Effect of a second, booster, influenza vaccination on antibody responses in quiescent systemic lupus erythematosus: an open, prospective, controlled study

Albert Holvast1, Sander van Assen2, Aalzen de Haan3, Anke Huckriede3, Cornelis A. Benne4, Johanna Westra1, Abraham Palache5, Jan Wilschut3, Cees G. M. Kallenberga1 and Marc Bijl1

Objective. In SLE, a decreased antibody response on influenza vaccination has been reported. In this study, we assessed whether a booster vaccination could improve antibody responses, as determined by seroprotection rates, in SLE patients.

Methods. SLE patients (n=52) with quiescent disease (SLEDAI ≤4) and healthy controls (HCs) (n=28) received subunit influenza vaccine in October–December 2007. After 4 weeks, only SLE patients received a second dose of vaccination. Sera were obtained before both vaccinations, and 4 weeks after the second vaccination. At each visit, SLE disease activity was recorded. The haemagglutination inhibition test was used to measure antibody titres. Seroprotection was defined as a titre ≥40.

Results. Following the first vaccination, seroprotection rates and geometric mean titres (GMTs) to each vaccine strain increased in both SLE patients and controls to comparable levels. Seroprotection rates in SLE patients after the first vaccination were 86.5% to A/H1N1, 80.8% to A/H3N2 and 61.5% to the B-strain while GMTs were 92.6, 56.2 and 39.2, respectively. Overall, the booster vaccination did not lead to a further rise of seroprotection rates and GMTs in SLE patients. However, in patients not vaccinated in the previous year, GMT and seroconversion rate to A/H1N1 did rise following the booster vaccination. Both influenza vaccinations did not increase SLEDAI scores.

Conclusions. Additional value of a booster influenza vaccination in SLE is limited to patients who were not vaccinated in the previous year.

Key words: Systemic lupus erythematosus, Influenza vaccination, Booster vaccination, Antibody responses.

Introduction

Infections are a frequent cause of death in SLE patients, accounting for up to 20–55% of all deaths [1]. An increased risk of infection in SLE is related to both intrinsic disturbances of immune responses and use of immunosuppressive drugs, which are often needed to control disease activity.

One of the most frequent infections is influenza, with an estimated 5% of the adult population infected annually [2]. In immunocompromised patients, influenza has a higher morbidity and mortality [3]. Vaccination is considered a cornerstone for prevention of influenza-related morbidity and mortality, and is recommended in immunocompromised patients [4]. As influenza vaccination does not induce disease activity in SLE, support is increasing for annual influenza vaccination of SLE patients [5, 6]. However, several studies have reported a decreased antibody response in SLE patients. Seroprotection (titre ≥40) rates were lower in SLE patients than in healthy adults, which may limit clinical protection from influenza in (part of) vaccinated SLE patients [7]. Several strategies have been developed to increase antibody responses to influenza vaccination, the most important being addition of an adjuvant, administration of booster vaccinations, increase of antigen dosage in the vaccine and use of intradermal instead of intramuscular vaccine. All these strategies have additional value in certain patient groups, as compared with conventional vaccination [8–11]. We chose to evaluate a booster vaccination in our SLE cohort, as this strategy has two advantages over the others. First, in contrast to other strategies, the safety profile of conventional subunit vaccine in SLE has been established. This fact is important as triggering of autoimmunity is a concern in systemic autoimmune disease. Second, this strategy would be easiest to implement within current vaccination practice.

In liver transplantation patients, an increase of the antibody response following trivalent booster vaccination has been shown [11]. Moreover, in SLE, a booster of A/H1N1 solely, 1 month after a first vaccination, increased geometric mean titre (GMT) [12]. However, there are also patient groups in which a booster vaccination had no additional value, such as dialysis patients, bone marrow transplant recipients and severely immunocompromised HIV patients [10, 13–17].

On the basis of previous data from our group, we hypothesized that influenza vaccination would result in a lower seroprotection rate in SLE patients [18], and that administration of a booster vaccination would increase seroprotection rate up to the level of seroprotection reached in healthy adults after a single vaccination. To test this hypothesis, we administered a booster dose of influenza subunit vaccine to SLE patients with quiescent disease, 4 weeks after a first vaccination. Antibody responses were determined prior to the first and the second vaccination, and 4 weeks after the booster vaccination.

Methods

Patients and controls

SLE patients were eligible for the study when they fulfilled at least four of the ACR criteria for SLE [19] and had quiescent disease, defined as a SLEDAI ≤4 [20]. Exclusion criteria were pregnancy, malignancy and the use of prednisone >30 mg/day. A control group of healthy individuals was included who were age and sex matched to the patients on group level. Pregnancy was an exclusion criterion for participation as healthy control (HC).

Study design

We conducted an open, prospective, controlled study. SLE patients and controls were included from October to
December 2007. At entry (t = 0), patients and controls received intramuscularly, a single dose of trivalent subunit influenza vaccine (Influvac 2007–2008, Solvay Pharmaceuticals, Weesp, The Netherlands), containing A/Solomon Islands/3/2006 [H1N1], A/Wisconsin/67/2005 [H3N2] and B/Malaysia/2506/2004. After 4 weeks (t = 1), patients received a second booster vaccination. HCIs were not given a booster vaccination, because this does not increase antibody responses [11, 15, 17, 21]. Serum was obtained at t = 0 and t = 1 in patients and controls, and 4 weeks thereafter (t = 2) in patients alone. At each visit, the SLEDAI was recorded. Routine measures were used to determine anti-ds DNA (by Farr assay) and complement C3 and C4. From all participants, information on influenza vaccination in the previous year was obtained. Adverse effects to vaccination were recorded using a standardized questionnaire, which included itching, pain, erythema, induration at the site of vaccination, shivers, myalgia, fever, headache, nausea, arthralgia, diarrhoea and use of an analgesic/anti-phlogistic drug. The study was approved by the institutional medical ethics committee, and informed consent was obtained from all participants.

**Antibody response to influenza**

For quantitative detection of influenza antibodies, the haemagglutination inhibition (HAI) test was used. HAI tests were done in duplo with guinea pig erythrocytes following standard procedures [22] with slight modifications as described elsewhere [23]. Seroprotection was defined as a titre ≥40, seroconversion was defined as a 4-fold rise or more in titre; titres < 10 (below detection level) were assigned a value of five for calculation [24].

**Power and statistical analysis**

Data were analysed using SPSS 14 (SPSS, Chicago, IL, USA). Titres were log-transformed prior to testing of GMTs. For testing differences in age between groups, Student’s t-test was used. Changes of GMTs, anti-dsDNA antibodies, complement C3 and C4 were tested using Wilcoxon signed-rank test; McNemar tests were used to test changes in seroprotection rates and seroconversion rates. Between groups, differences in GMTs were tested using the Mann–Whitney U-test. For all other comparisons, the chi-square test or Fisher’s exact test was used, depending on the size of the expected counts. A P-value < 0.05 was considered statistically significant. On the basis of previous results, it was hypothesized that a single vaccination would result in a 60% seroprotection rate against all three vaccine strains together [18], and that this would increase to 78% following a booster vaccination [11]. Seroprotection against all three vaccine strains together was defined as a titre ≥40 against each of the vaccine strains in the same serum sample. For a power of 80% at an α of 5% to demonstrate such a difference, 47 SLE patients had to be included. Accounting for a 10% drop out, this number was raised to 52.

**Results**

**Patient characteristics**

Fifty-four SLE patients gave informed consent to participate, of whom one patient withdrew before entry and one patient was excluded because of active disease. Fifty-two patients completed the study, and their characteristics are summarized in Table 1. Their mean age ± s.d. was 45.2 ± 10 years and 17.3% were males. Seventy-one per cent of patients had been vaccinated against influenza in the previous year (2006). Median SLEDAI score at entry was 2, and most patients used immunosuppressives, especially prednisone, HCQ and AZA. In the group of HCIs, age and sex were comparable with those in SLE patients. Also vaccination history was similar, as most controls had participated in the hospital’s annual influenza vaccination campaign before.

**First influenza vaccination**

The first influenza vaccination induced comparable seroprotection rates and GMTs in SLE patients and controls. Before vaccination, seroprotection rate against all three vaccine strains together did not differ between SLE patients (19.2%) and controls (7.1%; P = 0.199). Following the first vaccination, this rate tended to be higher in patients than in controls, surprisingly (51.9% vs 28.6%, respectively, P = 0.060). For patients, this rate was close to what was expected, but for controls it was much lower than anticipated—largely due to a low post-vaccination seroprotection rate against the B strain.

Before vaccination, seroprotection rates and GMTs, for each strain, were comparable in SLE patients and controls. Following the first vaccination, seroprotection rates and GMTs increased in both patients and controls. Responses to the B strain were lower as compared with those to the A strains. SLE patients reached a seroprotection rate of 86.5% for A/H1N1, 80.8% for A/H3N2 and 61.5% for the B strain. Their post-vaccination GMT was 92.6 for A/H1N1, 56.2 for A/H3N2 and 39.2 for the B strain. Controls showed fold increases in GMTs of 2.7, 2.1 and 1.9 for strains A/H1N1, A/H3N2 and B, respectively. Controls showed fold increases in GMT of 2.7, 1.7 and 1.8 for strains A/H1N1, A/H3N2 and B, respectively.

**Booster influenza vaccination**

Primary focus was the effect of booster vaccination on seroprotection rates in SLE patients. The second vaccination did not increase these seroprotection rates further (Fig. 1A). Accordingly, at t = 2, the proportion of patients with seroprotection to all vaccine strains was 55.8%, showing that there was no significant increase following the second vaccination. Similarly, the second vaccination did not induce a significant rise in GMTs (Fig. 1B).

**Seroconversion rates in both patients and controls**

Seroconversion rates were low in both SLE patients and controls. After the first vaccination, seroconversion rates to A/H1N1 were 34.6% in SLE patients and 28.6% in controls, for A/H3N2 rates were 25 and 10.7% and for B rates were 19.2 and 10.7%, respectively. Following the booster vaccination (t = 2 vs t = 1), five (9.6%) SLE patients showed a seroconversion to A/H1N1, whereas none of the patients showed a seroconversion to either A/H3N2 or the B strain. In SLE patients, when using baseline

### Table 1. Baseline characteristics

<table>
<thead>
<tr>
<th></th>
<th>SLE, n = 52</th>
<th>HC, n = 28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex, males, n (%)</td>
<td>9 (17.3)</td>
<td>6 (21.4)</td>
</tr>
<tr>
<td>Age, mean ± s.d., years</td>
<td>45.2 ± 10</td>
<td>45.2 ± 11.3</td>
</tr>
<tr>
<td>Influenza vaccination in previous year (2006), n (%)</td>
<td>37 (71.2)</td>
<td>20 (71.4)</td>
</tr>
<tr>
<td>Patients not using immunosuppressives, n (%)</td>
<td>5 (9.6)</td>
<td>NA</td>
</tr>
<tr>
<td>Prednisone, n (%)</td>
<td>31 (59.6)</td>
<td>NA</td>
</tr>
<tr>
<td>In users, median (range), mg/day</td>
<td>5 (1.25–25)</td>
<td>25 (48.1)</td>
</tr>
<tr>
<td>HCQ, n (%)</td>
<td>2400 (200–400)</td>
<td>NA</td>
</tr>
<tr>
<td>In users, median (range), mg/day</td>
<td>15 (28.8)</td>
<td>125 (50–200)</td>
</tr>
<tr>
<td>AZA, n (%)</td>
<td>15 (28.8)</td>
<td>NA</td>
</tr>
<tr>
<td>In users, median (range), mg/day</td>
<td>125 (50–200)</td>
<td>NA</td>
</tr>
<tr>
<td>Other immunosuppressive drugs, n (%)</td>
<td>7 (13.5)*</td>
<td>NA</td>
</tr>
<tr>
<td>SLEDAI, median (range)</td>
<td>2 (0–4)</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Four patients used MTX (one patient 10 mg/week, three patients 15 mg/week), three patients used mycophenolate mofetil (one patient 1000 mg/day, two patients 2000 mg/day) and one patient used cyclosporin 200 mg/day (same patient also used MTX). NA: not applicable.
Influence of previous influenza vaccinations

A large part of SLE patients (71.2%) and controls (71.4%) had received an influenza vaccination in the previous year. Vaccination in the previous year led to higher pre-vaccination seroprotection rates, which reached significance for strains A/H3N2 ($P = 0.016$) and B ($P = 0.027$) in patients, and for A/H1N1 in controls ($P = 0.038$, Fig. 2A). Accordingly, pre-vaccination GMTs were higher in previously vaccinated participants; in patients this difference was significant again for strains A/H3N2 ($P = 0.001$) and B ($P = 0.026$), and in controls for A/H1N1 ($P = 0.004$, Fig. 2B). Influenza vaccination in the previous year did not influence titres and seroprotection rates after the first vaccination, except for the B strain in controls. The post-vaccination seroprotection rate to the B strain was higher in controls not vaccinated in the previous year (75%) than in previously vaccinated controls (30%, $P = 0.044$, Fig. 2A and B).

Higher pre-vaccination titres in patients and controls vaccinated in the previous year lowered seroconversion rates after the first vaccination. In patients, this was most pronounced for the A/H3N2 strain. Patients not vaccinated in the previous year showed a 60% seroconversion rate to A/H3N2 vs 10.8% in previously vaccinated patients ($P = 0.001$). In controls, similar differences were observed, reaching significance for the B strain. Controls not vaccinated in the previous year showed a 37.5% seroconversion rate to the B strain vs 0% of the previously vaccinated controls ($P = 0.017$).

Notably, for A/H1N1, vaccinations in the previous year influenced the response to the booster vaccination. In SLE patients not vaccinated in the previous year, the booster tended to increase the GMT to A/H1N1, but not to A/H3N2 and the B strain. Following the booster vaccination, the GMT to A/H1N1 increased from 89.8 to 139.3 ($P = 0.055$). In previously vaccinated patients, the GMT was not influenced (Fig. 2B). For seroconversion rate, a similar effect was found; in SLE patients not vaccinated in previous year, the seroconversion rate increased from 46.7 to 80% ($P = 0.062$), but in previously vaccinated patients the seroconversion rate did not change (29.7 vs 32.4%).

Influence of the use of immunosuppressives

The use of immunosuppressives was heterogeneous, but stable during the duration of the study. Previous studies have reported lower antibody responses to influenza vaccination in SLE patients treated with steroids and AZA, but not in patients treated with HCQ [18, 25–27]. We performed a subanalysis in which patients using prednisone and/or AZA (PRED/AZA; $n = 28$) were compared with patients using no immunosuppressives or HCQ only (NO-imm/HCQ; $n = 17$); patients using other immunosuppressive drugs then prednisone, AZA and HCQ were excluded because of low numbers ($n = 7$). PRED/AZA patients were somewhat younger than NO-imm/HCQ patients, but the groups did not differ with regard to influenza vaccination in the preceding year. PRED/AZA patients had a lower antibody response to influenza vaccination as compared with NO-imm/HCQ patients, reflected by a lower GMT against A/H1N1 and A/H3N2 following the first vaccination, and a lower seroconversion rate against A/H1N1. The second vaccination had a slight additional effect for A/H1N1 within PRED/AZA patients (Table 2).

Disease parameters

SLEDAI scores and levels of anti-dsDNA antibodies did not increase following the vaccinations. Levels of C3 and C4 remained almost stable during this period; slight increases of C3 and C4 levels were observed (Table 3). More SLE patients (19.6%) experienced erythema after both the first and second vaccination, compared with controls (0%; $P = 0.013$). In SLE patients, adverse effects to the first and second vaccination were comparable (data not shown).

Discussion

In SLE, a hampered antibody response to influenza vaccination has been reported in several studies [7]. As seroprotection rates are related to clinical protection from influenza, strategies to improve antibody responses are relevant in SLE. In the present study, we evaluated whether a second, booster, influenza vaccination could increase antibody titres. We did not find such an enhancing effect. Following the first vaccination, seroprotection rates and GMTs rose for each strain, but these did not rise further following the second vaccination. As an exception, there was a clear trend in the response to A/H1N1 in SLE patients who were not vaccinated in the previous year. This response did increase following the booster vaccination, in terms of GMT and seroconversion rate. The booster vaccination had mild adverse effects and did not increase SLEDAI scores.
Our findings regarding A/H1N1 in patients not vaccinated in the previous year appear to be in accordance with a previous study in SLE patients, in which boosting was performed for A/H1N1 solely and was found to increase GMT [12]. In this study, no information is presented regarding previous influenza vaccinations but it is likely that most patients had not received an influenza vaccination before, since there was much uncertainty regarding safety of vaccination in SLE [5].

In liver transplantation patients, a trivalent booster vaccination (28 days after the first vaccination) led to higher GMTs to all vaccine strains. Furthermore, the seroprotection rate against all three strains increased from >68% after the first vaccination to >80% after the booster vaccination [11]. Also in frail elderly, a booster vaccination after 84 days increased GMTs, as detected by ELISA assay [28]. In healthy elderly, increases in seroconversion rate and GMT following a booster vaccination have been reported [21]; however, most studies did not find an additional effect [29, 30]. Similarly, in other patient groups such as bone marrow transplant recipients [16], severely immunocompromised HIV patients [17] and dialysis patients [10, 13–15], booster vaccination did not have additional value. Also in healthy adults, booster vaccination did not increase antibody responses [11, 15, 17, 21].

Why booster vaccination did not improve the antibody response to influenza in SLE patients remains speculative. First, previous vaccinations appear to limit the effect of a booster...
vaccination, as reported in this study. Second, it may be argued that booster vaccination can only have effect in patients with a low (<40) titre after a first vaccination. In this study, over 80% of the patients had achieved protective titres to the A strains after the first vaccination, which may have hindered a further increase for these strains. This increase does not apply for the B strain as the seroprotection rate was 61.5% after the first vaccination. Nevertheless, the seroprotection rate to the B strain did not increase either following the booster vaccination.

Responses and titres to the B strain were low in both patients and controls. Generally, antibody titres to B strains are lower than titres to A strains [16, 31, 32], which may be due to lower immunogenicity of the B than the A strains, or a lower sensitivity of the HAI test. The HAI test for influenza B with whole virus particles, which is standard and was applied here, was previously found to be less sensitive than testing with influenza B virus disrupted with ether [33].

In accordance with previous reports, the use of prednisone and/or AZA was associated with lower antibody responses to influenza vaccination in SLE patients [18, 25–27]. As a secondary study question, we evaluated whether a booster vaccination, supposed it were effective, would increase antibody responses in SLE patients up to levels reached in HCs after a single vaccination. However, we did not observe differences in antibody responses between SLE patients and controls. Patients showed similar responses as in a previous study, but the responses of controls were lower than expected [18]. Although some previous studies did not find differences between patients and controls [26, 34–36], most have shown antibody responses in SLE patients to be lower than in controls [12, 18, 25, 27, 37]. Furthermore, we found that cell-mediated responses to influenza vaccination, which correlate to clinical protection from influenza infection [38], are hampered in SLE as well [39]. It is not clear as to why in the present study, SLE patients and controls did not differ in antibody responses, but several factors could be involved. First, lack of power, as the study was not powered to study this question. Second, lower immunogenicity of current vaccine strains could have restrained differences between patients and controls. Third, controls had a higher degree of previous influenza vaccinations as compared with a previous study, whereas they did not differ with regard to age and sex [18]. Possibly, influenza vaccinations in the preceding year hindered antibody responses [40–42], in which case previous findings of impaired responses were (partly) due to differences in vaccination history between SLE patients and controls. Therefore, actual differences between SLE patients and controls may be less than expected. In an extensive overview, Beyer et al. [31] reported that especially for the B strain there is a general tendency to show a lower post-vaccination GMT and seroprotection rate in previously vaccinated groups, as we observed in our HCs. Vaccines that are antigenically close to a prior vaccine may be partially eliminated by pre-existent cross-reactive antibodies, thus reducing the immune response [43].

Finally, the influenza vaccinations did not affect disease activity, which is in accordance with previous studies [5]. However, it has been reported previously that although SLEDAI scores remain stable after influenza vaccination, levels of auto-antibodies may transiently increase [44].

In this study, a control group of SLE patients vaccinated once was not included, which might be a limitation. Here, SLE patients functioned as their own controls for the effects of the first and the booster vaccination. This method increased the statistical power to detect the expected additional effect of a booster vaccination, as it enabled a matched samples analysis. This has been done previously [11, 12, 14–17, 21, 32], although some studies included a patient group vaccinated once and a patient group vaccinated twice [10, 13, 28–30].

In summary, booster vaccination with subunit influenza vaccine had no additional value in annually vaccinated SLE patients. In this study, we did not find differences between SLE patients and controls in the antibody response to subunit influenza vaccine. However, the study was not designed and powered to detect such a difference. Therefore, we do not challenge previous studies showing decreased responses in SLE patients after influenza vaccination. As such, other strategies to improve antibody responses, mentioned earlier, should be considered, such as the use of an MF59-adjuvanted influenza vaccine, which has a higher immunogenicity than conventional trivalent inactivated vaccine in adults with chronic diseases [8]. Another option would be to use an increased vaccine dose. In haemodialysis patients, not using immunosuppressive drugs, a booster influenza vaccination did not

### Table 2. Effects of immunosuppressive drugs on antibody responses

<table>
<thead>
<tr>
<th></th>
<th>Prednisone/AZA, n = 28</th>
<th>Patients not using immunosuppressives/HCQ, n = 17</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t = 0</td>
<td>t = 1</td>
</tr>
<tr>
<td>Age, mean ± s.d., years</td>
<td>42.1 ± 9.2</td>
<td>21 (75)</td>
</tr>
<tr>
<td>Influenza vaccination in previous year (2006), n (%)</td>
<td>14 (50)</td>
<td>23 (82.1)</td>
</tr>
<tr>
<td>SP rate, n (%)</td>
<td>10 (35.7)</td>
<td>19 (67.9)</td>
</tr>
<tr>
<td>H1N1</td>
<td>11 (39.3)</td>
<td>17 (60.7)</td>
</tr>
<tr>
<td>H3N2</td>
<td>39.5</td>
<td>72.5</td>
</tr>
<tr>
<td>B</td>
<td>20</td>
<td>39</td>
</tr>
<tr>
<td>SC rate, n (%)</td>
<td>22.9</td>
<td>36.7</td>
</tr>
<tr>
<td>H1N1</td>
<td>NA</td>
<td>4 (14.3)</td>
</tr>
<tr>
<td>H3N2</td>
<td>NA</td>
<td>5 (17.9)</td>
</tr>
<tr>
<td>B</td>
<td>NA</td>
<td>3 (10.7)</td>
</tr>
</tbody>
</table>

*P < 0.05; **P < 0.01; ***P = 0.004 (SLE patients using prednisone and/or AZA vs patients using no immunosuppressive drugs or HCQ only); t = 0: prior to vaccination; t = 1: 4 weeks after the first vaccination; t = 2: 8 weeks after the first vaccination. SP rate: seroprotection rate; SC rate: seroconversion rate; NA: not applicable.

### Table 3. Disease parameters

<table>
<thead>
<tr>
<th></th>
<th>t = 0</th>
<th>t = 1</th>
<th>t = 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLEDAI, median (range)</td>
<td>2 (0–4)</td>
<td>2.5 (0–6)</td>
<td>2 (0–6)</td>
</tr>
<tr>
<td>anti-dsDNA, median (range), U/ml</td>
<td>16 (3–397)</td>
<td>18.5 (3–275)</td>
<td>18.5 (3–261)</td>
</tr>
<tr>
<td>C3, median (range), g/l</td>
<td>0.91 (0.42–1.42)</td>
<td>0.91 (0.35–1.45)</td>
<td>0.93 (0.31–1.45)</td>
</tr>
<tr>
<td>C4, median (range), g/l</td>
<td>0.14 (0.02–0.52)</td>
<td>0.15 (0.02–0.52)</td>
<td>0.16 (0.02–0.50)**</td>
</tr>
</tbody>
</table>

t = 0: prior to vaccination; t = 1: 4 weeks after the first vaccination; t = 2: 8 weeks after the first vaccination, 4 weeks after the second vaccination. *P < 0.05; **P < 0.01 (at t = 8 weeks vs t = 0, prior to vaccination). C3, C4: complement C3 and C4.
have an additional effect upon titres, but a single double-dose vaccine did have additional value [10]. Finally, intradermal application of conventional influenza vaccine was reported to have higher immunogenicity in elderly than intramuscular vaccination [9]. Whether these strategies enhance the immune response to influenza vaccination in SLE should be studied in controlled studies.

We conclude that the positive effect of a booster influenza vaccination on antibody responses was limited to SLE patients who were not vaccinated in the previous year. These findings are restricted to patients with quiescent disease. Our results indicate that there is no additional value in offering a booster to annually vaccinated SLE patients. This point is of clinical importance, as annual influenza vaccination is recommended in SLE patients. Finally, it should be noted that in SLE patients who were not vaccinated in the previous year, administration of a booster vaccination may be considered.

Rheumatology key messages

- A booster influenza vaccination does not increase antibody titres in annually vaccinated SLE patients.
- However, antibody titres may increase in SLE patients not vaccinated in the previous year.

Acknowledgements

The authors would like to thank Eline Bloemink and Gioia Smid for their technical assistance.

Funding: This work was supported by unrestricted grants from the Jan Kornelis de Cock Foundation (The Netherlands) and Solvay Pharmaceuticals (Weesp, The Netherlands).

Disclosure statement: A.P. is an employee of Solvay Biologics, The Netherlands. All other authors have declared no conflicts of interest.

References