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Active offer of Tdap vaccination in a cohort of healthcare workers of Maternal and Neonatal Department: Data from a large hospital in Southern Italy

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ABSTRACT

Pertussis is a vaccine-preventable respiratory disease. Pertussis vaccination is currently mandatory for all children in Italy, and is administered in three doses at the beginning of the third, fifth, and twelfth month of life, respectively. Booster doses are also recommended at five-six years, at eleven-twelve years, and then once every ten years. Healthcare workers (HCWs) are a high-risk population for pertussis. Strategies to increase HCWs' compliance to this vaccination have not been investigated in depth. Our study investigates the determinants of acceptance of a "soft nudge" vaccination campaign in a large hospital in Apulia (Southern Italy).

HCWs from the Gynaecology and Neonatology Units of Bari's Policlinico General Hospital were screened in June 2023 for pertussis vaccination. Non-vaccinated subjects were offered a vaccination appointment. Vaccination determinants were studied, and a logistic regression model was built to identify determinants that significantly influence vaccination acceptance.

At the time of screening, only 31.34% of target HCWs (68/217) had already been vaccinated. After the active call intervention, vaccine coverage rose to 70.00% (152/217). Significantly higher coverage was found in the Neonatology Unit (30/43, 69.77%) than in the Gynaecology unit (54/106, 50.94%) (Chi2: 4.41; p-value: 0.036). A logistic regression model confirmed a higher compliance to vaccination in HCWs staffed in the Neonatology Unit (Chi2: 2.08; 95%CI: 1.04 – 4.73; p-value: 0.038).

Our intervention increased vaccination coverage in a high-risk cohort. The solicitation was effective, as communication with a trained specialist might have improved the subjects' perception of vaccination and individual risk of contagion and transmission to others. A synergistic approach, mixing active call with a vaccination mandate, might have greater effectiveness.

Introduction

Pertussis is a respiratory disease caused by Gram-negative bacterium *Bordetella pertussis* [1]. It is an exclusively human pathogen, and transmission occurs via exchange of airborne respiratory droplets from infected subjects to susceptible ones [2]. The disease's onset is often characterized by mild cough, fever and copious nasal discharge; cough may evolve into a paroxysmal form, eventually leading to respiratory difficulties caused by repeating apnoeic episodes with cyanosis and vomit [1,3]. Complications may vary widely according to the patient's age, spanning from otitis media to pneumonia, sometimes with neurological damage related to prolonged hypoxia. Coughing might also cause subconjunctival and nasal haemorrhages [3,4].

An effective vaccine exists against pertussis. In most Western countries, this product is manufactured as a combined vaccine against diphtheria, tetanus, and pertussis (paediatric formulation: DTaP vaccine; adult formulation: Tdap vaccine) [5]. Vaccination is both able to prevent the disease and improve its prognosis, preventing complications especially in children [4]. Due to its significant impact on life expectancy and paediatric mortality, the DTaP vaccine is currently mandatory for all newborns in Italy [6]. Furthermore, since response against these pathogens is subjected to a waning immunity phenomenon, booster

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doses are recommended once every ten years [7].

The introduction of mass vaccination has significantly modified the epidemiology of pertussis. In fact, pertussis has progressively become a concern for adults rather than children [8,9]. This is related to the higher immunization coverage achieved among infants and the already mentioned tendency of immune response against the bacterium to wane over time. New-borns are also a category at high risk of pertussis and his complications, before receiving vaccination recommended for the first semester of life [7].

Tdap immunization is strongly recommended for all healthcare workers (HCWs), with particular regard to those who work in close contact with children who are yet to be immunized. These HCWs, in fact, are highly exposed to respiratory pathogens (such as *B. pertussis,* influenza, SARS-CoV-2) which pose a threat both to them and their young patients [10–13]; booster doses are especially important and should be routinely verified during occupational medicine visits. Due to this rationale, Apulia, a Region in Southern Italy, provides for Tdap immunization of all HCWs operating in gynaecological, obstetric and neonatology wards [14]. Vaccination is routinely offered to these workers during periodic occupational medicine examinations.

HCWs who refuse Tdap vaccination might be removed from their ward and assigned to a different, lower-risk one. However, current staff shortage makes it impossible to adhere to a strict mandatory vaccination policy, and various studies carried out in different settings have observed low compliance in HCWs, especially in the case of booster doses [15–17]. However, there is currently scarce insight regarding strategies to increase Tdap vaccination coverage in these subjects.

To face low vaccination coverage in high-risk HCWs, an active call-based "soft nudge" strategy has been employed in Bari's Policlinico General Hospital. This study aims at investigating the determinants of acceptance of this vaccination offer method in a cohort of healthcare workers.

Materials and methods

This is a population-based interventional study. The study population is represented by all HCWs operating within the Gynaecology and Neonatology Units of Bari's Policlinico General Hospital who were identified as non-immunized with a Tdap product. Bari's Policlinico is the largest hospital in Southern Italy, with 1,550 beds and hosting over 30,000 patients per year. The two included wards are located within the same pavilion, and have a direct connection via the delivery room. Our intervention consisted in an active call for Tdap vaccination, targeting unvaccinated HCWs operating in these high-risk facilities. We employed a personalized call strategy, combined with in-person confrontations with physicians trained in vaccinology.

In June 2023, all HCWs staffed in target wards were screened for Tdap vaccination status by the Public Health Unit's "Control Room". The employees' names were obtained from the General Direction's staff registry, along with personal phone contacts. Their immunization status was determined via the analysis of the Apulian regional immunization database, and subjects who had not undergone Tdap vaccination booster during the last ten years were identified.

All data was treated in accordance with existing regulation and in full agreement with the occupational physician, who is in charge of ascertaining the vaccination status of all workers upon routine occupational medicine examinations. Personal information was anonymized upon retrieval, and only aggregated data was presented. In detail, the following data was obtained: sex, age, job title, ward of employment, vaccination status (i.e., full base vaccination cycle and last booster dose's date).

Tdap −negative HCWs were notified via hand-delivered mail about their need to conform to regional requirements [14]; the same letter was also delivered to the Units' directors, as well as to the wards' coordinator staff. The mail's full text has been added to this article as Additional Materials. A meeting was then held with the directors of both Units, reporting the results of the HCW screening and proposing a vaccination program for their wards' staff. All directors complied, and vaccination appointments were scheduled starting from September 1st, 2023.

HCWs were summoned to the hospital vaccination centre in dedicated appointments; when an appointment was missed, the subject was contacted once again via phone call. All subjects were provided information about Tdap vaccination, and were encouraged to ask the vaccination centre's personnel in case they had any doubts concerning the vaccine. Staff who still refused to undergo immunization were asked to sign a refusal form, in which they declared to be refusing vaccination despite being adequately informed by a specialized physician. The deadline for vaccination was October 27th, 2023.

The distribution of vaccination determinants between HCWs who accepted and who refused vaccination was studied via the Chi-squared test. HCWs' sex, age, job title (medical doctor vs. others) and ward were taken into consideration. Since age was not normally distributed, we chose to categorize it instead, dividing the study population into two groups, one below the median age (55 years) and one over it. Vaccination determinants with significantly different distributions between the two groups were then studied via a logistic regression model.

A two-sided p-value < 0.05 was identified as an indicator of statistical significance for all statistical tests. Data was organized in a database built via Microsoft Excel®. Statistical analysis was done entirely on StataMP®.

Results

Before our intervention, only 31.34 % of target HCWs (68/217) had already been vaccinated. After the active call intervention, vaccine coverage rose to 70.00 % (152/217).

On September 1st, 2023, a total of 217 HCWs from the Gynaecology and Neonatology Units of Bari's Policlinico were screened for their Tdap vaccination status, 145 of which belonging to the former and 72 to the latter. One-hundred-forty-nine HCWs were identified as in need of Tdap booster vaccination, and were therefore included into the study population. The characteristics of the study population are summarized in Table 1.

When studied via the Chi-squared test, the only two groups with different vaccination coverage were those related to the different wards (Chi2: 4.41; p-value: 0.036), with higher coverage in the Neonatology Unit (30/43, 69.77 %) than in the Gynaecology unit (54/106, 50.94 %). No significant differences were observed between males and females (p-value: 0.267), physicians and non-medical HCWs (p-value: 0.390), and younger vs. older HCWs (p-value: 0.252).

This significant difference was then confirmed by the fitted logistic regression model, which identified a higher compliance to vaccination in HCWs staffed in the Neonatology Unit (Chi2: 2.08; 95 %CI: 1.04 – 4.73; p-value: 0.038).

Discussion

Our intervention led to a substantial increase in vaccination coverage against pertussis (as well as the other diseases targeted by the Tdap vaccine) in the Gynaecology and Neonatology Units' HCWs. This raise was observed over a very short time span, shorter than two months, and was possible due to the existence of a hospital vaccination centre dedicated to HCWs. It is therefore possible to assume that our soft-nudge intervention was effective and reduce vaccine hesitancy [18].

Our results corroborate previous evidence regarding the need for hospital-based interventions to increase vaccination coverage of HCWs, as well as the effectiveness of active call strategies [19,20]. The "soft mandate" policy, in particular, is currently being given special importance since it grants an increase in compliance to vaccination while minimizing the risk of conflictual interactions with HCWs [21]. It is also apparent that a "background noise regulation", such as the HCW vaccination mandate existing in Apulia, is not enough when not

Table 1
Study population characteristics.

		Sex		Task		Unit		Age		Total
		Male	Female	Physician	Others	Gynaecology	Neonatology	< 55 years	≥ 55 years	
Vaccination	*Refused*	8	57	11	54	52	13	31	34	65
	Accepted	16	68	19	65	54	30	48	36	84
Tot		24	125	30	119	106	43	79	70	149

supported by other kinds of intervention.

Information might have also been key to the success of our intervention. Evidence exists suggesting the importance of communication in vaccination offer, also when HCWs are concerned. It is undoubted that vaccine's safety and real-world efficacy are crucial: post-marketing surveillance programs should be implemented to collect data regarding adverse events following immunization (AEFI), adverse events of special interest (AESI), immunogenicity and risk of infections [22–25]. It is widely acknowledged that HCWs should receive recommended vaccinations due to their occupational exposure, both to protect themselves and because they may act as vectors in the nosocomial transmission of infectious diseases, especially for immunocompromised patients, but also for co-workers and relatives [26–29]. This kind of interaction with the vaccination's target population allows to reduce the impact of vaccine hesitancy, which is a rampant issue among HCWs [30].

It is however important to highlight that our cohort's vaccination coverage stayed suboptimal even after the intervention. The reasons for this might be various, including distrust or misinformation about vaccines, safety-related doubts, perceived inconvenience, low risk perception and lack of real word effectiveness data [31–34].

Suboptimal vaccination coverage and/or acceptability of pertussis vaccination among HCWs have also been observed by other studies. Vaux et al. [35,36], in particular, showed a self-reported pertussis vaccine coverage just above 50 %, with a relatively higher acceptability of mandatory vaccination in French HCWs. A significatively lower coverage was observed by an Italian study by Taddei et al. [37], in which only 14.5 % of the sample population declared to be up-to-date with the pertussis vaccination schedule.

Two weaknesses have to be acknowledged, as far as our study is concerned. First of all, the cohort we targeted was fairly small, counting only 149 people. This low numerosity has surely impacted our study's significance, potentially interfering with the variables' impact on vaccination acceptance; at the same time, it allowed us to interact with a fairly homogeneous group of individuals. Secondly, in order to properly ascertain the effectiveness of our intervention, we would have needed an interventional design with a non-intervention population group. However, this could have not been realized without intentionally exposing both the operators and the patients to harm.

On the other hand, we can highlight a few strengths. Most importantly, as already observed, considered HCWs were homogeneous in terms of occupational exposure to vaccine-preventable pathogens, even sharing their physical workplace. Secondly, the low numerosity allowed us to provide personalized information to all subjects. Finally, the existence of an informatized database for immunization status granted us full knowledge about these HCWs' vulnerability.

it would be interesting to repeat our study in post-pandemic scenario in order to evaluate the effects of the COVID-19 pandemic and immunization campaigns on vaccination attitudes towards vaccine-preventable pathogens [38,39].

Conclusions

In perspective, a mixed approach relying both on a vaccination mandate and on alternative forms of intervention might represent a future development of HCWs vaccination strategies [40,41]. Organizational and educational program have a relevant role in determining the vaccine compliance; information and proper communication are also fundamental, as they reinforce the intervention while also empowering the individual, thus granting their future active seek for vaccination [42–45].

CRediT authorship contribution statement

Antonio Di Lorenzo: Writing – original draft, Methodology. **Luca Capodiferro:** Writing – original draft, Data curation. **Michele Illuzzi:** Data curation. **Chiara Scaltrito:** Data curation. **Luigi Vimercati:** Methodology. **Lorenza Moscara:** Data curation. **Silvio Tafuri:** Writing – review & editing, Conceptualization. **Pasquale Stefanizzi:** Writing – review & editing, Supervision.

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.

Data availability

Data will be made available on request.

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