has led to an increase in vaccine coverage. Nevertheless, the enforce of this law was still controversial and subject of debate. In our opinion, this could cause vaccination coverage to fall down again, particularly given the already growing vaccination hesitancy even among expectant mothers (29-31).

Therefore urgent measures are needed to achieve satisfactory coverage. However, in view of the low coverage rates detected there is still undoubtedly a long way to go (7, 18, 19, 28, 29, 32).

Steps have been taken in some regions in Italy, which have introduced mandatory immunization policies to tackle the low vaccination coverage among HCWs (33-34). However, other measures were necessary to convince all HCWs (especially physicians) that vaccination is a duty entailed by their profession. Only in this way they could
be the proponents of a real change in the general population attitude. Finally, future physicians and nurses must be considered a priority target group for campaigns promoting vaccination, not only due to their work in the hospital, but especially as part of a future vision of creating a new generation of immunized (and immunizing!) HCWs.

Riassunto

Valutazione delle coperture vaccinali negli operatori sanitari di un ospedale universitario del Sud Italia

Introduzione. Negli operatori sanitari un adeguato intervento di immunizzazione è fondamentale per la prevenzione e il controllo delle infezioni, con ricadute non soltanto sullo stesso operatore, ma soprattutto nei confronti dei pazienti, ai quali potrebbe trasmettere l’infezione determinando gravi danni e/o morte. Purtroppo, a tutt’oggi, nonostante la presenza di linee guida internazionali e nazionali (DL 119/2017) le coperture vaccinali si mantengono basse, anche a causa del fenomeno della “vaccine hesitancy” diffuso tra gli stessi operatori sanitari. Alla luce di quanto sopra, l’obiettivo del nostro studio è stato quello di indagare la copertura vaccinale degli operatori sanitari di tutte le unità operative presenti nel nostro ospedale e di valutare le differenze tra sesso, età, profilo professionale e area di lavoro.

Materiali e metodi. È stato condotto da Marzo a Giugno 2018 uno studio al fine indagare le coperture vaccinali degli operatori sanitari dell’Azienda Ospedaliera-Università “G. Martino” di Messina; la raccolta dati è stata effettuata tramite la somministrazione di un questionario cartaceo da autocompilare basato sull’Allegato 3 della Circolare 25233 del 18 agosto 2017. È stata indagata la presenza di differenze statisticamente significative nelle coperture vaccinali tra medici e pediatri e tra classi decennali di età, attraverso il metodo chi quadrato. Inoltre, per ogni vaccinazione, è stata utilizzata una regressione logistica considerando la variabile vaccinazione e le seguenti covariate: tipo di unità operativa, sesso, età e area, verificando il peso di ognuna al fine di prevedere la probabilità di vaccinazione.

Risultati. È stato analizzato un campione di 822 operatori sanitari (di cui 324 maschi e 498 femmine con età pari a 49,5±10,5 DS). Il campione era composto da medici (36%) infermieri (21%) e da altre categorie professionali (43%). Dall’analisi dei dati emergono coperture vaccinali al di sotto dell’obiettivo richiesto per garantire la herd immunity, con maggiori coperture nelle femmine, nei medici e nell’area clinica; e, per la vaccinazione antifluenzale, nelle classi di età avanzate, mentre per tutte le altre vaccinazioni per i giovani.

Conclusioni. Dall’analisi dei dati emerge una mancata attenzione alle vaccinazioni da parte degli operatori sanitari e la necessità di misure tese all’incremento delle coperture vaccinali, onde evitare che gli stessi diventino fonte di pericolose epidemie.

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