

Suboptimal immunization coverage among Canadian rheumatology patients in routine clinical care

Tedi Qendro, María Laura de la Torre, Pantelis Panopalis, Elizabeth Hazel, Brian J. Ward, Inés Colmegna, Marie Hudson

Key Indexing Terms: Vaccination coverage, Rheumatic diseases, Preventative health services, Canada, Quebec

From the Department of Medicine, McGill University, Montreal; Division of Rheumatology, McGill University Health Center, Montreal; Infectious Diseases and Immunity in Global Health Program, Research Institute of the McGill University Health Center, Montreal; Division of Rheumatology and Lady Davis Institute for Medical Research, Jewish General hospital, Montreal, Canada; Internal Medicine, Rheumatology and Immunology, Centro de Educacion Medica e Investigaciones Clinicas Norberto Quirno, Buenos Aires, Argentina.

This research was in part supported by the Canadian Rheumatology Association and a 2016 Canadian Institute for Outcomes in Rheumatology cAre (CIORA) grant on “Strategies to enhance Influenza/Pneumococcal vaccination coverage among rheumatoid arthritis patients”.

Disclosures: Authors declare no conflicts of interest.

T. Qendro, MSc, Department of Medicine, McGill University; M.L. de la Torre, MD, Internal medicine, Rheumatology and Immunology, Centro de Educacion Medica e Investigaciones Clinicas Norberto Quirno; P. Panopalis, MD, Division of Rheumatology, McGill University Health Center; E. Hazel, MD, Division of Rheumatology, McGill University Health Center; B.J. Ward, MD DTM&H, Infectious Diseases and Immunity in Global Health Program, Research Institute of the McGill University Health Center; I. Colmegna, MD, Division of Rheumatology, McGill University Health Center; M. Hudson, MD MPH FRCPC, Division of Rheumatology and Lady Davis Institute for Medical Research, Jewish General Hospital

Address correspondence to *Dr. M. Hudson, Jewish General Hospital and Lady David Research Institute, 3755 Côte Ste-Catherine Road, Room A725, Montreal, QC H3T 1E2, Canada. E-mail: marie.hudson@mcgill.ca*

Running title: Immunization in Rheumatic Diseases

This article has been accepted for publication in The Journal of Rheumatology following full peer review. This version has not gone through proper copyediting, proofreading and typesetting, and therefore will not be identical to the final published version. Reprints and permissions are not available for this version. Please cite this article as doi 10.3899/jrheum.181376. This accepted article is protected by copyright. All rights reserved.

Abstract

Objective: To assess vaccination coverage and predictors of vaccination among a Canadian population of rheumatology patients in routine clinical care.

Methods: In this cross-sectional study, consecutive adult patients presenting to a tertiary rheumatology clinic at the McGill University Health Center between May and September 2015 were asked to fill a survey on vaccination. Patients self-identified as having rheumatoid arthritis (RA), systemic autoimmune rheumatic diseases (SARD), spondyloarthropathies (SpA), or other diseases (OD). Multivariate logistical regression analyses were performed to evaluate patient and physician factors associated with vaccination (influenza, pneumococcal, hepatitis B virus [HBV]). Published Quebec general population influenza and pneumococcal vaccination rates in those aged ≥ 65 were used as comparative baseline rates.

Results: 352 patients were included in the analysis (RA:136, SARD:113, SpA:47, OD:56). Vaccination rates were reported as: (1) influenza: RA:48.5%, SARD:42.0%, SpA:31.9%, OD:88.9%, Quebec general population:58.5%; (2) pneumococcal: RA:42.0%, SARD:37.8%, SpA:29.7%, OD:33.3%, Quebec general population:53.2%; (3) HBV: RA:33.6%, SARD:55.6%, SpA:73.5%, OD:36.8%; and (4) herpes zoster: RA:5.6%, SARD:28.6%, SpA:25.0%, OD:16.7%. Physician recommendation was the strongest independent predictor of vaccination across all vaccine types (influenza: OR 8.56, 95% CI 2.80-26.2, $p<0.001$; pneumococcal: OR 314, 95% CI 73.0-1353, $p<0.001$; HBV: OR 12.8, 95% CI 5.27-31.1, $p<0.001$). Disease group, disease duration, comorbidities, treatment type, and being followed by a primary care physician were not significantly associated with vaccination.

Conclusion: There is suboptimal immunization coverage among ambulatory rheumatology patients. An important role for patient and physician education is highlighted from our study, especially as physician recommendation of vaccination was strongly predictive of vaccine uptake.

Introduction

Compared to the general population, patients with rheumatic diseases (RD) have an increased risk of infection and infection-related morbidity and mortality¹. Immune dysfunction due to disease specific-processes, the use of immunosuppressive or biologic agents targeting key components of immunity, and disease-related comorbidities contribute to the increased risk from infectious diseases². Consequently, infection prevention is an important goal in the treatment of patients with RD. Vaccines are available for several infectious agents, and as such, provide an effective opportunity for prophylaxis.

Respiratory tract infections caused by influenza virus and *Streptococcus pneumoniae* are among the most important infectious risks in patients with RD^{3,4}. A retrospective cohort study of 46,030 rheumatoid arthritis (RA) patients and a matching number of controls from the United States demonstrated a higher incidence of influenza and its complications in RA patients⁵. A similar study in the United Kingdom showed an increased likelihood of hospital admission for pneumococcal disease in patients with RA, scleroderma, Sjögren's syndrome, and systemic lupus erythematosus (SLE) compared to the general population⁶. Importantly, influenza and pneumococcal vaccines have not been shown to trigger autoimmune disease activity in RD patients¹⁻³.

Patients with RD also have an increased risk of developing herpes zoster (HZ) that is further elevated with exposure to corticosteroids, non-biological disease-modifying antirheumatic drugs (DMARDs), TNF- α blockers, and JAK inhibitors^{1,7-9}. Although a live-attenuated vaccine to prevent HZ was introduced in 2006, it could only be administered to RD patients prior to the start of immunosuppression or in those taking low-dose immunosuppressive therapies^{1,7,8}. An adjuvanted, non-living recombinant zoster vaccine, Shingrix®, was approved for use by Health Canada in 2017. Although limited data are available on the use of this vaccine in immunocompromised adults aged ≥ 50 , vaccination will likely provide some degree of protection from HZ reactivation¹⁰.

Data on the incidence of hepatitis B virus (HBV) infection in patients with RD are limited but do not suggest an increased incidence; however, the immunosuppressive nature of treatment may put them at risk for HBV reactivation^{11,12}. Nevertheless, HBV vaccination guidelines in RD patients follow those for the Canadian general population, with immunization recommended in patients with an increased risk of exposure^{1,12}.

In the management of patients with RD, European, American, and Canadian guidelines recommend vaccination against several infectious agents, including influenza virus, pneumococcus, HBV, and HZ^{1,7,8,12,13}. Despite these recommendations, immunization coverage remains suboptimal. Influenza and pneumococcal vaccination rates vary widely by country, but seldom exceed 50% in patients with RD¹⁴⁻²⁸. Additionally, low vaccination rates against HZ are reported in even older RD patients for whom vaccination would be recommended independent of their underlying rheumatologic condition^{29,30}. In cross-sectional survey-based studies, a lack of physician recommendation is cited as the principle reason for non-vaccination, with patient concerns of adverse effects and uncertainty about vaccine efficacy also contributing to low vaccine uptake^{15,17,19,24-26,28}.

To improve the outcomes of patients with rheumatic diseases, we considered implementing a vaccination program in our academic center. In preparation for this, and in the absence of data on vaccination rates in rheumatology patients in Canada, we undertook this study to assess vaccination coverage and predictors of vaccination among a Canadian population of rheumatology patients in routine clinical care.

Methods

Ethics

This study was approved by the Ethics Committee of the McGill University Health Center (MUHC) (protocol number 14-386 GEN). Waiver of informed consent to publish this material was granted by the MUHC Research Ethics Board as this study fulfilled criteria for Quality Improvement Research.

Design

This cross-sectional study consisted of a patient-administered survey developed to assess vaccination coverage and patient-reported barriers for non-vaccination among rheumatology patients in routine clinical care (Supplementary Figure 1). The survey was developed for this study by rheumatologists in English and forward translated to French by a professional translator. A bilingual panel of rheumatologists resolved inadequate concepts of translation. There was no back-translation. Pre-testing of the survey was done with ten respondents who were systematically debriefed.

Study subjects

Consecutive adult patients presenting to a single-center tertiary care rheumatology clinic between May and September 2015 were asked to fill a survey without identifiers. The patients self-identified as having rheumatoid arthritis (RA, juvenile idiopathic arthritis), systemic autoimmune rheumatic diseases (SARD) (i.e. vasculitis, SLE, systemic sclerosis, myositis), spondyloarthropathies (SpA) (i.e. psoriatic arthritis, ankylosing spondylitis), or other diseases (OD) (i.e. osteoarthritis, fibromyalgia, crystal arthropathies). The case definition for RA was based on self-reported diagnosis and use of disease-modifying anti-rheumatic drugs or biologics, while it was solely based on self-reported diagnosis for SARD and SpA. Patients in the OD group were classified according to self-reported diagnosis and a lack of treatment with DMARDs/biologics. Details of the diagnoses of each study group are presented in Supplementary Table 1.

Study variables

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Data collected for this study were self-reported, including demographics (sex and age), diagnosis, disease duration, current treatment (corticosteroids, DMARDs, biologics), comorbidities (cancer, diabetes, renal disease [not considered a comorbidity in patients with SLE]), and whether they were followed by a primary care physician (PCP), defined as a PCP seen at least once a year for routine care. In addition, information was collected regarding influenza vaccination in the previous year (2014-2015 influenza season) and vaccination status for pneumococcus, HBV, and HZ. We considered coverage for pneumococcal and HBV vaccination if patients indicated they had received at least one dose of a relevant vaccine. We did not collect information on the type of pneumococcal vaccine used. Canadian guidelines recommend influenza and pneumococcal vaccination in persons aged ≥ 65 and in those aged 18-64 with at least one chronic medical condition, including patients with RD classified as having an immune disease/suppression^{31,32}. As such, since patients aged 18-64 in the OD group do not have a chronic medical condition, we only reported influenza and pneumococcal vaccination rates for those patients aged ≥ 65 in the OD group. Likewise, at the time of this study, Canadian guidelines recommended HZ vaccination in those aged ≥ 60 irrespective of risk; therefore, we reported HZ immunization rates in those patients aged ≥ 60 years across the four disease groups^{8,12}. Moreover, we collected information on whether patients were aware that they could be protected from the infectious agent through vaccination (yes/no), and whether a physician had ever recommended the vaccine (yes/no).

To establish baseline influenza and pneumococcal vaccination rates among the Quebec general population, we utilized data published by the National Public Health Institute of Quebec (INSPQ). The INSPQ reported Quebec general population influenza vaccination rates for the 2015-2016 season and pneumococcal vaccination rates for 2015 in those aged ≥ 65 ²⁸. No data were reported by the INSPQ with respect to the Quebec influenza vaccination rates for the 2014-2015 season. There are no published data with respect to HBV and HZ vaccination rates in the Quebec general population.

Statistical Analysis

Descriptive statistics were used to summarize baseline characteristics of each disease group (RA, SARD, SpA, OD). Continuous variables were reported as mean \pm standard deviation and categorical variables as frequency (%) relative to the number for whom data were available.

Univariate logistical regression models were generated to evaluate the association between vaccination rates among all rheumatology patients in routine clinical care and explanatory variables, including sex, age, followed by a PCP, disease duration (years), comorbidities (cancer, diabetes, renal disease), treatment (DMARDs, biologics, both, neither), awareness that they could be protected from the infectious agent through vaccination, vaccine recommendation by a physician, and disease group (RA, SARD, SpA, OD). Univariate predictors found to be significant at the $p < 0.20$ level were included in a multivariate model to determine potential independent predictors of vaccine uptake, while controlling for confounding. Sex, age, and disease group were chosen for inclusion *a priori* in multivariate analysis. p values < 0.05 were considered statistically significant.

Analyses were performed using IBM SPSS Statistics.

Results

Study Population

The study population included 352 adult patients presenting to a tertiary care rheumatology clinic between May and September 2015. Patients self-classified as RA:136, SARD:113, SpA:47, OD:56 (Supplementary Table 1). The baseline characteristics of the patients are summarized in Table 1. The proportion of patients followed by a PCP was similar across the different groups (RA:77.7%, SARD:80.4%, OD:82.7%), and slightly lower for SpA (65.2%). The presence of comorbidities (cancer, diabetes, renal disease) was greatest in the OD and RA groups (28.6% and 25.7% respectively). The majority of RA and SARD patients were treated with DMARDs (69.1% and 61.1% respectively), while those with SpA were often on neither DMARDs nor biologics (48.9%). Awareness that vaccination is protective against infection was highest for influenza vaccination (RA:88.8%, SARD:91.1%, SpA:91.5%, OD:100%). Similarly, physician recommendation was greatest for influenza vaccination (RA:74.4%, SARD:77.3%, SpA:60.9%, OD:88.2%). Among the RA, SARD, and SpA patients who received a recommendation for pneumococcal vaccination by a physician, rheumatologists more frequently made the recommendation than PCPs (RA 49.2% vs. 18.0%, SARD 53.6% vs. 17.9%, SpA 83.3% vs. 16.7%).

Vaccination Rates

Within the disease groups, vaccination rates are reported for patients that had an indication for vaccination (Table 2). Influenza and pneumococcal vaccination rates were greater in the Quebec general population compared to the RD groups. HBV vaccination was greatest in the SARD and SpA groups, while HZ immunization rates were below 30% for all groups.

Multivariate Predictors of Vaccination

Univariate predictors associated with influenza, pneumococcal, or HBV vaccination are shown in Supplementary Tables 2-4. For influenza vaccination, multivariate analysis demonstrated that older age

(odds ratio (OR) 1.03, 95% confidence interval (CI) 1.01-1.05, $p=0.01$), physician recommendation (OR 8.56, 95% CI 2.80-26.2, $p<0.001$), and previous pneumococcal vaccination (OR 3.31, 95% CI 1.71-6.40, $p<0.001$) were predictors of vaccination (Table 3). Multivariate predictors of pneumococcal vaccination were physician recommendation (OR 314, 95% CI 73.0-1353, $p<0.001$) and previous influenza vaccination (OR 4.05, 95% CI 1.36-12.0, $p=0.01$) (Table 3). Lastly, younger age (OR 0.96, 95% CI 0.94-0.99, $p=0.01$), awareness of the protection offered by HBV vaccination (OR 11.5, 95% CI 2.49-52.8, $p=0.002$), and HBV vaccine recommendation by a physician (OR 12.8, 95% CI 5.27-31.1, $p<0.001$) were predictors of HBV vaccination in multivariate analysis (Table 3).

Due to the limited numbers of patients vaccinated against HZ, it was not possible to perform univariate or multivariate analyses of predictors of HZ vaccination in this population.

Discussion

This study highlights the suboptimal vaccination coverage in ambulatory RD patients. This is the first such report in a Canadian setting and is consistent with published literature from the US and Europe^{14-27,29,30}. As has been previously reported, we identified physician recommendation of vaccination as the strongest predictor of vaccination against influenza, pneumococcus, and HBV. This indicates that physicians play a central role in improving vaccination coverage in this at-risk population.

The Canadian National Immunization Strategy has set targets of 80% coverage for influenza and pneumococcal vaccination³³. Our data demonstrate suboptimal influenza and pneumococcal vaccination coverage in patients with rheumatic diseases, with vaccination rates below 50%. Quebec general population influenza and pneumococcal vaccination rates are similarly below Public Health targets at 58.5% and 53.2%, respectively²⁸. Nevertheless, there is a gap in vaccine uptake between the Quebec general population and RD groups despite both having indications for vaccination.

Several factors may help explain the low vaccination rates for influenza and pneumococcal disease among the RD groups. As disease activity and patient monitoring take priority during clinical visits, rheumatologists may not convey the need for vaccination to their patients. PCPs may be unaware of the need to vaccinate adult patients with rheumatic diseases at any age against influenza and pneumococcus, which may partially account for the gaps between the RD groups and the Quebec general population¹⁹. Moreover, PCPs may be uncertain about the safety of vaccination in patients on immunosuppressive therapy. This was highlighted by our results, as a recommendation for pneumococcal vaccination was more often made by a rheumatologist than a PCP in the RD groups. In line with this observation, a similar study investigating factors affecting influenza and pneumococcal vaccination rates among patients with chronic inflammatory joint diseases (RA and SpA) in France found that rheumatologists were more likely to recommend vaccination compared to PCPs (79% vs. 37% for influenza, and 78% vs. 14% for

pneumococcus)²⁴. A separate French study also demonstrated that in a cohort of patients with RA, scleroderma, ankylosing spondylitis, psoriasis, psoriatic arthritis, solid organ transplants, and malignant blood diseases, those followed by a specialist were more likely to be vaccinated against influenza than those followed by a PCP³⁴. In addition, we did not observe an association between being followed by a PCP and vaccine uptake in our multivariate analyses. Together, these findings point to a knowledge gap among PCPs with respect to vaccine recommendations in patients with RD. Nevertheless, in multivariate analyses examining associations between predictive factors and a physician recommendation for influenza or pneumococcal vaccination, we observed that having a PCP was associated with a recommendation for influenza but not pneumococcal vaccination (Supplementary Tables 5-6). Thus, it may be that in our setting, PCPs are more aware and comfortable with guidelines for influenza as compared to pneumococcal vaccination in patients with RD. Several factors could contribute to this, including the annual Public Health initiatives in support of influenza vaccination³⁴.

Our data may also suggest a reluctance by PCPs to recommend vaccination for rheumatology patients, possibly in deference to rheumatologists who PCPs may perceive as better suited for the task. This was highlighted by a qualitative study aimed at identifying barriers and facilitators of vaccination among rheumatoid arthritis patients³⁵. PCPs and nurse providers argued that rheumatologists should initiate the discussion about vaccination due to their involvement in diagnosis, treatment prescription, and recognition that their advice may bear more weight³⁵. This underscores the issue of perceived responsibility between providers regarding the discussion and administration of vaccines. Some physicians may choose to forgo a discussion on vaccination if they believe the onus lies with another provider. This attitude has been shown to lead to decreased vaccination coverage among other high-risk patients receiving care from both PCPs and subspecialists^{34,36-38}. A lack of healthcare provider communication is central to this problem, and strategies to bridge this gap may prove successful in improving vaccine coverage.

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In multivariate analysis, age was associated with decreased HBV vaccination (OR 0.96, 95% CI 0.94-0.99, $p=0.01$), echoing previously reported HBV vaccination data in RD patients and at-risk individuals^{11,27}. Consequently, HBV vaccination coverage was highest in patients grouped under SpA and SARD (73.5% and 55.6% respectively), as they were also found to be younger than patients in the RA and OD groups (Table 1). The adoption of universal childhood vaccination programs in the mid-1990's in Canada, coupled with HBV testing as part of routine STI screening in sexually active persons can account for much of our observations within these younger populations³⁹. To further accentuate this point, the overall vaccination rate against HBV rises from 46.2% to 69.1% ($n=55$) amongst all patients aged ≤ 35 (approximate cut-off age since the start of HBV childhood vaccination in Canada), while it falls to 39.7% ($n=204$) in those aged >35 (data not shown). Thus, while the future of HBV coverage is promising due to routine childhood and infant vaccination programs, our results serve as a reminder not to neglect screening and vaccination in older patients at high-risk of contracting HBV, especially as we demonstrate a strong generational difference in vaccination rates.

Despite being at increased risk of infection from HZ, we observed poor vaccine coverage against HZ across all disease groups. Low levels of physician recommendation for HZ vaccination (overall proportion=17.6%, calculated from Table 1) most likely accounts for the low vaccination rates, especially as our multivariate analyses demonstrate the importance of physician recommendation in the context of vaccine uptake (Table 3). This is further supported by the fact that patients who did not receive the HZ vaccine cited the lack of vaccine recommendation as the principle reason for non-vaccination (Supplementary Table 7). Although this barrier has been removed with the introduction of a non-living HZ vaccine, there was likely a strong disinclination in 2015 from rheumatologists and PCPs alike to recommend or administer a live HZ vaccination to immunosuppressed RD patients. Some RD patients could have safely received the living HZ vaccine, but a lack of safety and efficacy data regarding HZ vaccination in immunocompromised and RD patients was undoubtedly compounded by a lack of knowledge concerning HZ guideline

recommendations and policies^{2,8,29,30}. An additional barrier to HZ vaccination with Zostavax®II was patient cost as the vaccine was not covered by the Quebec Immunization Program¹⁰. However, recent Health Canada approval of Shingrix®, a non-living, recombinant subunit adjuvanted vaccine to prevent HZ, may lead to improved HZ protection in RD patients by overcoming structural, financial, and biological barriers to HZ vaccination¹⁰.

We identified several predictors of vaccination uptake in our multivariate analyses. Of note, physician recommendation of the vaccine was the strongest independent predictor of vaccination and the only factor consistently associated with vaccine uptake. This emphasizes the central role of the physician in the appropriate and effective vaccination of at-risk patients. It also adds to a growing body of literature placing physician recommendation as a crucial factor in patient vaccination^{15,19,24,26,28}. Nevertheless, as outlined above, the notion of perceived responsibility for vaccination between PCPs and subspecialists can lead to oversight and missed opportunities for vaccination. Improved collaboration and communication across healthcare professionals is imperative to bridging this gap in care.

Patient factors, including education and attitude, can affect vaccination rates. We show in our multivariate analyses that patient awareness of the protection offered by vaccination is associated with physician recommendation of influenza and pneumococcal vaccination (Supplementary Table 5-6). Thus, patients who are more mindful about vaccination will better engage their physicians on the topic. Additionally, the principle reasons for non-vaccination against influenza cited by patients were disinterest and misconceptions regarding the vaccine (Supplementary Table 7). While we are conducting qualitative studies in RA to define the perceived barriers and facilitators of vaccine acceptance, interventions to improve vaccine acceptance among patients at high risk for vaccine-preventable diseases are highly needed⁴⁰.

Improving vaccination access is vital to enhancing vaccination uptake. The availability of specialized vaccine centers, immunization programs targeting at-risk populations, electronic medical record (EMR)-based alert systems, and staff education are strategies proven to increase influenza vaccination rates^{30,41-43}. Where EMR-based solutions are not available, clinical reminders in paper charts and the use of standing order programs have also been shown to improve vaccine uptake⁴⁴⁻⁴⁶. Furthermore, due to the strong association between physician recommendation and vaccine uptake, physician education is consistently a key component of vaccination improvement strategies^{30,47}. Lastly, a willingness to evaluate vaccination practices within a clinic by routinely measuring and reporting vaccine coverage data is a crucial component in the improvement process^{20-22,48}.

Our study has several limitations. First, there is the risk of recall bias as we relied on self-reported vaccination rates and diagnoses that were not verified by medical records. While this may have resulted in an overestimation of some vaccination rates and inappropriate categorization of patients, self-reporting has been shown to be a reliable method of vaccination and disease assessment^{49,50}. In addition, by considering if patients had ever been vaccinated against pneumococcus or HBV, we overestimated the number of appropriately immunized patients as both vaccines require more than one dose for optimal long-term protection¹⁹. Further work to address appropriate pneumococcal and HBV vaccination status in this vulnerable population would be of value. Moreover, our data reflect vaccination rates from a single academic center, which may not be reflective of community rates. As response rate data were not collected, non-responder demographics are not available. Thus, despite survey availability to all patients presenting to the rheumatology clinic, certain patient populations were biased by our sample collection. This could include patients who are hesitant or reluctant to be vaccinated. If that was the case, the estimates we report may represent an overestimation of the real number of patients vaccinated. While comparator data from other Canadian centers are not available, our findings are in line with similar studies in Europe and the US, suggesting that the quality gap in immunization coverage among rheumatology

patients is not unique to our population^{14-27,29,30}. Limited by our sample size, we used INSPQ data to establish baseline values for influenza and pneumococcal vaccination rates in the Quebec general population²⁸. Consequently, this proved useful as it allowed for the direct comparison of the vaccination rates against influenza and pneumococcal disease in our study to those of the Quebec general population with an indication for vaccination. Furthermore, owing to small sample sizes in some of our groups, we observed some inflated ORs and wide 95% CIs in our multivariate analyses (e.g. physician recommendation and pneumococcal vaccination, Table 3). Additional research with a larger sample size would be needed to provide more robust estimates of the association between vaccine recommendation by a physician and vaccine uptake. To the best of our knowledge, this is the first study examining vaccination rates in a population of Canadian rheumatology patients.

In conclusion, despite national guidelines and recommendations for vaccination in rheumatology patients, we demonstrate suboptimal vaccination coverage against influenza, pneumococcus, HBV, and HZ. Physician recommendation of vaccination was the strongest independent predictor of vaccine uptake in our study, highlighting a central role for physician education, engagement, and collaboration towards the optimization of vaccination rates in this at-risk population.

Acknowledgments

A warm thank you is extended to Maria C.B. Bardales, Stefanie Lutak, and Heather Wiseblatt for help coordinating and recruiting patients.

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Table 1. Baseline characteristics of study subjects by disease group

Variable	RA (n = 136)	SARD (n = 113)	SpA (n = 47)	OD (n = 56)
	Frequency (%) or Mean \pm SD			
Sex				
Female	110 (80.9)	91 (81.3)	24 (52.2)	37 (68.5)
Male	26 (19.1)	21 (18.8)	22 (47.8)	17 (31.5)
Age (years)	55.0 \pm 17.0	48.6 \pm 16.6	44.8 \pm 14.1	56.7 \pm 15.4
Age Category				
18-64	92 (68.1)	92 (82.1)	44 (93.6)	38 (67.9)
65+	43 (31.9)	20 (17.9)	3 (6.4)	18 (32.1)
Followed by a Primary Care Physician				
No	29 (22.3)	22 (19.6)	16 (34.8)	9 (17.3)
Yes	101 (77.7)	90 (80.4)	30 (65.2)	43 (82.7)
Disease Duration (years)	9.5 \pm 9.3	9.7 \pm 9.8	6.8 \pm 9.9	6.4 \pm 7.5
Comorbidities $^{\Psi}$				
No	101 (74.3)	93 (82.3)	43 (91.5)	40 (71.4)
Yes	35 (25.7)	20 (17.7)	4 (8.5)	16 (28.6)
Treatment				
DMARD	94 (69.1)	69 (61.1)	9 (19.1)	0
Biologics	16 (11.8)	4 (3.5)	7 (14.9)	0
DMARD and Biologics	26 (19.1)	6 (5.3)	8 (17.0)	0
Neither	–	34 (30.1)	23 (48.9)	56 (100)
Awareness of Benefits of Influenza Vaccination a				
No	15 (11.2)	10 (8.9)	4 (8.5)	0
Yes	119 (88.8)	102 (91.1)	43 (91.5)	18 (100)
Influenza Vaccine Recommended by Physician a				
No	34 (25.6)	25 (22.7)	18 (39.1)	2 (11.8)
Yes	99 (74.4)	85 (77.3)	28 (60.9)	15 (88.2)
Awareness of Benefits of Pneumococcal Vaccination a				
No	45 (34.9)	44 (46.8)	20 (48.8)	8 (50)
Yes	84 (65.1)	50 (53.2)	21 (51.2)	8 (50)
Pneumococcal Vaccine Recommended by Physician a				
No	66 (52.4)	61 (67.8)	28 (68.3)	9 (60)
Yes	60 (47.6)	29 (32.2)	13 (31.7)	6 (40)
Who Recommended Pneumococcal Vaccine a				
Rheumatologist	30 (49.2)	15 (53.6)	10 (83.3)	0
PCP	11 (18.0)	5 (17.9)	0	6 (100)
Both	15 (24.6)	4 (14.3)	2 (16.7)	0
OD	5 (8.2)	4 (14.3)	0	0
Awareness of Benefits of HBV				

Vaccination				
No	42 (33.9)	21 (22.3)	7 (17.1)	15 (31.9)
Yes	82 (66.1)	73 (77.7)	34 (82.9)	32 (68.1)
HBV Vaccine Recommended by Physician				
No	85 (69.1)	58 (68.2)	19 (50.0)	32 (71.1)
Yes	38 (30.9)	27 (31.8)	19 (50.0)	13 (28.9)
Awareness of Benefits of Herpes Zoster Vaccination ^b				
No	35 (62.5)	13 (50.0)	2 (33.3)	6 (28.6)
Yes	21 (37.5)	13 (50.0)	4 (66.7)	15 (71.4)
Herpes Zoster Vaccine Recommended by Physician ^b				
No	50 (89.3)	16 (72.7)	4 (66.7)	14 (77.8)
Yes	6 (10.7)	6 (27.3)	2 (33.3)	4 (22.2)

^ψ Comorbidities include cancer, diabetes, and renal disease. Note, renal disease was not considered a comorbidity in SLE patients (part of SARD).

^a Patients in OD are ≥ 65 years-old

^b Patients in all groups are ≥ 60 years-old

Table 2. Vaccination rates by disease group

Vaccine	RA	SARD	SpA	OD	Quebec General Population
	Frequency (%)				
Influenza (2014-2015 season) ^a					
No	69 (51.5)	65 (58.0)	32 (68.1)	2 (11.1)	41.5
Yes	65 (48.5)	47 (42.0)	15 (31.9)	16 (88.9)	58.5
Pneumococcal ^a					
No	69 (58.0)	56 (62.2)	26 (70.3)	10 (66.7)	46.8
Yes	50 (42.0)	34 (37.8)	11 (29.7)	5 (33.3)	53.2
Hepatitis B Virus					
No	71 (66.4)	36 (44.4)	9 (26.5)	24 (63.2)	—
Yes	36 (33.6)	45 (55.6)	25 (73.5)	14 (36.8)	—
Herpes Zoster ^b					
No	51 (94.4)	15 (71.4)	3 (75.0)	15 (83.3)	—
Yes	3 (5.6)	6 (28.6)	1 (25.0)	3 (16.7)	—

^a Patients in the OD and Quebec General Population groups are ≥ 65 years-old

^b Patients in all groups are ≥ 60 years-old

Table 3. Multivariate analyses* to identify predictors of vaccination

Influenza Vaccination ^δ			
Variable	Odds Ratio	95% CI	P-Value
Female	0.71	0.32 – 1.60	0.41
Age, years	1.03	1.01 – 1.05	0.011
Followed by a Primary Care Physician	1.69	0.76 – 3.75	0.20
Comorbidities ^ψ	1.19	0.50 – 2.83	0.69
Awareness of Benefits of Influenza Vaccination	4.28	0.75 – 24.4	0.10
Influenza Vaccine Recommended by Physician	8.56	2.80 – 26.2	< 0.001
Previous Pneumococcal Vaccination	3.31	1.71 – 6.40	< 0.001
Disease group (OD as reference group)			0.67
RA	0.47	0.09 – 2.53	
SARD	0.38	0.07 – 2.12	
SpA	0.35	0.05 – 2.12	
Pneumococcal Vaccination ^δ			
Female	0.40	0.11 – 1.54	0.18
Age, years	1.01	0.97 – 1.04	0.76
Treatment (Neither as reference group)			0.78
DMARD	0.89	0.16 – 4.95	
Biologics	2.52	0.25 – 25.9	
DMARD and Biologics	0.89	0.13 – 6.23	
Pneumococcal Vaccine Recommended by Physician	314	73.0 – 1353	< 0.001
Previous Influenza Vaccination	4.05	1.36 – 12.0	0.01
Disease group (OD as reference group)			0.09
RA	2.94	0.20 – 44.2	
SARD	14.5	0.94 – 225	
SpA	2.41	0.17 – 34.4	
HBV Vaccination			
Female	0.51	0.20 – 1.34	0.17
Age, years	0.96	0.94 – 0.99	0.01
Disease Duration, years	0.99	0.94 – 1.05	0.75
Comorbidities ^ψ	1.30	0.44 – 3.83	0.63
Awareness of Benefits of HBV Vaccination	11.5	2.49 – 52.8	0.002
HBV Vaccine Recommended by Physician	12.8	5.27 – 31.1	< 0.001
Disease group (OD as reference group)			0.06
RA	0.76	0.22 – 2.66	
SARD	2.74	0.74 – 10.1	
SpA	2.02	0.43 – 9.48	

* For multivariate analyses, sex, age, and disease group were included *a priori*

^δ Patients in the RD groups are of any age, patients in OD group are ≥ 65 years-old

^ψ Comorbidities include cancer, diabetes, and renal disease. Note, renal disease was not considered a comorbidity in SLE patients (part of SARD).