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## Vaccine hesitancy among hospital staff physicians: A cross-sectional survey in France in 2019

Pierre Verger, Christian Dualé, Nezha Lenzi, Dimitri Scronias, Céline Pulcini, Odile Launay

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1 Title. Vaccine hesitancy among hospital staff physicians: a cross-  
2 sectional survey in France in 2019

3 Pierre Verger<sup>1,2</sup>, Christian Dualé<sup>3,2</sup>, Nezha Lenzi<sup>4,2</sup>, Dimitri Scronias<sup>4</sup>, Céline Pulcini<sup>5,6</sup>, Odile Launay<sup>2,4</sup>

4 <sup>1</sup>Southeastern Health Regional Observatory (Observatoire régional de la santé Paca), Marseille, France

5 <sup>2</sup>Inserm, F-CRIN, Innovative Clinical Research Network in VACCinology (I-REIVAC), Paris, France

6 <sup>3</sup>Centre hospitalo-universitaire, Clermont-Ferrand, Centre d'Investigation Clinique; INSERM, CIC1405,  
7 Clermont-Ferrand, France

8 <sup>4</sup>Université de Paris, Faculté de médecine Paris Descartes; Inserm, CIC 1417; Assistance Publique  
9 Hôpitaux de Paris, Hôpital Cochin, Paris, France

10 <sup>5</sup>Université de Lorraine, APEMAC, équipe MICS, F-54000 Nancy, France

11 <sup>6</sup>Université de Lorraine, CHRU-Nancy, Infectious Diseases Department, F-54000 Nancy, France

12 **Corresponding Author:** Dimitri Scronias

13 **Address:** Observatoire régional de la santé PACA – Faculté de médecine

14 27, Bd Jean Moulin

15 13385 Marseille, Cedex 5

16 France

17 **Telephone number:** +33 6 79 03 12 10; **Email:** dimitri.scronias@inserm.fr

# 1 Introduction

2 Vaccine hesitancy (VH), defined as the refusal, delay, or acceptance of vaccines with doubts about  
3 their usefulness and safety [1], is recognized as one of the 10 most important health threats in the  
4 world today; while it varies between countries, it concerns up to 50% of the French public [2].

5 Because of their role in motivating their patients to be vaccinated and answering questions and  
6 concerns about vaccines and because their patients trust them strongly, healthcare professionals  
7 (HCPs) are the cornerstone of vaccination. Nonetheless, a growing number of publications from  
8 various countries show that VH also exists among them [3]. Because most are not really experts in  
9 vaccination, they sometimes share with laypeople uncertainties about vaccines' benefits and safety  
10 [4]. They may hesitate to accept some vaccines that health authorities recommend, such as seasonal  
11 influenza vaccines [5,6], or to recommend and/or prescribe some vaccines to their patients [7,8].

12 Nonetheless, studies quantifying the prevalence of VH among HCPs for various vaccines and target  
13 populations are infrequent. In France in 2014, we found moderate to high levels of VH in 1 in 8  
14 general practitioners (GPs), defined by uncertainty about vaccine utility and safety [9]. Moreover, VH  
15 was strongly associated with a reduced propensity to recommend vaccines on the official schedule to  
16 their patients [8]. Studies suggest that level of initial medical training and confidence in health  
17 authorities are important determinants of HCPs' VH [10–12].

18 Hospital staff physicians (HSPs) treat people with chronic and severe conditions, who account for a  
19 substantial portion of the general population often targeted for specific vaccine recommendations.  
20 Despite studies suggesting VH among HSPs, we have not found publications addressing  
21 simultaneously all specialties and various vaccine situations encountered in hospitalized patients. We  
22 organized a national survey of HSPs aimed at studying: 1) their prevalence of VH, by specialty 2) their  
23 characteristics associated with VH, and 3) the impact of their VH on their behaviors and attitudes

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Abbreviations: HCP, healthcare professionals; HSP, hospital staff physicians; VH, vaccine hesitancy; dTP, diphtheria-tetanus-poliomyelitis; HBV, hepatitis B; MCA, multiple correspondence analysis; AHCA, agglomerative hierarchical cluster analysis; VIF, variance inflation factor

24 toward their patients (recommendation frequency and communication attitudes) and themselves  
25 (self-vaccination acceptance).

## 26 Methodology

### 27 Population

28 We conducted a cross-sectional in-person questionnaire survey [13] (fewer than 5% of the  
29 questionnaires were self-administered) of HSPs in 14 French public hospitals (Figure S1,  
30 supplementary material). They represent 15.0% of the hospitals of their size in mainland France and  
31 21.5 % of their HSPs. We excluded hard-to-reach HSPs (physicians working in emergency  
32 departments, who rotate frequently) and specialties that do not address vaccination with patients  
33 (e.g., clinical biologists and radiologists). HSPs were stratified into specialties likely to deal with  
34 vaccination in their daily practice (e.g. pediatricians) or not (e.g. surgeons), referred to hereafter as  
35 “vaccinators” and “non-vaccinators”.

### 36 Procedure and questionnaire

37 Clinical research associates established the list of eligible HSPs in each hospital, contacted them by e-  
38 mail or telephone, and, if they agreed to participate, used computer-assisted personal interview  
39 software to interview them from September 2018 to October 2019.

40 The standardized questionnaire was adapted from a previous questionnaire developed and used to  
41 study vaccination practices and perceptions among French GPs [9]. After qualitative interviews with  
42 18 HSPs of various specialties in several hospitals in Marseille (France), the questionnaire was  
43 adapted by a multidisciplinary panel of experts including epidemiologists, HSPs, and infectious  
44 disease specialists. We pilot-tested it for clarity, length, and face validity among 50 HSPs in 3  
45 hospitals.

46 The questionnaire asked about participants' professional characteristics (e.g., specialty, continuing  
47 medical education on the topics of infectious diseases and/or vaccination over the past three years),  
48 their own vaccinations against HBV, diphtheria-tetanus-poliomyelitis (dTP) (both mandatory for HCPs  
49 at the time of the study), and seasonal influenza (only recommended) and the frequency at which  
50 they recommend vaccines to at-risk patients in three vaccine situations frequently observed in their  
51 specialty (these situations thus differed between specialties; see Table S1, supplementary material).  
52 It also asked about HSPs' perception of their role towards patients related to vaccination, experience  
53 with severe side effects potentially related to vaccination (leading to hospital admission) among their  
54 vaccinated patients, and whether any of their patients in the past five years had had any of the  
55 following vaccine-preventable diseases: measles, acute or recently diagnosed chronic hepatitis B  
56 (HBV), bacterial meningitis, cervical cancer, or complicated seasonal influenza requiring  
57 hospitalization. Finally, the questionnaire asked about their perception of the utility and safety of  
58 vaccines, trust in different sources of information about vaccine risks and benefits (French Ministry of  
59 Health, scientific sources, and medical colleagues), knowledge about vaccine components (if the  
60 influenza vaccine contains aluminum), and perceived self-efficacy in explaining the role of vaccine  
61 adjuvants.

62 The participants gave their written consent and did not receive any incentive. The Ethics Committee  
63 of Aix-Marseille University approved this study (2017-14-12-006).

#### 64 Statistical analysis

65 We weighted data for age and sex, according to the Ministry of Health's Shared Directory of Health  
66 Professionals to match the HSP population in France. In a sensitivity analysis, we separately weighted  
67 data on regional HSP numbers and hospital size (in addition to age and sex) and found no significant  
68 differences in the distribution of HSPs' responses compared to that after age- and sex-weighting. The  
69 following results are thus presented with the latter weighting only.

70 To estimate vaccine hesitancy prevalence among HSPs, we constructed a typology of vaccine-related  
71 attitudes, based on items on trust in sources of information about vaccines, perceived usefulness and  
72 risks of vaccines, and self-efficacy (Table A2, Appendix), adapting a previously published approach  
73 used for GPs [9]. In addition to the self-efficacy dimension, our measure of vaccine hesitancy also  
74 covers the two dimensions of the Vaccine Hesitancy Scale developed by the WHO SAGE group: lack  
75 of confidence in vaccine benefits and information, and fear of vaccine risk [14]. We performed a  
76 weighted multiple correspondence analysis (MCA) combined with an agglomerative hierarchical  
77 cluster analysis (AHCA) of the different dimensions of HSPs' VH [15]. MCA is an exploratory technique  
78 used to understand the interrelations between multiple categorical variables [16]; it allows  
79 correlated variables to be combined into continuous factors [17]. These factors are then introduced  
80 in the AHCA, which classifies individuals with similar characteristics into clusters. To identify the  
81 optimal number of clusters, we used a method based on minimum inertia lost [17,18], corresponding  
82 to the lowest total within-cluster variance (individuals with maximum similarity in each cluster) and  
83 highest between-cluster variance.

84 We then used this typology as a dependent variable in univariate and multiple modified Poisson  
85 regressions to analyze factors potentially associated with it [19]. We tested the following explanatory  
86 variables: demographic and professional characteristics, perceived role in the field of vaccination,  
87 experience of serious adverse effects with vaccines (Yes/No), experience of vaccine-preventable  
88 diseases among patients (count variable ranging from 0 to 5), knowledge about vaccine components,  
89 self-vaccination behaviors, and a score of the HSPs' frequency of patient vaccine recommendations.  
90 We calculated the latter by adding their responses on a Likert scale (range [0–6]; Cronbach's alpha =  
91 0.66). Because we observed multicollinearity between specialty and the vaccine recommendation  
92 frequency score, we constructed two models each including one of these two variables.

93 We used the variance inflation factor (VIF) to test for multicollinearity and interpreted VIF values of  
94 <5 as not presenting any multicollinearity issues. All analyses were based on two-sided *P* values, with

95 statistical significance defined as  $P \leq 0.05$ ; they were performed with Stata 14 (StataCorp, College  
96 Station, TX, USA) and R 3.6.3 (R Foundation, Vienna, Austria).

## 97 Results

98 Of the 4,327 eligible HSPs, 2,154 (50%) could be contacted: 1,851 (86%) participated in the survey; 45  
99 (2.4%) of them were excluded because their specialty was outside the scope of the study (biologists,  
100 radiologists, etc.), and 11 (0.6%) who did not provide their age or sex. This left 1,795 (83%) HSPs for  
101 the analyses. Female HSPs accounted for 53.6% of the participants, and 49.1% of HSPs were younger  
102 than 45 years; the specialties included most often (i.e., >6% of the sample) were cardiology, geriatrics,  
103 hepato-gastroenterology, oncohematology, pediatrics, and pulmonology; specialties least  
104 represented were general practice, ophthalmology-otolaryngology, physiatrics, psychiatry, public  
105 health-social medicine-occupational medicine (Table 1).

106 Almost all HSPs (99%) were favorable to vaccination (93.7% strongly; Table 2). Among those  
107 accustomed to discussing vaccination with their patients, 54% reported that they try to convince  
108 vaccine-reluctant patients to be vaccinated while 45% reported that they would simply inform them  
109 of the benefits and risks of vaccines, but do not try to convince patients about the need for  
110 vaccination.

111 Most HSPs reported that they had been vaccinated against seasonal influenza (82%) in 2017/18, that  
112 they had their last dTP booster within the past 20 years (91%), and at least 3 doses of the HBV  
113 vaccine (86%). Only 20%, however, had taken at least one continuing medical education program on  
114 infectious diseases and/or vaccination in the past three years.

115 Among the participants, 52.5% trusted the Ministry of Health as a source of information about the  
116 benefits and risks of vaccines (Table 3). Only 3% agreed with the proposition that some vaccines  
117 recommended by health authorities are useless, and only 40.7% felt comfortable giving their patients  
118 explanations about the role of adjuvants. Regarding the potential risks of vaccines, 10.3% found a

119 causal link between hepatitis B vaccine and multiple sclerosis to be likely or did not express an  
120 opinion about this purported link, while the corresponding percentages were 26.3% for a link  
121 between seasonal influenza vaccine and Guillain-Barré syndrome, and 21.3% for one between  
122 aluminum adjuvants and neurological complications (Table 4).

123 The analysis of cross-tabulated proportions of HSPs attributing to a particular vaccine a specific  
124 severe adverse effect (or other severe adverse effects or unsure about it, Table S1) shows that these  
125 responses were all very significantly associated. For example, of the HSPs who considered a causal  
126 link between seasonal influenza vaccination and Guillain-Barré syndrome to be likely (or who were  
127 unsure), 22% attributed multiple sclerosis to hepatitis B vaccine (or were unsure), compared with  
128 4.6% of other HSPs ( $P<0.001$ ). The percentages of participants attributing one, two, or three or more  
129 severe adverse effects to vaccines were respectively 22.0%, 9.6%, and 3.1%.

130 We identified three clusters according to VH level (Figure 1). HSPs in cluster 1 (58%) were  
131 characterized by low or almost no VH (Table 3): they had the greatest trust in official sources of  
132 information about vaccine risks and benefits and reported the fewest doubts regarding vaccine utility  
133 and safety. Most considered links between all of the proposed vaccines and potential severe adverse  
134 effects unlikely.

135 Given the very small size of cluster 3 (High VH;  $n=14$ ; 0.8%), we merged it with cluster 2 (41%, Table  
136 3). HSPs in the resulting cluster (“moderate” VH; they will be referred hereafter as to hesitant HSPs)  
137 were relatively less trustful of official sources of information on vaccination (higher frequency of  
138 “trust somewhat” answers); in particular, 37% of them believed that French health authorities are  
139 influenced by the pharmaceutical industry. Hesitant HSPs did not perceive vaccines to be as useful or  
140 as safe as those in cluster 1 and showed lower perceived self-efficacy in their responses in general  
141 (Tables 3 & 4). Prevalence of hesitancy was lowest in infectious disease specialists (12.3%) and  
142 pediatricians (27.7%) and highest in ophthalmologists or otolaryngologists (61.9%) (Table S2).



143 The two-model strategy presented above showed no multicollinearity issue. In both the univariable  
144 and multivariable regressions, the least vaccine-hesitant among all "vaccinators" were the specialists  
145 in infectious diseases and the pediatricians (Table 7). Apart from these two specialties, VH prevalence  
146 did not differ significantly between "vaccinators" and "non-vaccinators". Vaccine-hesitant HSPs  
147 reported they were less frequently vaccinated against seasonal influenza and were less often up-to-  
148 date for their vaccination against HBV, less likely to try to convince reluctant patients to accept  
149 vaccines and to discuss vaccination with their patients and more likely to rely on their own judgment  
150 over national vaccine recommendations (Table 5). HSPs' VH was associated with a significantly lower  
151 patient vaccine recommendation frequency score. It was less prevalent among HSPs who had had  
152 training on infectious diseases and vaccination over the past three years.

153

## 154 Discussion

155 While almost all the HSPs in our study reported that they were strongly favorable to vaccination, 40%  
156 of them reported moderate VH.

157 Among hesitant HSPs, VH remained moderate, however, with only 14 HSPs showing high VH: the  
158 very low percentage of HSPs considering that some vaccines recommended by health authorities are  
159 useless (Table 3) contrasts with the corresponding percentage found among French GPs in 2014  
160 (25%) [9]. Less than one in five HSPs found a causal link between hepatitis B vaccine and multiple  
161 sclerosis to be likely or preferred not to express an opinion about this purported link, compared with  
162 30% among French hesitant GPs in 2014 [9] and 74% among French nurses in 2018 [20]. As we had  
163 noticed for GPs previously, HSPs' answers about the potential links between vaccines and severe  
164 adverse effects reflect their risk perceptions more than their knowledge of epidemiological results in  
165 this field. This finding is supported by the strong association in the cross-analyses (Table S1) of HSPs'  
166 responses between the corresponding six items, whether these side effects were rumored or  
167 documented. Moreover, the high frequency of "don't know" answers (Table 4) suggests that  
168 significant proportions of them feel uncertain about vaccine safety, an important subject of concern  
169 for hesitant patients. However, the results also suggest that HSPs' knowledge was somewhat better  
170 with regard to the links between seasonal influenza vaccination and Guillain-Barré syndrome, and  
171 Pandemrix and narcolepsy for which there is some evidence [21–23] (Table 4). These percentages  
172 differed less markedly between non-hesitant and hesitant HSPs than for alleged neurological effects  
173 of adjuvants, which have been an important subject of controversy in France over the past two  
174 decades [8].

175 Another feature of hesitant HSPs is their moderate or relative trust of health and safety agencies and  
176 the Ministry of Health (Table 3). Comparisons of our results with previous ones among other French  
177 HCPs using an item proposing that the Ministry of Health is influenced by the pharmaceutical  
178 industry show a rising gradient of distrust towards the Ministry of Health from HSPs (35%, whole

179 sample) to GPs (53%) [8] and nurses (80%) [20]. Trust in public health institutions plays a substantial  
180 role in shaping GPs' perceptions of vaccine utility and safety [10]. The results of this study illustrate  
181 that trust in the healthcare system and, more generally, in government bodies affects vaccine  
182 acceptance not only by the public but also by HCPs, even those who have had more extensive  
183 medical training about vaccination. These results might be explained by multiple factors that deserve  
184 further research. The numerous health crises – at the time of this survey, the most recent was that of  
185 Mediator® (benfluorox), a drug marketed as an antidiabetic with harmful cardiac effects claimed to  
186 have resulted over the years in the deaths of as many as 2000 patients without being withdrawn by  
187 its manufacturer or removed by French health authorities) – as well as the decades-long social  
188 conflicts and underfunding of public hospitals, could well have significantly impaired HSPs'  
189 confidence in the Ministry of Health [24].

190 Our results are consistent with previous results suggesting that VH in physicians and other HCPs is  
191 associated with their lower uptake of some vaccines, especially against the seasonal flu [25,26], even  
192 though self-reported vaccine coverage against this disease is high in our study [27]. A questionnaire  
193 survey of more than 1200 physicians in 2018-19 in France found a self-reported vaccine coverage  
194 rate of 67% for seasonal flu: the inclusion in their sample of some hospitals in the French overseas  
195 territories (about 15% of the sample), where seasonal flu vaccine uptake was very low, may explain  
196 in part the difference with our results.

197 They also suggest that hesitant HSPs have different behaviors and attitudes towards their patients  
198 than non-hesitant doctors do (Table 5). First, they suggests that hesitant HSPs might be less prone  
199 than their non-hesitant counterparts to recommend to their patients vaccines officially  
200 recommended for them because of their chronic or severe conditions [8]. This is a matter of concern  
201 because the recommendation of vaccines to patients by their doctors is one of the most important  
202 drivers of their acceptance [28]. VH also encompasses the greater tendency by hesitant than non-  
203 hesitant HSPs to give more weight to their own judgment than to official vaccine recommendations,

204 as we previously found in a qualitative study of hesitant GPs [12]. In that study, some GPs criticized  
205 official vaccine recommendations that they found too complex to apply; others considered that their  
206 frequent revision creates doubt about their validity; finally, many were willing to adapt the  
207 vaccination schedule for acute conditions.

208 Second, hesitant HSPs were less proactive in motivating their hesitant patients to be vaccinated than  
209 non-hesitant HSPs (Table 5), perhaps because they might share some concerns with their hesitant  
210 patients about some vaccines and/or may not feel adequately prepared to address these concerns  
211 appropriately. In the current context of scientific debate about the most effective communication  
212 approaches in the field of vaccination [1], it is difficult to draw firm conclusions about the  
213 consequences of such attitudes: they are not necessarily a sign that HSPs are disengaging from their  
214 role in patient vaccination.

215 As expected, VH frequency was lowest among infectious disease specialists and pediatricians,  
216 specialties (Table S2) in which vaccination has a more important place in training and practice than in  
217 other specialties. A recent study in Finland among various HCPs (doctors and nurses) found that their  
218 vaccine confidence followed a gradient that increased with their educational level [11,12]. In our  
219 results, however, this gradient was limited to the comparison of infectious disease specialists and  
220 pediatricians to other doctors, thereby suggesting that, except for these specialties, moderate VH  
221 prevalence was present in all other specialties, vaccinators or non-vaccinators, with prevalence rates  
222 of the same order of magnitude. In other words, most hospital physician specialties may be affected  
223 by VH.

224 These results should be interpreted while bearing the study's strengths and limitations in mind. The  
225 participation rate was high (86%). The main reasons for refusing participation were lack of time or  
226 lack of interest in the topic. Selection bias cannot be ruled out, however, as not all eligible HSPs could  
227 be contacted by the clinical research associates, and participation was voluntary: physicians who  
228 agreed to participate could have been more aware of vaccination issues than non-participants, and

229 this could have led to an underestimation of VH prevalence. The questionnaire used in this study was  
230 adapted from a previous one prepared for a survey among GPs in 2014 [8] and thus enabled some  
231 “qualitative” comparisons of HSPs' answers with those of GPs several years earlier. After adaptation  
232 of the questionnaire, its face validity was very good, with few non-responses.

233 The 14 participating hospitals (among 93 in mainland France) were not randomly selected: the  
234 resulting sample may not be representative of all HSPs in France. However, weighting the data  
235 according to hospital region and size did not produce changes in the observed distributions of  
236 responses to questionnaire items. Moreover, most HSPs' specialties (and all of those participating in  
237 vaccination tasks) were represented in the sample and were affected by VH at similar frequencies  
238 and to similar extents (with the exception of specialists in infectious diseases and pediatricians; see  
239 the supplementary analysis detailing the specialty variable (Table A3, Appendix).

240 The cross-sectional design prevents us from drawing any conclusions about causality for the relations  
241 between VH and its potential determinants, as is the case for most studies in this field. Finally, all  
242 data were self-reported and a social desirability bias cannot be ruled out. The field survey  
243 nonetheless took place during a period not marked by intense vaccine controversies. Memory bias  
244 might have affected the reliability of responses to self-reported vaccination: authors consider that it  
245 could slightly overestimate actual uptake [29]; it should not, however, have influenced the relation  
246 between self-declared uptake and VH.

247 In conclusion, the results of this study contribute to a more complete assessment and understanding  
248 of VH among HCPs. Concerns or uncertainties about the safety of specific vaccines were observed in  
249 most specialties in hospitals, with the exception of infectious disease specialists and pediatricians.

250 Our results, combined with those of previous studies of HCPs, suggest that hesitant HSPs may have  
251 less proactive practices than non-hesitant HSPs.

252 Qualitative studies are needed to better understand the various determinants underlying HSPs' VH,  
253 as hospitals are an important specific setting as mentioned above. Taken together our results

254 underscore once again the urgent need to address VH in physicians and to allocate to vaccination the  
255 place it deserves in their initial training curriculum [30] and in continuing medical education.  
256 Interventions are needed to help them discern falsities from truth about vaccine controversies and  
257 better prepare them to cope with their patients' hesitancy.

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273

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## 363 Tables

364 Table 1: Characteristics of hospital staff physicians (n = 1,795)<sup>a</sup>

	No. (N = 1,795)	%
Characteristics		
Sex		
Women	962	53.58
Men	833	46.42
Age (years)		
< 35	407	22.67
35-44	475	26.47
45-54	357	19.87
55-64	488	27.18
> 64	68	3.81
Specialty		
Anesthesiology-critical care	62	3.46
Cardiology	119	6.61
Dermatology	68	3.78
Endocrinology-diabetes	88	4.91
General practice	32	1.81
Geriatrics	118	6.56
Gynecology-obstetrics	95	5.32
Hepato-gastroenterology	122	6.81
Infectious diseases	102	5.70
Internal medicine	100	5.56
Nephrology	93	5.20
Neurology	104	5.78

Oncohematology	115	6.42
Ophthalmology, otolaryngology	30	1.65
Pediatrics	186	10.35
Physiatrics	12	0.70
Psychiatry	32	1.77
Public health, social medicine and occupational health	52	2.89
Pulmonology	117	6.52
Rheumatology	60	3.33
Surgery	87	4.87

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<sup>a</sup> weighted data, France, September 2018 to October 2019

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367 Table 2: Experience, practices, knowledge and opinions of hospital staff physicians towards vaccines and  
 368 vaccination (n = 1,795)<sup>a</sup>

	No. (N = 1,795)	%
<b>Opinions on vaccination in general &amp; perceived role</b>		
Favorable to vaccination in general		
Strongly favorable	1682	93.70
Somewhat favorable	99	5.50
Not favorable/NR (N = 11) <sup>b</sup>	14	0.80
Perceived role towards vaccine-hesitant patients (N=1,659) <sup>c</sup>		
Try to convince reluctant patients to get vaccinated	898	54.13
Inform patients on vaccines benefits & risks, without trying to convince them	753	45.41
Will not agree to care for patients refusing vaccination	8	0.46
<b>Experience with vaccination</b>		
Has had at least one patient hospitalized with at least one vaccine-preventable disease in the past 5 years <sup>d</sup>		
Yes	1,603	89.30
No/DK (3) <sup>e</sup> /NR (3)	192	10.70
Has had any patients with a serious health problem potentially related to vaccination		
Yes	141	7.84
No/DK (11)/NR (6)	1,654	92.16
<b>Personal vaccinations</b>		
Against 2017/18 seasonal influenza		
Yes	1,468	81.76
No/DK (3)/NR (1)	327	18.24

Last diphtheria-tetanus-polio (DTPolio) booster		
< 20 years ago	1,627	90.62
> 20 years ago	111	6.16
Does not remember/NR (2)	58	3.22
Against hepatitis B		
Yes, 3 or more doses	1,547	86.18
Yes, fewer than 3 doses	150	8.34
No/DK (48)/NR (2)	98	5.49
<b>Knowledge about vaccination</b>		
Has taken at least one continued medical education program on infectious diseases and/or vaccination in the last three years		
Yes	371	20.68
No, but teaches classes about vaccination	101	5.64
No/DK (3)	1,323	73.68

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<sup>a</sup> Weighted data

<sup>b</sup> NR: no response

<sup>c</sup> Question asked only to HSs who are accustomed to discuss vaccination with their patients; 5 NRs

<sup>d</sup> Five vaccine-preventable diseases were mentioned in the questionnaire: measles, acute or recently diagnosed chronic hepatitis B, bacterial meningitis, cervical cancer, and complicated seasonal influenza requiring hospitalization

<sup>e</sup> Does not know

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372 Table 3: Typology of hospital physicians according to their level of vaccine hesitancy, cross-tabulated with their  
 373 trust in sources of information about vaccines, and their perceptions of usefulness vaccines (n = 1,795)<sup>a</sup>

	Vaccine hesitancy		
	Almost none or low (N = 1,038) 57.83% [55.38-60.25] <sup>b</sup>	Moderate <sup>c</sup> (N = 757) 42.17% [39.75-44.62]	Total (N = 1,795) %
<b>Trust in sources of information about the benefits and risks of vaccines</b>			
<b>French Ministry of Health***</b>			
Distrust/DK (N = 18)/NR (7) <sup>d</sup>	5.24	9.60	7.08
Somewhat trust	28.14	57.22	40.40
Strongly trust	66.61	33.18	52.52
<b>French Health and Safety agencies***</b>			
Distrust/DK (34)/NR (6)	2.90	7.79	4.96
Somewhat trust	22.99	51.94	35.20
Strongly trust	74.11	40.27	59.84
<b>Scientific sources***</b>			
Distrust/DK (3)/NR (3)	0.52	1.59	0.97
Somewhat trust	13.48	35.21	22.64
Strongly trust	86.00	63.20	76.39
<b>Physician colleagues***</b>			
Distrust/DK (3)/NR (1)	0.74	1.64	1.12
Somewhat trust	10.05	23.40	15.68
Strongly trust	89.21	74.96	83.20
<b>French health authorities are influenced by the pharmaceutical industry***</b>			
Disagree/DK (66)/NR (18)	78.05	63.19	71.78

Agree	21.95	36.81	28.22
You trust the group of experts who establishes vaccine recommendations in France*			
Disagree/DK (4)/NR (2)	1.51	3.56	2.37
Agree	98.49	96.44	97.63
<b>Perception of the usefulness of vaccines</b>			
Some vaccines recommended by health authorities are useless			
Disagree/DK (18)/NR (39)	97.43	96.38	96.77
Agree	2.57	3.62	3.23
Children are vaccinated against too many diseases***			
Disagree/DK (14)/NR (3)	99.03	93.66	96.77
Agree	0.97	6.34	3.23
<b>Self-efficacy</b>			
<b>Generally, do you feel comfortable giving your patients explanations about the:</b>			
Usefulness of vaccines***			
No/DK (1)/NR (7)	3.10	10.69	6.30
Yes	96.90	89.31	93.70
Role of adjuvants***			
No/DK (18)/NR (12)	51.10	70.59	59.32
Yes	48.90	29.41	40.68

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\*\*\*:  $p < 0.001$ , \*\*:  $p < 0.01$ , \*:  $p < 0.05$  (Chi-squared test (with Rao-Scott correction))

<sup>a</sup> Agglomerative hierarchical cluster analysis, weighted data

<sup>b</sup> 95% confidence interval

<sup>c</sup> 14 HSs with high VH were included with the low to moderate VH group

<sup>d</sup> DK/NR: Does not Know/No Response



375 Table 4: Typology of hospital physicians according to their level of vaccine hesitancy, cross-tabulated with their  
 376 perceived risks of vaccines (n = 1,795)<sup>a</sup>

	Vaccine hesitancy		
	Almost none or low	Moderate <sup>b</sup>	Total
	(N = 1,038) %	(N = 757) %	(N = 1,795) %
<b>Perceived likelihood of risks between specific vaccines</b>			
<b>and potential severe adverse effects</b>			
Seasonal influenza vaccine and Guillain-Barré syndrome***			
Unlikely	81.69	62.67	73.67
Likely	16.39	27.28	20.98
Does not know (N = 88)/NR (8) <sup>c</sup>	1.92	10.05	5.35
Hepatitis B vaccine and multiple sclerosis***			
Unlikely	97.02	82.33	90.82
Likely	2.86	11.83	6.64
Does not know (36)/NR (9)	0.13	5.84	2.54
Aluminium adjuvants and neurological complications***			
Unlikely	89.58	63.89	78.75
Likely	4.32	19.86	10.88
Does not know (178)/NR (8)	6.09	16.25	10.37
AS03-adjuvanted influenza A(H1N1)pdm09 vaccine			
Pandemrix® and narcolepsy***			
Unlikely	76.46	56.65	68.11
Likely	11.80	10.90	11.42
Does not know (360)/NR (8)	11.74	32.45	20.47
Human papilloma virus vaccine and multiple			

sclerosis***			
Unlikely	96.14	76.97	88.06
Likely	0.15	3.19	1.43
Do not know (182)/NR (6)	3.71	19.84	10.51
MMR vaccine and autism***			
Unlikely	97.36	81.92	90.85
Likely	0.06	1.50	0.67
Does not know (143)/NR (9)	2.57	16.58	8.48

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\*\*\*:  $p < 0.001$ , \*\*:  $p < 0.01$ , \*:  $p < 0.05$  (Chi-squared test (with Rao-Scott correction))

<sup>a</sup> Agglomerative hierarchical cluster analysis, weighted data, France, September 2018 to October 2019

<sup>b</sup> 14 HSs with high VH were included with the low to moderate VH group

<sup>c</sup> NR: No response

378 Table 5: Factors associated with higher vaccine hesitancy among hospital physicians, modified Poisson  
 379 regression (n = 1,795)

<b>Moderate vaccine hesitancy</b>					
(ref. Almost none or low)					
N = 1,795					
	Simple	Multiple – Model 1		Multiple – Model 2	
	RR†	aRR†	CI 95%	aRR†	CI 95%
<b>Characteristics</b>					
Specialty (ref. Likely vaccinators <sup>a</sup> )					
Infectious disease specialists	<b>0.25***</b>			<b>0.31***</b>	[0.17,0.55]
Pediatricians	<b>0.58***</b>			<b>0.63***</b>	[0.49,0.81]
Likely non-vaccinators <sup>b</sup>	1.04			0.95	[0.81,1.13]
Other <sup>c</sup>	1.12			1.11	[0.88,1.39]
<b>Perceived role</b>					
Perceived role towards vaccine-hesitant patients (ref. Motivate them to vaccinate, even when they are reluctant)					
Inform them of the benefits and risks of vaccines, but let them decide	<b>1.23***</b>	<b>1.18**</b>	[1.05,1.32]	<b>1.20**</b>	[1.07,1.34]
Not concerned (does not discuss vaccination with patients)	<b>1.61***</b>	<b>1.34**</b>	[1.08,1.66]	<b>1.34**</b>	[1.11,1.61]
<b>Experience related to vaccination</b>					
Number of different vaccine-preventable diseases among the HSPs' patients [0–5]	<b>0.94***</b>	1.00	[0.96,1.04]	1.01	[0.97,1.06]
<b>Knowledge on vaccines and vaccination</b>					
Has had at least one continuing medical education in infectious diseases and/or vaccination in the last three years (ref. No/Do					

not Know)

No, but trains others in the field of vaccination	<b>0.59**</b>	<b>0.71*</b>	[0.50,0.99]	0.83	[0.60,1.17]
Yes	<b>0.66***</b>	<b>0.76***</b>	[0.64,0.90]	<b>0.81*</b>	[0.69,0.95]
According to you, does the flu vaccine contain aluminum? (ref. No)					
Yes	1.05	1.01	[0.82,1.24]	0.98	[0.80,1.21]
Does not know	<b>1.30***</b>	1.15	[1.00,1.31]	1.13	[0.99,1.29]

### Personal vaccinations

Against 2017–2018 seasonal influenza (ref. Yes)

No/Does not know	<b>1.46***</b>	<b>1.23***</b>	[1.09,1.39]	<b>1.26***</b>	[1.12,1.43]
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Last diphtheria-tetanus-polio (dTPolio) booster (ref. <20 years ago)

>20 years ago	1.18	1.06	[0.86,1.32]	1.03	[0.83,1.28]
Does not remember	<b>1.40**</b>	1.21	[0.95,1.54]	1.21	[0.96,1.52]

Against hepatitis B (ref. Yes, 3 or more doses)

Yes, fewer than 3 doses	<b>1.29**</b>	<b>1.19*</b>	[1.01,1.41]	1.15	[0.97,1.35]
No/Does not know	<b>1.39**</b>	<b>1.26*</b>	[1.03,1.55]	<b>1.25*</b>	[1.02,1.54]

### Vaccination towards patients

Score of vaccine recommendation (ref. Low, first tertile [0–3])

Moderate, second tertile [4–5]	<b>0.79**</b>	0.87	[0.75,1.00]		
High, third tertile [6]	<b>0.64***</b>	<b>0.75***</b>	[0.64,0.88]		
Not concerned (does not vaccinate patients)	0.97	0.91	[0.76,1.08]		

You rely on your own judgment over official vaccine recommendations (ref. No)

Yes	<b>1.22*</b>	<b>1.22*</b>	[1.02,1.46]	<b>1.23*</b>	[1.03,1.47]
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RR: relative risks; aRR: adjusted relative risks; CI: confidence interval; \*\*\*: p <= 0.001, \*\*: p < 0.01, \*: p < 0.05

Variables not shown (not significant): age, sex, has had patients with a serious health problem potentially related to vaccination. All VIF < 5: no proof of multicollinearity.

<sup>a</sup>Likely vaccinators: cardiologists, dermatologists, endocrinologist-diabetologists, geriatricians, gynecologist-obstetricians, internists, nephrologists, neurologists, oncohematologists, pulmonologists, rheumatologists; <sup>b</sup>Likely non-vaccinators: anesthetist/intensivists, ophthalmologists, otolaryngologists, psychiatrists, surgeons; <sup>c</sup>Others: general practitioners, physiatrists, doctors working in public health, social medicine and occupational health

