**Supplementary table 1: The National Institute of Health classification for COVID-19 infection severity**

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| **NIH classification of COVID-19 severity (available at:** <https://www.covid19treatmentguidelines.nih.gov/overview/clinical-spectrum> [accessed on August 8, 2022]) | |
| **Asymptomatic infection** | Individuals who test positive for SARS-CoV-2 using a virologic test (i.e., a nucleic acid amplification test or an antigen test) but who have no symptoms that are consistent with COVID-19 |
| **Mild illness** | Individuals who have any of the various signs and symptoms of COVID-19 (e.g., fever, cough, sore throat, malaise, headache, muscle pain, nausea, vomiting, diarrhea, loss of taste and smell) but who do not have shortness of breath, dyspnea, or abnormal chest imaging. |
| **Moderate illness** | Individuals who show evidence of lower respiratory disease during clinical assessment or imaging and who have an oxygen saturation (SpO2) ≥94% on room air at sea level. |
| **Severe illness** | Individuals who have SpO2 <94% on room air at sea level, a ratio of arterial partial pressure of oxygen to fraction of inspired oxygen (PaO2/FiO2) <300 mm Hg, respiratory frequency >30 breaths/min, or lung infiltrates >50%. |
| **Critical illness** | Individuals who have respiratory failure, septic shock, and/or multiple organ dysfunction. |

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| Supplementary table 2: Summary of prognostic studies included in the review including cohort, case-control, and cross-sectional studies | | | | | | | |
| Authors, Yr [Reference] | **Vaccine platform** | **Region/Time period** | **Population/ Sample size** | **Study Design** | **Topics** | **Key findings** | **Bias risk (QUIPS)** |
| Ammitzbøll et al. (2021) [1] | mRNA-vaccine | Denmark/  Dec 2020 to April 2021 | SLE or RA/  134 | Cohort | Humoral response | * 77% of patients mounted detectable serological response. * Rituximab use was associated with lower percentage (24%) of immunological response to vaccination * No difference between SLE and RA | Moderate |
| Barbhaiya et al. (2021) [2] | mRNA-vaccine  Adenoviral-vector vaccine | New York-USA/  March-April, 2021 | ARD/  1483 (41.8% response) | Web-based survey | Self-reported disease flare | * Disease flare occurred in 15.9% of patients receiving Moderna vaccine and 14.2% receiving Pfizer vaccine * Vaccination rate with AstraZeneca vaccine was extremely low * Most flares were moderate to severe in intensity but resolved mostly within 1 week | High |
| Bartels et al. (2021) [3] | mRNA-vaccine | Denmark/  Up to July, 2021 | SLE and RA/  285 | Cohort | Adverse events | * 78% and 80% reported local and systemic reaction at 7-day post second dose * 1.8% had a grade-4 reaction * Patients with SLE/RA had higher rate of fatigue, headache, muscle ache, and arthralgia compared to control | Moderate |
| Bixio et al. (2021) [4] | mRNA-vaccine | Italy/  March and April 2021 | RA in clinical remission/  77 | Prospective cohort | Disease flare | * All patients discontinued therapy prior to vaccination * 7.8% had disease flare within 3 months post vaccination, one flare was classified as severe and all resolved within 2 weeks | High |
| Boekel et al. (2021) [5] | mRNA-vaccine (46%)  Adenoviral-vector vaccine (54%) | Netherlands/  March 2020 to April, 2021 | Older patients with ARD/  (574 rheumatic diseases) | Prospective cohort | Serological response | * Seroconversion after first dose in the absence of previous infection is lower in patients with ARD versus control (OR 0.33 95%CI 0.23-0.48 p<0.001) especially with methotrexate and anti-CD20 use * High rate in seroconversion after second dose of vaccine or a single dose with previous COVID-19 infection except for patients on anti-CD20 therapies | Low |
| Braun-Moscovici et al. (2021) [6] | mRNA-vaccine | NA/  NA | ARD with stable disease activity/  264 | Prospective cohort | Humoral response and disease activity flare | * 86% of patients mounted immunological response 4-6 weeks post second dose of vaccine * Humoral response was affected by type of immunomodulatory therapy and not the type of ARD * Only ARD duration, treatment with anti-CD20, abatacept or MMF were associated with the humoral response * Anti-CD20 impaired humoral response especially in elderly * Stable rheumatic disease in all patients with minor side effects only | Moderate |
| Cherian et al. (2021) [7] | Adenoviral-vector vaccine (86%)  Others (14%) | India/  Up to May, 2021 | ARD/  513 | Prospective cohort | Adverse events 1 week after first dose of vaccine | * All adverse events were self-limiting * Four patients reported flare of arthritis that resolved with 5 days | High |
| Connolly et al. (2021) [8] | mRNA-vaccine 91.7%  others (8.3%) | USA/  NA | AAV  92% were on rituximab/  48 | Prospective cohort | Tolerability and humeral response to COVID-19 vaccine | * Only 37% had detectable humeral response to vaccination * Absent humoral response was associated with vaccine type, low IgM, lack of CD19 reconstitution and shorter interval from last rituximab dose * No disease flare was reported * Mild side effects mostly fatigue and headache * Two patients with no humoral response had severe COVID-19 disease, and one of them died | High |
| Connolly et al. (2022a) [8] | mRNA-vaccine | USA/  December 2020 and April 2021 | Rheumatic and musculoskeletal diseases/  1,377 | Prospective cohort | Disease flare Local and systemic side effects | * 11% had disease flare, none was severe * Higher risk for flare with prior COVID-19 infection, use of combination immunomodulatory drugs and flares in the past 6 months * Injection site pain and fatigue were the most common adverse reactions | Moderate |
| Connolly et al. (2022b) [10] | mRNA-vaccine  other (87.5%)  other (12.5%) | USA/  December 2020 and May 2021 | ARD/  24 | Prospective cohort | Impact of withholding mycophenolate perivaccination | * Withholding mycophenolate was associated with higher likelihood of positive and higher humoral response * 8.3% had disease flare requiring steroids | High |
| Cook et al. (2022) [11] | mRNA-vaccine  other (75%)  other (25%) | USA/  January 2020 and July 2021 | ARD/  16 | Prospective cohort | Rate of breakthrough COVID-19 infections in fully vaccinated patients | * 4.7% of patients with ARD who developed COVID-19 infection were fully vaccinated * 38% needed hospitalization and 6% required mechanical ventilation, 13% died * 2 patients deceased were on rituximab and had ILD * Blunted humoral response with glucocorticoid use was dose-dependent (particularly above 10 mg per day) | High |
| Cristaudo et al. (2022) [12] | mRNA vaccine | Italy/  1st April to 31st May 2021 | Psoriasis on biologic treatment/  48 | Prospective cohort | Humoral response to vaccine and local/systemic side effects | * Biologic therapy was not modified * Methotrexate dose was held one week after vaccine dose * No difference between antibody response between patients and controls * Combination therapy was associated with lower immunological response than biologic monotherapy * Older age was associated with lower antibody response * No significant side effects and documented flares | High |
| Deepak et al. (2021) [13] | mRNA vaccine | USA/  December 2020 and March 2021 | Chronic inflammatory disease (67.7% had ARD)/ 133 | Prospective cohort | Humoral response at 20 days post full vaccination | * 88.7% of participants with ARD developed antibody response compared to 100% in healthy controls * Glucocorticoids and B-cell depletion therapy users had lower antibody titer * No significant differences in vaccine immunogenicity with the use of antimetabolites (methotrexate, mycophenolate, azathioprine, leflunomide, teriflunomide, or 6-mercaptopurine), TNFi or JAK inhibitors | Moderate |
| Delvino et al. (2021) [14] | mRNA vaccine | Italy/  Up to 30th April, 2021 | GCA/ 81 | Prospective cohort | Adverse events | * 60.5% had one or more adverse event * Local skin reaction and fatigue were the most common * Arthralgia was more common in patients >75 years * Treatment modality did not affect safety profile * None had severe adverse event | High |
| Dimopoulou et al. (2022a) [15] | mRNA vaccine | NA/  April 15 and May 15, 2021 | JIA on TNFi/  21 | Prospective cohort | Adverse events and exacerbation of flares | * 74% had local reaction * 19% had systemic reaction * No disease exacerbation noted * No change in medications peri-vaccination | High |
| Dimopoulou et al. (2022b) [16] | mRNA vaccine | NA/  April 15 and May 15, 2021 | JIA on TNFi/  21 | Prospective cohort | Humoral response to COVID-19 vaccine | * Seropositivity in 100% * All patients were in remission * Medications were not changed peri-vaccination * No difference in humoral response according to type of disease, type of TNFi used or use of MTX in combination | High |
| Esquivel-Valerio et al. (2021) [17] | mRNA-vaccine (59.9%)  Adenoviral-vector vaccine (9.7%)  Others (30.4%) | Mexico/  May 3 to July 21, 2021 | ARD/  225 | Cross-sectional | Prevalence of vaccine-associated adverse events | * No serious adverse event was reported with any vaccine type * Local side effects occurred in 60.7 to 75.7% * Systemic side effects 44.8-50%, most commonly headache, myalgia then fever | Moderate |
| Ferri et al. (2021) [18] | mRNA-vaccine | Italy/  March and July 2021 | ARD/  478 | Prospective cohort | Humoral response to vaccine  Adverse events | * Significantly lower levels of NAbs in patients with ARD compared to control * Higher percentage of non-responders in ARD compared to control (13.2% versus 2.8%, p < 0.0001) * Nonresponse is higher in patients with ARD-associated ILD, on glucocorticoids, mycophenolate mofetil or rituximab (significant p value) * 53.8% had vaccine-related side effects, most commonly local skin reaction then fever, fatigue and headache * 2.1% had disease flare * No statistical difference in adverse events between responders and non-responders | Low |
| Fornaro et al. (2022) [19] | mRNA vaccine | Italy/  April, 2021 | Rare ARD and SLE/  287 | Prospective cohort | Adverse events and disease flare | * Immunomodulatory drugs were modified according to ACR recommendations in peri-vaccination period * 64.7% had vaccine-related adverse events, all were self-limiting * Predictors of adverse events (excluding local skin reaction) female gender, older age, moderate/high disease activity * 2.1% had arthralgia and cutaneous flare * No disease flare was documented using objective measures of assessment | Moderate |
| Fragoulis et al. (2022) [20] | mRNA-vaccine (90%)  Adenoviral-vector vaccine (10%) | Cyprus/  June 15-July 1, 2021 | ARD/  441 | Cross-sectional study | Adverse events and disease flare | * 33.6% had vaccine-related adverse events, most commonly fatigue, local skin reaction ad fever * Adverse events were more common in females and with COPD * 2% had disease flare, marginally more common in patients who discontinued their treatment | Moderate |
| Furer et al. (2021a) [21] | mRNA-vaccine | Israel/  December 2020 and March 2021 | ARD/  686 | Prospective cohort | Humoral response to vaccination  Adverse events and disease flare | * Seropositivity and level of NAbs are significantly less in patients with ARD versus control (seroconversion in 86 versus 100%) * Risk factors for reduced immunogenicity included older age, treatment with glucocorticoids, rituximab, mycophenolate mofetil and abatacept * 2 patients died (0.3%) 3 weeks and 2 months after second dose respectively * Local skin reaction, myalgia and malaise were more common in ARD * Adverse events of special interest: uveitis (n=2), herpes labialis (n=1), pericarditis (n=1), and non-disseminated herpes zoster (6) * Post vaccination disease activity was stable | Low |
| Geisen et al. (2021) [22] | mRNA-vaccine | Germany/  NA | ARD/  26 | Prospective cohort | Humoral response  Adverse events and disease flare | * All patients had seroconversion, but level of antibodies was lower in patients with ARD compared to control group * No serious side effects or disease flare * mild side effects (fatigue, myalgia and headache) were marginally more common in ARD | Moderate |
| Haberman et al. (2021) [23] | mRNA-vaccine | USA and Germany/  December 2020 to March 2021 | ARD/  82 | Prospective cohort | Humoral and cellular response to vaccine | * 100%, >90% and 62% had humoral response in control, ARD not on methotrexate, and methotrexate users respectively * Cellular response increased significantly in all patients groups (CD4+, CD8+) * Impaired CD8+ cellular response with methotrexate us | Low |
| Iancovici et al. (2021) [24] | mRNA-vaccine | Israel/ NA | RA/  12 patients received JAK inhibitors  3 patients on TNF-i | Prospective cohort | Humoral response to vaccine | * JAK inhibitor use in RA was associated with suppressed humoral response to vaccine both quantitively and qualitatively * TNF-I use in RA was associated with lower AB titer than control but no difference in plasma neutralizing activity | Moderate |
| Izmirly et al. (2022) [25] | mRNA-vaccine (94.5%)  other (5.5%) | New York-USA/  NA | SLE/  90 | Prospective cohort | Humoral and cellular response to vaccine  Disease flare | * Lower humoral response in SLE patients compared to control * Lower vaccine response with the use of any immunosuppressant or steroids, and normal anti-dsDNA * Humoral response correlated with cellular response (interferon-γ release) * No change in disease activity score * 11.4% had post vaccination disease flare, 1.3% were severe * Dose pf methotrexate was held at the time of vaccination in alliance with ACR guidelines | Low |
| Jyssum et al. (2022) [26] | mRNA-vaccine | Norway/  Feb 9, 2021, and May 27, 2021 | RA on rituximab/  87 receiving 2 doses  49 patients receiving 3 doses  19 patients were analysed for T cell response | Prospective cohort | Humoral and cellular immune responses after two or three doses of vaccine | * 21·8% had serological response in rituximab users compared to 98.4% in control group * Time interval between rituximab use and vaccine administration and type of vaccine (mRNA-1273 compared with BNT162b2) were significantly associated with humoral response * CD19+ B cell count was associated with humoral response in univariate but not multivariate logistic regression * 53% had CD4+ T-cell responses and 74% had CD8+ T-cell responses after 2 doses * A third dose was associated with humoral response in 16·3% only but all patients had inducible CD4+ and CD8+ T-cell responses * No serious adverse events or deaths. | Low |
| Kant et al. (2022) [27] | mRNA-vaccine (86.7%)  other (13.3%) | USA/  January 2021 and September 2021 | ANCA vasculitis on rituximab/  15 | Prospective cohort | Humoral response to a booster dose | * All patients had B-cell depletion at the time of completing first dose series * 71.4% of responders to booster vaccine had B cell reconstitution at the time of third dose * 28.6% of responders to booster vaccine were initially receiving other vaccine followed by a mRNA-vaccine | High |
| Krasselt et al. (2022) [28] | mRNA-vaccine (85.1%)  Adenoviral-vector vaccine (14.9%\*) | Germany/  July and September 2021 | ARD/  303 assessed for humoral response  20 assessed for cellular response | Prospective cohort | Humoral and cellular response to vaccine | * Patients with previous COVID-19 infection were excluded * Overall seropositivity in ARD was 78.5% with a lower rate in patients receiving immunosuppressive therapy (75.7 vs 93.2%, P = 0.009) * No difference between vaccination type in seropositivity level but antibody level decreased overtime with mRNA-vaccine * Highest risk of non-response with rituximab use * 50% of humoral non-responders showed a T-cellular response | Moderate |
| Lee et al. (2022) [29] | mRNA-vaccine (66.3%)  Adenoviral-vector vaccine (33.7%) | Taiwan/  July and September 2021 | ARD/  265 | Retrospective observational study | Adverse events | * Comparable adverse events and disease flare between both types of vaccine (18-19%, and 5.6-6.2% respectively). * Thromboembolic events were more common with mRNA-vaccine compared to adenoviral-vector vaccine (5.7% vs 3.4%, p value=0.6) * Herpes zoster reactivation in 10 patients who all received mRNA-vaccine | High |
| Li et al. (2022a) [30] | mRNA-vaccine (64%)  other (36%) | Hong Kong/  June 2021 and October 2021 | ARD/  413 | Prospective cross-sectional study | Adverse events | * 81.1% had side effects mostly injection site pain, headache, and fever * Younger age is minimally associated with higher risk for side effects (age, OR = 0.96; p = .003) * mRNA vaccines were associated with higher risks for side effects (OR = 4.79; p < .001) * No difference in risk of side effects between specific rheumatic diseases or drug therapies | Moderate |
| Li et al. (2022b) [31] | mRNA-vaccine (49.3%)  other (50.7%) | Hong Kong/  Up to 31 July 2021 | RA/  1324 | Retrospective cohort study | Disease flare following full vaccination | * No significant association between arthritis flare and COVID-19 vaccination | High |
| Liew et al. (2022) [32] | mRNA-vaccine (75.8%)  Adenoviral-vector vaccine (6.9%)  other (17.3%) | Global Rheumatology Alliance registry/  January to September 2021 | ARD/  87 (fully vaccinated)  197 total sample | Registry analysis | Breakthrough COVID-19 infections in fully vaccinated patients with ARD | * Among fully vaccinated, infection occurred at a mean of 112 (±60) days after the second vaccine dose * Among fully vaccinated and hospitalised (22 patients), more than half of patients were in B-cell depleting therapy or mycophenolate, 8 had lung disease * 5 out of fully vaccinated patients died, 3 were on B-cell depleting therapy, 2 had lung disease | High |
| Machado et al. (2022) [33] | mRNA-vaccine (78%)  Adenoviral-vector vaccine (17%)  other (5%) | 30 countries/  Feb to July 2021 | ARD/  4604 | Registry analysis | Breakthrough COVID-19 infections  Disease flare and adverse events | * 0.7% of fully vaccinated patients had breakthrough infection * 4.4% had disease flare, and 0.6% were severe * 37% had adverse events, and 0.4% were severe * Generally reassuring safety profile of COVID-19 vaccine that is comparable to patients with non-inflammatory musculoskeletal disease | Moderate |
| Madelon et al. (2021) [34] | mRNA-vaccine | Switzerland/  NA | ARD (+Multiple sclerosis) treated with anti-CD20/  37 (11 with ARD) | Prospective cohort study | Humoral and cellular response to vaccination | * Seroconversion occurred in 69.4% compared to 100% in control group * Cellular immunity was equally detected in both groups 85–90% | High |
| Magliulo et al. (2022) [35] | mRNA-vaccine (90.5%)  other (9.5%) | USA/  January 2020 to February 2021 | ARD on rituximab/  41 (humoral response)  51 (adverse events) | Prospective cohort study | Humoral response to vaccine in ARD receiving rituximab  Adverse events | * Seroconversion occurred in 36.5% only * Negative correlation with Hypogammaglobulinemia (IgG and/or IgM), B cell numbers and concomitant use of immunosuppressants * Timing of vaccination in relation to rituximab was not significantly associated with response rate * Pain at the injection site (52.4%) and fatigue (40.2%) were the most common side effects * No serious adverse events or disease flare | Moderate |
| Marty et al. (2022) [36] | mRNA-vaccine (89.5%)  other (10.5%) | USA/  April and August 2021 | ANCA vasculitis on rituximab/  19 (B-cell depleted 11, B-cell recovered 8) | Prospective cohort study | Humoral and cellular response to vaccine | * None of the B-cell depleted patients had seroconversion * All patients in the control and B-cell recovered group had similar humoral response * Cellular response was similar in B-cell depleted, B-cell recovered and control groups | Moderate |
| Moyon et al. (2022) [37] | mRNA-vaccine | France/  NA | SLE/  126 | prospective cohort study | Humoral and cellular response to vaccine  Adverse events | * Vaccine was well-tolerated and no significant increase in flares * Methotrexate and mycophenolate mofetil are associated with lower humoral response * Higher baseline IgG level, naïve B cell frequencies and cellular immunity were positively correlated with Ab response * Neutralizing Abs cross neutralize variants of concerns but was lower for a certain mutation | Low |
| Mrak et al. (2021) [38] | mRNA-vaccine | Austria/  NA | ARD on rituximab/  74 | Prospective cohort study | Humoral and cellular response to vaccine with rituximab use | * 39% of patients had seroconversion compared to 100% in control group * Circulating B cells correlated with the levels of antibodies * Low number of peripheral B cells associated with detectable Ab * 33 out of 34 patients with undetectable peripheral B cells did not mount Ab response * 58% of all patients had cellular response irrespective of humoral response | Low |
| Mettler et al. (2022) [39] | mRNA-vaccine (61.9%)  Adenoviral-vector vaccine (37.4%\*) | Global  (>130 countries)/  until 30 June, 2021 | Vaccinated people/ 446 out of 1 295 48:  147 GCA  290 PMR  9 GCA+PMR | Registry | Incidence of PMR and GCA post COVID-19 vaccine | * Medan time (IQR) =4 days (1-14) * ROR for GCA:2.7 [95% CI: 2.3, 3.2] * ROR for PMR:2.3 [95% CI: 2.0, 2.6] * COVID-19 vaccines have lower ROR compared to influenza vaccine | High |
| Ozdede et al. (2022) [40] | mRNA-vaccine (51%)  Other (49%) | Turkey/  January and March, 2021 | BS, GCA and ARD/  Behçet’s syndrome: 147  familial Mediterranean fever: 157  ARD: 258 | Cross-sectional study | Side effects and efficacy | * Number of COVID-19 infection was less with mRNA-vaccine but no statistical significance * Side effects were more common in mRNA-vaccine than the other type and mostly mild or moderate * Disease flare was more common in BS and FMF compared to other ARD | Low |
| Picchianti-Diamanti et al. (2021) [41] | mRNA-vaccine | Italy/  NA | RA/  35 | Prospective cohort study | Humoral and cellular response to vaccine  Disease flare | * 97% had positive antibodies against receptor binding domain but at a lesser titer with the use of CTLA-4-inhibitors or IL-6 inhibitors * 69% had specific cellular immunity with a lower degree with using IL-6 inhibitors, CTLA-4 inhibitors or TNFi * Humoral and cellular responses were positively correlated * No increase in disease activity | Moderate |
| Pinte et al. (2021) [42] | mRNA-vaccine (89%)  Adenoviral-vector vaccine (9%)  Other (2%) | Romania/  February until May 2021 | ARD/  Total: 623  Vaccine 416  No vaccine: 207 | Prospective cohort study | Incidence of disease flare | * No difference in the incidence of disease flare between vaccinated and unvaccinated patients with ARD with a median follow up of 5.9 months * Higher risk of flare with multiple ARD and recent flare | Moderate |
| Prendecki et al. (2021) [43] | mRNA-vaccine (74.3%)  Adenoviral-vector vaccine (25.7%) | UK/  January to March 2021 | ARD (+GN)/  Total 140  ARD: 73  GN: 67 | Prospective cohort study | Serological and T-cell immune response to vaccine | * 59.3% and 82.6% had seroconversion and T-cell immunity after second dose * Less likelihood for seroconversion with adenoviral-vector vaccine, prior rituximab use, B-cell depletion, older age * Higher peripheral B-cell correlated with higher serological response * T-cell response was not related to seroconversion * Tacrolimus was associated with less T-cell response | Moderate |
| Ramirez et al. (2021) [44] | mRNA-vaccine | Italy/  December 2020 to March 2021 | ARD/  26 | Prospective cohort study | Adverse events | * Mild side effects including constitutional (49%) and injection site pain (38%) * More common in women and in younger age * Less common with IgG4 related disease | Moderate |
| Rotondo et al. (2021) [45] | mRNA-vaccine (78%)  Adenoviral-vector vaccine (22%) | Italy/  NA | ARD/  137 | Cross-sectional | Adverse events and disease flare | * Adverse events were less common in older people and those with controlled disease activity * Adverse events occurred in 43-57% after first dose and 31% after second dose of mRNA-vaccine only, none was serious * Disease relapse occurred in 3.8% after first dose of mRNA-vaccine and none after two doses or with Adenoviral-vector vaccine | Moderate |
| Ruddy et al. (2021) [46] | mRNA-vaccine | USA/  12/7/2020–3/16/2021 | ARD/  404 | Prospective cohort | Humoral response to vaccination | * Seroconversion in 94% * Lower seroconversion rate in patients receiving rituximab, mycophenolate, regimens contesting steroids and in patients with myositis * Lower AB titer with mycophenolate and rituximab use * All patients using anti-TNFi or glucocorticoids monotherapy had positive seroconversion | Moderate |
| Saleem et al. (2022) [47] | mRNA-vaccine and Adenoviral-vector vaccine | UK/  Starting January, 2021 | RA on DMARDs/  100 | Prospective cohort | Humoral ad cellular response | * 45%, 53% and 77% had seroconversion, cellular immunity and either type of immunity respectively after a single dose in infection-naïve * 74% of those with negative seroconversion had positive cellular immunity after single dose * Seroconversion occurred in 54% and 20% in non-responders after second and third dose respectively * IFN score analysis showed no change post-vaccine * Reduced conversion with abatacept, rituximab or methotrexate use * Better seroconversion rate in age less than 50 and more than 6 months from rituximab * T-cell response was less affected by drugs | Moderate |
| Santos et al. (2021) [48] | mRNA-vaccine | Spain /  April and July 2021 | ARD/  160 | Prospective cohort | Humoral and cellular response | * ARD had lower seroconversion and T-cell immunity compared to control (80 vs 100% and 75 vs 100% respectively) * Methotrexate use: 62% humoral response, and 80% cellular response * Abatacept: low humoral and cellular response * Low humoral response with rituximab and belimumab but preserved cellular response * Low Ab titer with azathioprine and mycophenolate but preserved with leflunomide and anticytokines | Low |
| Spinelli et al. (2022) [49] | mRNA-vaccine | Italy/  NA | ARD/  126 | Prospective cohort | Adverse events and disease flare | * Incidence of disease flare 0.007 person/month * No difference in local and systemic side effects between control and ARD | Moderate |
| Sattui et al. (2021) [50] | mRNA-vaccine (74.5%), Adenoviral-vector vaccine (22.6%) | International/  April, 2021 | ARD/  2860 | Online survey | Adverse events and disease flare | * Mostly mild side effects: fatigue, somnolence, headache, myalgia, arthralgia, fever and chills * 4.6% had disease flare that required change in medications | Moderate |
| Schreiber et al. (2021) [51] | mRNA-vaccine | Denmark /  March, 2021 | ARD/  243 | Prospective cohort | Humoral response | * Significant increase in Ab titer at 6 weeks compared to baseline * 32% had an insufficient IgG response * Lower mean Ab titer in patients receiving DMARDs versus ARD not on DMARDs | Moderate |
| Shields et al. (2022) [52] | mRNA-vaccine (41.7%) Adenoviral-vector vaccine (58.3%) | UK/  NA | ARD on CD-20 depleting agents (+other)/  36 | Prospective cohort | Humoral response | * 33.3% of ARD on CD-20 depleting agents within 6 months had seroconversion * Vaccine responsiveness significantly improved after 6 months ( * No difference in vaccine response between the two types of vaccines * B-cells were undetectable in most patients during the first 6 months, after that ARD had slower B-cell reconstitution | Moderate |
| Simader et al. (2022) [53] | mRNA-vaccine | Austria/  NA | RA and SpA not receiving B-cell depleting therapy/  99 | Prospective cohort | Humoral response  Adverse events and disease flare | * Seroconversion in 54% in ARD compared to 98% in control after first dose * 100% seroconversion in both groups after second dose * DMARD monotherapy did not affect seroconversion rate or titer * DMARD Combination was associated with lower rate of seroconversion and lower titer * Local adverse more common in ARD but less fever * No change in disease activity | Moderate |
| Simon et al. (2021) [54] | mRNA-vaccine | Germany/  Starting in February, 2020 | ARD/  84 | Prospective cohort | Humoral response | * 90.5% vs 99.5% developed NAbs in ARD vs control * Overall responses were delayed and reduced in ARD * No difference in seroconversion among different treatment groups | Moderate |
| Speer et al. (2021) [55] | mRNA-vaccine | Germany/  NA | ANCA vasculitis/  21 | Prospective cohort | Humoral response (general + delta variant  Adverse events | * Significant increase in Ab titer after third dose * Number of patients with NAbs significantly increased after third dose against delta variant * Rituximab use was associated with lower Nab titer and no Nab against delta variant * Local adverse events were more common after third dose * No disease flare during follow up | Moderate |
| Tani et al. (2021) [56] | mRNA-vaccine | Italy/  NA | ARD/  101 | Prospective cohort | Humoral response with DMARDs | * 93% and 83% of ARD had receptor-binding antigen IgG and IgA respectively * 87% had NAbs * Abatacept and mycophenolate impacted the Ab titer | Moderate |
| Tzioufas et al. (2021) [57] | mRNA-vaccine | Greek/  Starting January, 2021 | ARD/  605 | Prospective cohort | Humoral response and adverse events | * ARD with extended treatment modification had similar response to ARD not in treatment and control * ARD with partial or no adjustment in medications had response in 87.50% and 84.50%, respectively * Mycophenolate mofetil, rituximab and methotrexate negatively impacted humoral response * Similar side effects in ARD and control * 10.5% had mild clinical deterioration but no difference between treatment modifications | Low |
| van der Togt et al. (2022) [58] | mRNA-vaccine (84%) Adenoviral-vector vaccine (16%) | Netherland/  April and July 2021 | RA on rituximab/  196 | Prospective cohort | Humoral response with rituximab dose and timing | * Seroconversion in 28% overall, and 46% after patients with previous infection plus 2-dose vaccination * Humoral response is significantly better for patients receiving 200 mg compared to 1000 mg rituximab * Humoral response is significantly higher for each one-month delay between rituximab and vaccination | Low |
| Visentini et al. (2022) [59] | mRNA-vaccine (93.6%) Adenoviral-vector vaccine (4.7%)  other (1.5%) | Rome/  NA | mixed cryoglobulinemia/  71 | Prospective cohort | Humoral response and disease flare | * 12.7% had post vaccination disease flare * 9.5% of patients with stable disease had flare post vaccination * Negative seroconversion in 11.6% in patients not receiving rituximab and 71% in rituximab group * Seronegativity correlated with disease subtype and with B cell count <5 cells/µL | Moderate |
| Zavala-Flores et al. (2022) [60] | mRNA-vaccine (91%) Adenoviral-vector vaccine (9%) | Italy/  December 2020 and October 2021 | SLE/  452 | Prospective cohort | Adverse events and disease flare | * 26% had adverse event after first or second dose (local pain, fatigue, arthralgia) * 4% had disease flare, none needed hospitalization * Increase medication requirement in 16 patients * Adverse events more common in patients with constitutional symptoms and those receiving belimumab * Disease flare more common with anti-dsDNA, moderate/high DAS score and belimumab use | Moderate |
| Abbreviations: RA: rheumatoid arthritis, SLE: systemic rheumatoid arthritis, JIA: juvenile inflammatory arthritis, SpA: spondyloarthritis, AVA: ANCA-associated vasculitis, PsA: psoriatic arthritis, PMR: polymyalgia rheumatica, GCA: giant cell arteritis, BS: Bahcet syndrome, FMF: familial Mediterranean fever | | | | | | | |

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| **Supplementary table 3: Summary of case reports and case series included in the review** | | | | | | | | |
| Authors, Year [Reference] | **Study design** | **Vaccine platform** | **Patient description** | **Event** | **Time period between vaccination and event** | **ARD described** | **Outcome** | **Comments** |
| Albach et al. (2021) [61] | Case report | mRNA-vaccine | 54-year-old male with RA on upadacitinib and methotrexate | Vaccine efficacy measured by NAbs | Negative serological response after two doses but positive response after the fourth dose | RA and leukocytoclastic vasculitis | Positive immunological response after repeated doses of vaccine in initially negative NAbs response | Immunosuppression was not paused at time of vaccination |
| Altun et al. (2022) [62] | Case report | mRNA-vaccine | 34-year-old male | Skin rash and arthralgia of lower limbs | 4 days after first dose of COVID-19 vaccine | New onset of leukocytoclastic vasculitis | Patient improved with antihistamine and prednisolone | Diagnosis was made based on clinical and histopathological findings |
| Capassoni et al. (2021) [63] | Case report | mRNA-vaccine | 76-year-old female | Skin rash, proximal myopathy and dysphagia | 1 day after second dose of COVID-19 vaccine | New onset dermatomyositis | Patients improved with steroids and methotrexate | Diagnosis was based on clinical. Histopathological and EMG findings |
| Ceccarelli et al. (2021) [64] | Case report | mRNA-vaccine | 45-year-old female with SLE | Minimal NAbs response after two doses of COVID-19 vaccine in the context of rituximab use | Four weeks post second dose of mRNA-vaccine | SLE | Impaired serological response to mRNA-vaccine in a patient with SLE receiving rituximab | Vaccine was given six-month after rituximab dose |
| Chan-Chung et al. (2021) [65] | Case report | mRNA-vaccine | 62-year-old female | EGPA associated skin rash, neuropathy and cardiomyopathy | Few days following second dose of COVID-19 vaccine | EGPA | Patient improved clinically and eosinophilic count decreased | Diagnosis was based on ACR diagnostic criteria 1990  Treated with pulse steroids plus rituximab |
| Cohen et al. (2021) [66] | Case report | mRNA-vaccine | 46-year-old female | A case of psoriatic arthritis and leukocytoclastic vasculitis in remission developed flare of vasculitis rash after the first and second doses of vaccine | 2 days post vaccination | leukocytoclastic vasculitis | Patient improved with prednisone taper | Rash was worse after the second dose of vaccine  Diagnosis was made based on clinical and histopathological features |
| Conticini et al. (2021) [67] | Case report | mRNA-vaccine | 77‐year‐old male | A case of microscopic polyangiitis in remission who developed disease flare post vaccination | Few days after first dose of COVID-19 vaccine | Microscopic polyangiitis | Patient required hospitalization for severe respiratory distress but improved eventually | Methotrexate was held before vaccination  Patient required pulse steroid therapy |
| David et al. (2021) [68] | Case report of 2 patients | Adenoviral-vector vaccine | 75- and 74-year-old men | Relapse of microscopic polyangiitis which was in remission | First case 5 weeks post first dose  Second case 2 weeks post first dose of vaccine | Microscopic polyangiitis | Both patients required pulse steroids and immunosuppressive therapy  First case required renal replacement therapy |  |
| Dicks et al. (2021) [69] | Case report | mRNA-vaccine | 65-year-old male | New onset vasculitis skin rash of the lower limbs | Two days post third dose of vaccine | Leukocytoclastic vasculitis | Patient improved on systemic and topical steroids | No systematic involvement |
| Erler et al. (2021) [70] | Case report | mRNA-vaccine | 42-year-old female | New onset vasculitis skin rash of the lower limbs | Four days post vaccination | Leukocytoclastic vasculitis | Improved on systemic steroids | No systematic involvement |
| Furer et al. (2021b) [71] | Case series | mRNA-vaccine | Six female patients (age 49 ± 11 years) with stable ARD | Herpes zoster infection | Short time after the first dose in 5 patients and after few days of the second dose in one patient | ARD developing Herpes Zoster | Improved with treatment, no recurrence after second dose of vaccine | Mild infections except for one case of varicella zoster opthalmicus |
| Gouda et al. (2022) [72] | Case report | mRNA-vaccine | 43-year-old female | New onset skin rash and muscle weakness typical to dermatomyositis | 10 days post second dose of vaccine | Dermatomyositis | Improved on systemic steroids and immunosuppressive therapy | Diagnosis was based on EULAR criteria  Arthralgia and weight loss started 1 month earlier |
| Grossman et al. (2022) [73] | Case report | mRNA-vaccine | 94-year-old male | Purpuric skin rash and new onset renal impairment | 10 days post second dose of vaccine | Leukocytoclastic vasculitis | Improved on high dose oral steroids | IgA vasculitis with skin and renal involvement |
| Guzmán‐Pérez et al. (2021) [74] | Case report | Adenoviral-vector vaccine | 57‐year‐old female | One day fever and myalgia then new onset vasculitic skin rash | 9 days post first dose of vaccine | Leukocytoclastic vasculitis | Improved without treatment | Diagnosis was made based on clinical and histopathological features |
| Hakroush et al. (2021) [75] | Case report | mRNA-vaccine | 79-year-old female | New onset ANCA-associated vasculitis with severe rhabdomyolysis and pauci-immune glomerulonephritis | 2 weeks post second dose of vaccine | ANCA-associated vasculitis | Improved with pulse steroid therapy and cyclophosphamide infusion | Marked eosinophilia, positive MPO-ANCA |
| Hidaka et al. (2021) [76] | Case report | mRNA-vaccine | 53-year-old female | New onset thrombocytopenia, hemolytic anemia, positive ANA, lupus anticoagulant and low complements | 2 weeks post second dose of vaccine | Evans syndrome with SLE | Improved on high dose oral steroids | No oral ulcers, arthritis or renal involvement |
| Ireifej et al. (2022) [77] | Case report | mRNA-vaccine | 59-year-old female | New onset vasculitic skin rash | 1-day post second dose of vaccine | Leukocytoclastic vasculitis | Improved on oral prednisolone | Involvement of the skin and gastrointestinal tract |
| Ishay et al. (2021) [78] | Case series | mRNA-vaccine | 3 males (49, 28, 60 years presenting with polyarthritis, uveitis and GCA picture respectively)  37-year-old female presented with oligoarthritis | 3 cases had new onset ARD-like illness  1 case exacerbation of uveitis in known Bechet | Variable onset between 3 days and 3 weeks | RA, GCA, undifferentiated oligoarthritis and flare of eye symptoms in Bechet | Disease flare was frequently mild and required modest therapy |  |
| Iwata et al. (2021) [79] | Case report | mRNA-vaccine | 70‐year‐old female | Underlaying RA on biologic therapy developed new onset vasculitic skin rash on | 2 days post second dose of vaccine | Leukocytoclastic vasculitis | Resolved spontaneously without treatment | No flare in joint disease or gastrointestinal involvement |
| Izuka et al. (2022) [80] | Case report | mRNA-vaccine | 70‐year‐old male | New onset low grade fever, malaise, neck and pelvic girdle pain, headache, jaw claudication and scalp tenderness | 7 days post second dose of vaccine | Polymyalgia rheumtica | Symptoms and high inflammatory markers improved spontaneously within one month without using steroids | Diagnosis fits PMR criteria  Received paracetamol only |
| Jin et al. (2021) [81] | Case report | Adenoviral-vector vaccine | 68‐year‐old female | New onset vasculitic skin rash on lower limbs | 7 days post first dose of vaccine | Leukocytoclastic vasculitis | Improved with oral and topical steroids  Mild recurrence in rash after second dose but resolved spontaneously | Diagnosis was made based on clinical and histopathological features |
| Khajavirad et al. (2022) [82] | Case report |  | 77-year-old female | New onset vasculitic skin rash on lower limbs, elevated inflammatory markers and pancytopenia | 2 days post first dose of vaccine | Leukocytoclastic vasculitis | Improved with oral steroids (Prednisolone 0.5 mg/kg/day) | Diagnosis was made based on clinical and histopathological features |
| Kim et al. (2022a) [83] | Case report | mRNA-vaccine | 30-year-old male | New onset proximal muscle weakness, fever, rash, dysarthria and dysphagia | 6 days after the second dose of vaccine | Inflammatory myositis | Gradual improvement with oral steroids and immunosuppressive therapy | Diagnosis was made based on clinical, laboratory, and muscle biopsy findings |
| Kim et al. (2022b) [84] | Case report | Adenoviral-vector vaccine | 60-year-old female | New onset class III lupus nephritis with multi-organ involvement | Nonspecific symptoms started immediately after second dose of vaccine; renal impairment was diagnosed 2 months afterward | Lupus nephritis | Improved with pulse steroids, cyclophosphamide infusion and maintenance dose of steroids and hydroxychloroquine | Suspected to have background history of undiagnosed ARD |
| Kreuter et al. (2021) [85] | Case report | Adenoviral-vector vaccine | 62‐year‐old female | Transition from subacute cutaneous lupus erythematosus to SLE | 10 days post the first dose of vaccine | SLE | Improved with high dose oral steroids |  |
| Lawson-Tovey et al. (2022) [86] | Case series (10 fully vaccinated) | mRNA-vaccine (80%)  other (20%) | Median age 62.5 (49–72), 70% females | Incidence of COVID-19 disease in fully vaccinated ARD | Median time from second dose to COVID-19 infection 45 day (19–58) | 50% had RA | 2 patients fully vaccinated with mRNA-vaccine died  8 patients fully recovered | All cases were in remission or had low disease activity |
| Lemoine et al. (2022) [87] | case report | mRNA-vaccine | 68-year-old female | New onset inflammatory arthritis with positive serology | 2 days post first dose of vaccine | SLE | Improved with methotrexate and oral prednisolone | Recurrence of symptoms after initial improvement |
| Lin et al. (2022) [88] | case report | mRNA-vaccine | 40-year-old female | Intracerebral and intraventricular hemorrhage | 3 days after the second dose of the vaccine | Sjogren’ disease | Underlaying Sjogren’ disease, autoimmune thyroiditis and aberrant intracranial arteries “Moyamoya disease” | Significant residual neurological deficit |
| Liu et al. (2021) [89] | Case report | mRNA-vaccine | 70-year-old male | New onset violaceous skin rash with central hypopigmentation  Positive ANA, anti-SSA/Ro | Two-and-a-half-month post second dose | cutaneous lupus erythematosus | Underlaying lung cancer | Treated with topical steroids  Pt expired later due to cancer |
| Lukaszuk et al. (2021) [90] | Case report | mRNA-vaccine | 50-year-old female | Antibody response to vaccine with the use of methotrexate compared to humoral response in 118 control group | Ab level at the day of second dose, then 8, 14 and 30, 90 and 180 days after dose 2 | RA | Humoral response to vaccine | Ab level at the time of second dose was negative but increased later at a slower rate compared to other patients but decreased at day 180 |
| Manzo et al. (2021) [91] | Case report | mRNA-vaccine | 69-year-old female | Shoulder and pelvic girdles pain and stiffness, fever High inflammatory markers | One day after first dose of vaccine | PMR | No evidence for GCA  PET scan suggestive for PMR | Rapid response to 15 mg per day prednisolone |
| Maranini et al. (2021) [92] | Case report | mRNA-vaccine | 41-year-old female | New onset vesicular rash on the forearm on dermatomal distribution | 7 days after the first dose of vaccine | Ankylosing spondylitis | Patient was in remission on TNF-i | Improved on systemic anti-viral therapy  Next dose of adalimumab was postponed 6-7 weeks |
| Molina-Rios et al. (2022) [93] | Case report | mRNA-vaccine | 42-year-old female | Polyarthritis, synovitis, pulmonary embolism and cardiac tamponade | 2 weeks after first dose of vaccine | SLE with secondary antiphospholipid syndrome | Previous 2 first trimester miscarriage, no formal diagnosis | Patient improved on immunosuppressive therapy and warfarin |
| Misumi et al. (2022) [94] | Case report | mRNA-vaccine | A 59-year-old male | New onset dyspnea and lower limb edema due to constrictive pericarditis | 5 days post first dose of vaccine | Systemic sclerosis | Improved with prednisolone | Initially pericarditis with pericardial effusion then constrictive pericarditis |
| Mücke et al. (2021) [95] | Case report | mRNA-vaccine | 76-year old male | New onset pruritic purpuric macules and bloody diarrhea | 12 days post second dose of vaccine | Cutaneous immune complex vasculitis | Improved with a short course of oral steroids | Background history of liver cirrhosis |
| Muench et al. (2021) [96] | Case report | mRNA-vaccine | twenty-year-old female | Fever, fatigue, severe myalgia, sore throat, and laboratory features of MAS | 6 days post first dose of vaccine | Multisystem Inflammatory syndrome | Improved with pulse steroid, IVIG, increased dose of anakinra and cyclosporin | Background history of adult onset still’s disease |
| Nastro et al. (2021) [97] | Case report | mRNA-vaccine | 84‐year‐old female | Burning pain on right leg followed by purpuric papules and vesicles | Few hours after the first dose of vaccine | Small vessel vasculitis with atypical varicella zoster skin infection | Improved with oral antiviral therapy but pain persisted | Background history of chronic kidney disease and depression |
| Naitlho et al. (2021) [98] | Case report | Adenoviral-vector vaccine | 62-year-old male | Petechial purpuric rash, polyarthralgia and hematuria | 8 days post first dose of vaccine | Henoch-Schönlein purpura | Rapid improvement with prednisolone | Previous history of uncomplicated COVID-19 infection |
| Nakatani et al. (2022) [99] | Case report | mRNA-vaccine | 80-year-old male | Fever, lower limb pain and weakness | 1-day post second dose of vaccine | Systemic vasculitis | NA | Positive PET scan  Temporal artery biopsy showing arteritis but not typical for GCA |
| Nazzaro et al. (2021) [100] | Case report | mRNA-vaccine | 27-year-old female | Itchy, diffuse, cutaneous eruption | 10 days post first dose of vaccine | Urticarial vasculitis | Improved on oral methylprednisolone with slow tapering | Diagnosis was proved by histopathological examination |
| Niebel et al. (2021) [101] | Case report | mRNA-vaccine | 73-year-old female | Exacerbation of known subacute cutaneous lupus erythromatosus | 10 days post first dose of vaccine | Subacute cutaneous lupus erythromatosus | Improved on high dose prednisolone | Patient tolerated second dose without symptoms |
| Nune et al. (2021a) [102] | Case report | mRNA-vaccine | 44-year-old female | Injection site pain followed by fever, diarrhea, pulmonary embolism and acute kidney injury | 2 days after first dose of vaccine | Multisystem inflammatory syndrome | Patient required admission to intensive care unit but subsequently improved on pulse steroid | Pt required long term rehabilitation  Discharged on apixaban |
| Nune et al. (2021b) [103] | Case report | mRNA-vaccine | 24-year-old male | Polyarthritis, fever and fatigue | 2 weeks after second dose | SLE | Improved with high dose steroids and methotrexate | SLE with necrotizing lymphadenitis |
| Obata et al. (2022) [104] | Case report | mRNA-vaccine | 84-year-old male | Fever, malaise and cough, hematuria and worsening of previously known interstitial pneumonia | 1-day post second dose of vaccine | Renal limited MPO-ANCA vasculitis | Patient condition was stabilized with initial pulse steroids followed by oral prednisolone | Positive MPO-ANCA  Kidney biopsy showing focal necrotizing glomerulonephritis |
| Okada et al. (2021) [105] | Case series (3) | mRNA-vaccine | 70-year-old female  Two males: 78 and 79-year-old | Vaccine induced thrombocytopenia in patients with RA | 4 days after second dose  4 days post first dose  5 days post first dose | RA | Two patients had intracranial bleeding, one died  Third patient was asymptomatic | Baseline thrombocytopenia in all patients, one had ITP  platelet-associated IgG positive in 2 cases |
| Okuda et al. (2021) [106] | Case report | mRNA-vaccine | 37-year-old female | Fever, rash and redness/swelling of left auricle | 12 days post first dose of vaccine | ANCA-vasculitis | Patient improved on oral prednisolone | Probably propylthiouracil-induced ANCA vasculitis |
| Osada et al. (2022) [107] | Case report | mRNA-vaccine | 80-year-old female | Bilateral shoulder and hip pain | 2 days post second dose | PMR | Improved on oral prednisolone | Suggestive US features |
| Ottaviani et al. (2022) [108] | Case series (10) | mRNA-vaccine | Median age 74.5 years  70% were females | All patients fulfilled 2012 ACR/EULAR criteria for PMR | Median time to onset of symptoms from vaccination was 10 days (range 5-15) | PMR | All patients improved  9 out of ten treated with steroids | 7 patients had new onset PMR, whereas 3 patients had relapse |
| Park et al. (2021) [109] | Case report | mRNA-vaccine | 36-year-old female | Fever and sore throat, arthralgia, splenomegaly, pleural and pericardial effusion | 10 days after the first dose of vaccine | Adult onset Still’s disease | Improved with high dose steroids and tocilizumab | Dramatic response to tocilizumab |
| Parperis et al. (2021) [110] | Case report | mRNA-vaccine | 80-year-old male | Bilateral hand pain, pitting oedema and synovitis | 2 days after the second dose of vaccine | Remitting seronegative symmetrical synovitis with pitting oedema | Improved with oral prednisolone 15 mg per day | Needed to be maintained on low dose prednisolone (5 mg daily) at 3 months of follow up |
| Peluso et al. (2021) [111] | Case report | mRNA-vaccine | 37-year-old female | Patient mounted weak receptor binding domain–specific antibody level, no NAbs but positive cellular immunity against SARS-CoV-2 | After 3 doses of the vaccine  Rituximab was held for more than 7 months prior to vaccination | ANA-positive undifferentiated CTD | Patient was on rituximab, oral steroid taper, hydroxychloroquine, and regular IVIG infusions | CD-19 B-cell percentage of ≤1% before and after vaccination |
| Rechtien et al. (2021) [112] | Case report | mRNA-vaccine | 24-year-old female | Widespread papulosquamous rash of upper trunk and proximal limbs | 2 weeks post first dose of vaccine and worsened after second dose | SCLE in a patient with SLE | patient slowly improved and returned back to her baseline medications | Required high dose pulse steroid and increase in immunosuppressive drugs |
| Ramos-Casals et al. (2021) [113] | Case report | Adenoviral-vector vaccine | 55-year-old male | New onset of ITP with positive anti-Ro, ocular and salivary involvement | 10 days after the first dose | subclinical Sjögren's syndrome | Patient was treated for ITP with pulse steroids, IVIG and eltrombopag | No symptoms of sicca  Background history of colon cancer in clinical remission |
| Salviani et al. (2021) [114] | Case series | mRNA-vaccine | 31-year-old female  60-year-old female  43-year-old female | Patients did not mount NAbs after vaccination (2 cases) or after infection (1 case) | Last rituximab dose was 6-9 months back | ANCA-associated vasculitis on rituximab | No humoral response to vaccine/infection  One case mild infection only | All patients had 0 peripheral B cells and normal immunoglobulin level |
| Sauret et al. (2022) [115] | Case report | Adenoviral-vector vaccine | 70-year-old man | headache and hyperesthesia of the scalp | Few days after the first dose | GCA | Patient improved dramatically on 0.5 mg/kg/day steroids | PET scan negative for large vessel vasculitis  Positive temporal artery biopsy  HLA-DR4 positive |
| Sekar (2021) [116] | Case report | mRNA-vaccine | 30-year-old male | Known lupus nephritis developed fever, polyarthralgia and worsening of kidney function | 3 days post first dose | SLE with lupus nephritis flare | Improved with pulse steroid therapy followed by high dose oral steroids | Had a previous mild COVID-19 infection  Second dose not given |
| Senda et al. (2022) [117] | Case report | mRNA-vaccine | 72-year-old female | Rheumatoid vasculitis had headache, fatigue and depressed consciousness | 3 days post first dose | RA | Improved with pulse steroid therapy and IVIG | Diagnosis was based on clinical, laboratory, microbiological and MRI findings |
| Shakoor et al. (2021) [118] | Case report | mRNA-vaccine | 78-year-old female | New onset acute kidney injury, proteinuria and hematuria | 16 days post first dose | Renal-limited ANCA-associated vasculitis | Improved with steroids and rituximab | Positive serology and kidney biopsy |
| Sharabi et al. (2021) [119] | Case report (2) | mRNA-vaccine | 43-year-old male  56-year-old female | headache, malaise, sore throat, fever, polyarthritis | 10- and 7-days post second dose respectively | Adult onset Still’s disease | Prompt response to high dose steroids | Diagnosis was based on Yamaguchi classification |
| Takeyama et al. (2022) [120] | Case report | mRNA-vaccine | 48-year-old female | Progressive left hemiparesis and anisocoria due to intracranial hemorrhage | 2 days post first dose | Vasculitis | Patient was discharged after 4 weeks of hospitalization | Negative autoantibodies  Neutrophilic infiltrate of the small vessels |
| Torrealba-Acosta et al. (2021) [121] | Case report | mRNA-vaccine | 77-year-old male | Fever, rash, confusion and myoclonus | 1-day post first dose | Sweet syndrome | Marked and complete resolution of symptoms with pulse steroids | Neutrophilic dermatosis |
| Tuschen et al. (2021) [122] | Case report | mRNA-vaccine | 42-year-old female | New onset nephrotic range proteinuria with fatigue | 7 days after first dose | Relapse of class V lupus nephritis | Improved with high dose steroids and mycophenolate mofetil | Diagnosis confirmed by kidney biopsy |
| Ursini et al. (2022) [123] | Case series (66) | mRNA-vaccine (64%)  Adenoviral-vector vaccine (36%) | Females (65%)  Mean age for polyarthritis 54±16  Mean age for oligoarthritis 64±15  Mean age for PMR 67±10 | New onset of inflammatory musculoskeletal disorders | Average duration between injection and outcome 11-14 days | PMR-like illness  Polyarthritis  Oligoarthritis  Tenosynovitis  Enthesitis | Most patients were treated with steroids, NSAIDs or analgesics  DMARDs were used in 5 patients | Autoantibodies were uncommonly found  2 patients had inflammatory low back pain and sacroiliitis on MRI |
| Valor-Méndez et al. (2021) [124] | Case series (10) | mRNA-vaccine | Females (80%)  mean age was 33±10 years | Development of humoral response in the setting of IL-1 use | Up to 60 days post vaccination | Autoimmune disease on IL-1 inhibitor | NAbs occurred in 90% of ARD vs 100% in control  IgG titer was higher in ARD  Similar receptor-binding domain Abs to control | Only one patient did not develop seroconversion (gout +ESRD) |
| Vassallo et al. (2021) [125] | Case report | mRNA-vaccine | 51‐year‐old female | Injection site pain, fever, arthralgia and skin rash | 6 hours after the first dose | lymphocytic vasculitis of small vessels | Rapid response to systemic antihistamine and local steroids | Previous symptomatic COVID-19 infection  Marked increase in serological markers post vaccine |
| Vutipongsatorn et al. (2022) [126] | Case report (2) | mRNA-vaccine | 55- and 72-year-old females | Proximal myopathy in both cases  Skin rash in first case | 2 days post first dose  1-day post first dose | Dermatomyositis and Inflammatory myositis | Improved with IVIG | Both did not improve with initial pulse steroid therapy |
| Watad et al. (2021) [127] | Case series (27) | mRNA-vaccine (22)  Adenoviral-vector vaccine (2) | Females (55%)  Mean age 54.4 ± 19.2 years | Worsening of underlaying ARD or new onset ARD | Average 4 days post first or second dose | ARD flare (17)  New onset ARD (10) | 20 had mild to moderate disease severity  More than 80% had excellent response mostly with steroids | 21 patients had at least one underlaying autoimmune disease |
| Wu et al. (2022) [128] | Case report (2) | mRNA-vaccine | 60-year-old male  32-year-old female | Case 1: Altered mental status, slurred speech, fever  Case 2: fever, anemia, high ferritin and transaminases | 6 days after first dose  4 weeks after second dose | Hemophagocytic lymphohistocytosis | Both were treated with etoposide and dexamethasone.  emapalumab-lzsg was added for the second case  both cases required maintenance immunosuppressants | Both patients fulfilled the criteria for HLH  Both cases initially improved but relapsed with tapering medications |

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| **Supplementary table 4: Risk of bias assessment based on Quality in Prognostic Studies (QUIPS) tool: Low risk of bias, Moderate risk of bias, High risk of bias (**[**https://doi.org/10.7326/0003-4819-158-4-201302190-00009**](https://doi.org/10.7326/0003-4819-158-4-201302190-00009) **)** | | | | | | | |
| **Reference** | **Study Population** | **Study Attrition** | **Prognostic Factor Measurement** | **Outcome Measurement** | **Study Confounding** | **Statistical Analysis and Reporting** | **Overall Risk of Bias** |
| Ammitzbøll et al. (2021) [1] |  |  |  |  |  |  |  |
| Barbhaiya et al. (2021) [2] |  |  |  |  |  |  |  |
| Bartels et al. (2021) [3] |  |  |  |  |  |  |  |
| Bixio et al. (2021) [4] |  |  |  |  |  |  |  |
| Boekel et al. (2021) [5] |  |  |  |  |  |  |  |
| Braun-Moscovici et al. (2021) [6] |  |  |  |  |  |  |  |
| Cherian et al. (2021) [7] |  |  |  |  |  |  |  |
| Connolly et al. (2021) [8] |  |  |  |  |  |  |  |
| Connolly et al. (2022a) [9] |  |  |  |  |  |  |  |
| Connolly et al. (2022b) [10] |  |  |  |  |  |  |  |
| Cook et al. (2022) [11] |  |  |  |  |  |  |  |
| Cristaudo et al. (2021) [12] |  |  |  |  |  |  |  |
| Deepak et al. (2021) [13] |  |  |  |  |  |  |  |
| Delvino et al. (2021) [17] |  |  |  |  |  |  |  |
| Dimopoulou et al. (2022a) [15] |  |  |  |  |  |  |  |
| Dimopoulou et al. (2022b) [16] |  |  |  |  |  |  |  |
| Esquivel-Valerio et al. (2021) [17] |  |  |  |  |  |  |  |
| Ferri et al. (2021) [18] |  |  |  |  |  |  |  |
| Fornaro et al. (2022) [19] |  |  |  |  |  |  |  |
| Fragoulis et al. (2022) [20] |  |  |  |  |  |  |  |
| Furer et al. (2021a) [21] |  |  |  |  |  |  |  |
| Geisen et al. (2021) [22] |  |  |  |  |  |  |  |
| Haberman et al. (2021) [23] |  |  |  |  |  |  |  |
| Iancovici et al. (2021) [24] |  |  |  |  |  |  |  |
| Izmirly et al. (2022) [25] |  |  |  |  |  |  |  |
| Jyssum et al. (2022) [26] |  |  |  |  |  |  |  |
| Kant et al. (2022) [27] |  |  |  |  |  |  |  |
| Krasselt et al. (2022) [28] |  |  |  |  |  |  |  |
| Lee et al. (2022) [29] |  |  |  |  |  |  |  |
| Li et al. (2022a) [30] |  |  |  |  |  |  |  |
| Li et al. (2022b) [31] |  |  |  |  |  |  |  |
| Liew et al. (2022) [32] |  |  |  |  |  |  |  |
| Machado et al. (2022) [33] |  |  |  |  |  |  |  |
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| Mettler et al. (2022) [39] |  |  |  |  |  |  |  |
| Ozdede et al. (2022) [40] |  |  |  |  |  |  |  |
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| van der Togt et al. (2022) [58] |  |  |  |  |  |  |  |
| Visentini et al. (2022) [59] |  |  |  |  |  |  |  |
| Zavala-Flores et al. (2022) [60] |  |  |  |  |  |  |  |

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| **Supplementary table 5: International societies recommendations on COVID-19 vaccines in patients with autoimmune rheumatic diseases** | | |
| **Society/ URL** | **Date of issue** | **Current recommendations** |
| American Collage of Rheumatologists  <https://doi.org/10.1002/art.42109> | April, 2022 | * COVID-19 vaccine is recommended for all patients with ARD as soon as possible irrespective of disease activity or severity except in patients with life-threatening disease * mRNA COVID-19 vaccine of either type (Pfizer or Moderna) is recommended over other types of vaccine platforms * First dose of COVID-19 vaccine should be given prior to initiation of immunomodulatory therapy when feasible. * A third dose of mRNA COVID-19 vaccine is recommended ≥28 days after the completing the first series for ARD patients receiving any immunosuppressive therapy * Modification is not needed with hydroxychloroquine use * Rituximab dosing and timing should either given according to CD-19 value or a booster dose is given 2-4 weeks before next dose * No consensus on dose modification and timing regarding TNFi, IL-6R, IL-1Ra, IL-17, IL-12/23, IL-23, and other cytokine inhibitors * For abatacept (subcutaneous), belimumab (subcutaneous), cyclophosphamide (intravenous), all other cDMARDs and tsDMARDs withhold the drug for 1–2 weeks (as disease activity allows) after each COVID-19 vaccine dose. |
| Australian Rheumatology Association  <https://arthritiscare.com.au/covid-19-and-advice-for-general-practitioners/> | April, 2021 | * Patients with ARD should receive the Astra Zeneca or the Pfizer vaccine * No enough evidence to alter or interrupt treatment regimens in patients with ARD except for those receiving rituximab * Administer COVID-19 vaccine toward the end of rituximab cycle or before initiation of therapy if feasible * For patients receiving methotrexate, holding one or two doses post vaccination should be individualized and discussed with the rheumatologist |
| Brazilian Society of Rheumatology  <https://advancesinrheumatology.biomedcentral.com/articles/10.1186/s42358-022-00234-7> | Jan, 2022 | * Patients with ARD should receive COVID-19 vaccination and the timing for administration should be individualized through a shared decision process * Immunosuppressive therapy should not be interrupted or altered except for B-cell depleting agents * COVID-19 vaccine should be given 6 months after rituximab dose and 4 weeks before the next dose if possible * A third dose should be considered for patients with ARD preferably with a different vaccine platform from the initial series |
| British Society for Rheumatology  <http://arma.uk.net/covid-19-vaccination-and-msk/> | April 2022 | * All patients on immunosuppressive therapy should receive one of the UK-licensed COVID-19 vaccines irrespective of their treatment regimen or disease severity * Patients should not stop immunosuppressive therapy * Rituximab dosing and timing should be individualized taking into account shared-decision plan. It is suggested to administer COVID-19 vaccine 2 weeks before or 4-8 weeks after rituximab dose * Consider administering both doses of the vaccine before commencing treatment with rituximab if possible * Do not delay COVID-19 vaccine in patients who are B-cell depleted. Do not delay rituximab dose in organ-or life-threatening conditions * It is safe to administer the vaccine in patients receiving glucocorticoids * Most patients with ARD on immunosuppressive therapy (except hydroxychloroquine and sulfasalazine) should receive a third dose * A fourth dose should be offered to those eligible for a third dose at least 3 months apart |
| Canadian Rheumatology Association  <https://www.jrheum.org/content/early/2021/05/11/jrheum.210288> | May, 2021 | * Conditional recommendation for COVID-19 vaccines in patients with ARD * Defer vaccination to ⩾ 4-5 months from last dose and at least 4 weeks prior to next dose of rituximab * Continue DMARDs with vaccine administration * The decision to hold DMARDs should be discussed and shared between patients and their healthcare providers/rheumatologist |
| The European Alliance of Associations for Rheumatology  <https://ard.bmj.com/content/early/2022/02/22/annrheumdis-2021-222006> | Nov, 2021 | * Patients with ARD should receive one of the COVID-19 vaccines licensed in their country * Patients with ARD should continue their treatment unchanged around vaccination time * COVID-19 vaccine should be given prior to commencing immunosuppressive therapy if feasible * Schedule rituximab/BCDT to optimise vaccine immunogenicity * The EULAR supports a third dose of vaccine for patients receiving immunosuppressive therapy |
| The Hong Kong Society of Rheumatology  <https://www.worldscientific.com/doi/10.1142/S2661341721400010> | April, 2021 | * COVID-19 vaccines are recommended for patients with ARD who have reasonable control of their disease activity * Immunogenicity of COVID-19 vaccines in patients with ARD could be compromised * No evidence for disease flare or adverse events for COVID-19 vaccines in patients with ARD in the absence of other comorbidities * There is currently no evidence that adjusting immunosuppressive medications schedule would enhance vaccine efficacy * Adjustment of immunosuppressive therapy should be individualized and discussed with the attending rheumatologist * COVID-19 vaccine should be scheduled shortly before next dose of rituximab. Postponing rituximab infusion for 4 weeks may be considered in stable disease |

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