Psoriasis care during the time of COVID-19: real-world data on changes in treatments and appointments from a German university hospital

Background: COVID-19 poses significant challenges for care of patients with chronic inflammatory skin diseases including psoriasis. Objectives: To investigate changes in treatment and/or appointments for psoriasis patients in a German university hospital due to the pandemic. Materials & Methods: A postal survey was conducted between May 15 and June 15, 2020. Potential determinants of changes were analysed with descriptive statistics and multivariate logistic regression. Results: Out of 205 respondents, 19.5% missed an appointment and 9.8% changed therapy due to the pandemic. Treatment alterations were encouraged by patients (50%) and physicians (40%), whereas cancellations of appointments mostly occurred on patients’ request (70%). Several patient-related key drivers of changes, including sociodemographic, disease- and health-related characteristics were identified. Changes in treatment and appointments were associated with higher psoriasis severity scores and more frequent disease aggravations. Conclusion: It is particularly crucial to tailor psoriasis care to individual needs in order to protect the physical and mental well-being of patients during the pandemic.

Key words: adherence, biologicals, coronavirus, COVID-19, pandemic, psoriasis

The first case of coronavirus disease 19 (COVID-19) was detected in December 2019 in China. Since then, the infection rapidly spread throughout the world, causing millions of confirmed cases and deaths [1]. As a result, the World Health Organization (WHO) declared the COVID-19 outbreak a pandemic in March 2020. The pandemic poses significant challenges for the global health care systems, as health care resources have to be reallocated and social distancing behaviours impair access to health services. In dermatology, patients with chronic inflammatory skin diseases such as psoriasis are severely affected by the pandemic. On the one hand, they require continuous care both due to their skin condition and due to psoriasis-associated physical and mental comorbidities [2]. On the other hand, numerous patients with moderate-to-severe psoriasis receive systemic immunosuppressive or immunomodulating therapies. Patients and physicians rely on these therapies due to their proven efficacy and safety [3, 4]. However, the new and unforeseeably changing situation gave rise to concerns that systemic psoriasis treatments may increase the risk for and severity of severe acute respiratory syndrome virus 2 (SARS-CoV-2) infections. At the beginning of the pandemic, an extensive and partly controversial debate emerged on the use of systemic agents in psoriasis [5-10]. Meanwhile, dermatological societies recommended continuing these therapies in most COVID-19-negative and asymptomatic patients and initiating novel systemic therapies if required after individual risk-benefit assessment [11-16]. In any case, patients should not change or stop therapy without consulting their physicians.

Clearly, discontinuation or delayed initiation of therapy can result in psoriasis flares. During the first wave of the pandemic, the number of outpatient visits in dermatological hospitals and practices was significantly reduced [17]. On the one hand, providers had to cut non-urgent routine visits. On the other hand, patients postponed appointments [17]. Missing physician’s appointments poses risks of undertreatment, insufficient monitoring, and non-recognition of adverse events.

The aim of our study was to investigate changes in treatment and/or appointments of psoriasis patients in a German university hospital due to the pandemic. Furthermore, we aimed to determine reasons for, and determinants of, these changes.

Materials and methods

Study cohort

Inclusion criteria were: age ≥ 18 years; physician-confirmed diagnosis of psoriasis; consultation at outpatient clinics of the Dermatology Department of the University Medical Center Mannheim between January 1, 2019, and May 1, 2020 due to psoriasis; and ability to provide informed consent. The time span was chosen in order to select patients with recently active psoriasis. Eligible patients were identified through the appointment calendar. All patients fulfilling the inclusion criteria were contacted.
by mail. We decided to send our questionnaires by ordinary mail, first because we do not request e-mail addresses of patients who visit our psoriasis clinics routinely, second, e-mail delivery of study documents is not considered data-secure in Germany, and third telephone interviews were considered less suitable for completing the questionnaire (supplementary file S1). The study was performed in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the Medical Faculty Mannheim (reference no. 2020-548N).

Data collection
A patient information sheet, two copies of the informed consent form, the questionnaire (supplementary file S1) and a prepaid envelope were sent to all eligible patients on May 15, 2020. Patients willing to participate were asked to return signed informed consent and the completed questionnaire until June 15, 2020.

The survey contained questions on demographics, medical history (self-perceived impairment of the general health on a 5-point scale [range: 0 = none to 4 = very much], comorbidities [self-reported by choosing out of a list of options and free text if required], increased susceptibility to infections [yes/no], disease duration [years since onset of the first symptoms of psoriasis]) and psoriasis severity scores (patient-assessed Body Surface Area [BSA] and Dermatology Life Quality Index [DLQI]) [18]. In addition, participants were asked for their current psoriasis therapy, whether therapy had changed due to the pandemic, the respective therapy that was changed, duration of this therapy (in months) and treatment satisfaction on a 5-point scale (range: 1 = very dissatisfied to 5 = very satisfied). Treatment options were subdivided into topical treatments, phototherapy, systemic non-biologic medication, and biologicals. Both generic and brand names were presented for all approved systemic drugs. Unlisted drugs could be indicated as free text. Multiple answers were permitted.

In addition, participants were asked to provide information about treatment changes due to the pandemic (yes/no). Those who reported changes were asked to specify the drug, the kind of alteration (treatment discontinuation, pause, dosage modification, or change of drug), the reason for the change, and whether the change was discussed with the physician.

Moreover, the survey contained questions on missed psoriasis-related appointments due to the pandemic (yes/no; if yes: rescheduled or cancelled). Participants who reported alterations were asked to indicate the initiator (patient or medical provider) and to specify the main reason if the change was requested by the patient (fear of SARS-CoV-2 infection, disease other than COVID-19, SARS-CoV-2 infection or other reasons that could be specified as free text).

Concerns about the patient’s own health due to the pandemic, continuation of the psoriasis therapy during the pandemic and a more severe course of COVID-19 because of the current psoriasis therapy were measured on 5-point scales (from 0 = none to 4 = very high). Furthermore, questions also addressed the probability of reducing future psoriasis-related appointments due to the pandemic (0 = in no case, 4 = definitely) and, in cases of planned reductions, feared sources of SARS-CoV-2 infection (medical staff/other patients/on the way to the appointment/other). Participants were also asked for perceived changes in psoriasis severity due to the pandemic (no change/improvement/aggravation). Those who stated an aggravation were asked for the supposed reason.

Lastly, the survey contained information on SARS-CoV-2 infections affecting the participants, household members and/or close acquaintances as well as on protective measures used against SARS-CoV-2 (degree of decreased social contact and mask use).

Statistical analyses
In a first step, we conducted univariate analyses to describe changes in appointments and treatments during the COVID-19 pandemic. In a second step, we used descriptive statistics to identify associations between missed appointments and therapy change (both: yes vs. no) on the one hand and sociodemographic, disease-, health-, and treatment-related characteristics, as well as impairment by the pandemic on the other hand. For parametric independent variables, differences between subgroups were tested for statistical significance with unpaired t-tests. For non-parametric variables Mann-Whitney-U tests were performed. Chi-square tests were used for binary and categorical variables.

In a third step, we further investigated variables that showed significant associations with the two dependent variables in bivariate analysis by using logistic regression analysis. The models contained missed appointments or treatment change, respectively, as dependent variables, and sex, age, DLQI, BSA, number of comorbidities, systemic treatment (with non-biologic drugs or biologicals) and concern about health because of the pandemic as independent variables. Further variables that showed significant associations in bivariate analysis were omitted because of multicollinearity (e.g., impairment of general health was highly correlated with number of comorbidities, and depression with worry about health). Data were analysed using IBM SPSS Statistics 25. The pre-defined level of significance was $p < 0.05$.

Results
Study population
In total, 568 individuals (41.7% females; mean age: 53.1 years) were contacted by mail, and 205 returned completed questionnaires, all of which were valid for data analyses, corresponding to a response rate of 36.1%. The questionnaires were completed between May 20, 2020 (176,007 confirmed COVID-19 cases and 8,090 deaths in Germany) and June 15, 2020 (186,461 COVID-19 cases and 8,791 deaths) [1].

Missed appointments because of the pandemic
In total, 40 patients (19.5%) missed at least one psoriasis-related appointment because of the pandemic, of which 22 (55%) were rescheduled and 18 (45%) cancelled (table 1). Most cancellations occurred on patients’ request (70.0%) due to fear of SARS-CoV-2 infection (62.5%).
Table 1. Changes in appointments and treatments during the COVID-19 pandemic.

| Missed at least one psoriasis-related appointment with a physician because of the pandemic, n (%) | All n = 205 (%) |
|---|---|
| No | 165 (80.5) |
| Yes | 40 (19.5) |
| Rescheduled | 22 (10.7) |
| Cancelled | 18 (8.9) |

| Reason for missed appointmenta, n (%) |  |
|---|---|
| Patient-related | 28 (70.0) |
| Fear of SARS-CoV-2 infection | 25 (62.5) |
| Disease other than COVID-19 | 3 (7.5) |
| Medical provider-related | 12 (30.0) |
| Other reasonsb | 0 (0) |

| Change in psoriasis treatment because of the COVID-19 pandemic, n (%) | All n = 205 (%) |
|---|---|
| No | 185 (90.2) |
| Yes | 20 (9.8) |

| Change in psoriasis treatmentc, n (%) |  |
|---|---|
| Topical therapy | 3 (15.0) |
| Phototherapy | 1 (5.0) |
| Non-biological systemic therapy | 1 (5.0) |
| Methotrexate | 1 (5.0) |
| Biological | 15 (75.0) |
| TNF-α inhibitor | 6 (30.0) |
| Adalimumab | 5 (25.0) |
| Certolizumab pegol | 2 (10.0) |
| IL-17 inhibitor | 4 (20.0) |
| Secukinumab | 4 (20.0) |
| IL-23 inhibitor | 5 (25.0) |
| Guselkumab | 3 (15.0) |
| Risankizumab | 2 (10.0) |

| Type of treatment changed, n (%) |  |
|---|---|
| Paused | 10 (50.0) |
| Stopped | 1 (5.0) |
| Switched | 4 (20.0) |
| Altered dosing regime | 3 (15.0) |
| Not specified | 2 (10.0) |

| Reasons for treatment changefore, n (%) |  |
|---|---|
| Patient’s request | 10 (50.0) |
| Physician’s recommendation | 8 (40.0) |
| Sickness other than COVID-19 | 3 (15.0) |
| Other reasonsf | 3 (15.0) |
| Not specified | 2 (10.0) |

| Change in treatment after consultation with a physiciang, n (%) |  |
|---|---|
| No | 10 (50.0) |
| Yes | 10 (50.0) |

a For calculation of proportions, the number of participants in the subgroup that missed an appointment (n = 40) was set to 100%. b Other reasons could be specified as free text. However, no participant stated other reasons. c For calculation of proportions, the number of participants in the subgroup that changed treatment (n = 20) was set to 100%. d Dosing alteration comprised less frequent use of therapy (n = 2) and more frequent application of topical therapy during home office (n = 1). e Multiple answers were permitted. f Other reasons could be specified as free text: insufficient drug supply n = 3. COVID: coronavirus disease; IL: interleukin; n: number; SARS-CoV-2: severe acute respiratory syndrome virus 2; TNF-α: tumour necrosis factor-α.

Treatment changes because of the pandemic

Twenty respondents (9.8%) modified their psoriasis therapy due to the pandemic (Table 1). Among these, biological therapy (tumour necrosis factor-α [TNF-α] antagonists: n = 6; interleukin (IL)-17 inhibitors: n = 4; IL-23 inhibitors: n = 5) was changed in 15 (75%). Alterations in non-biological drugs (methotrexate: n = 1), topical therapy (n = 3) and phototherapy (n = 1) were rare.

Treatment was mostly paused (50%) or switched (20%). Alterations in the dosing regimen were reported by three participants (less frequent use: n = 2, more frequent application of topical therapy during home office: n = 1). One participant stopped therapy and two participants did not specify the kind of change. Most alterations occurred on patients’ request (n = 10), followed by physicians’ recommendations (n = 8), and in some cases, due to a disease other than COVID-19 (n = 3) and insufficient drug supply (n = 3). Six participants indicated two reasons (patient’s request and physician’s recommendation: n = 4; disease other than COVID-19 and physician’s recommendation: n = 2) and two participants did not specify the reason. Half of the treatment alterations were made without consulting a physician. Details on treatment changes are presented in supplementary Table S1.

Characteristics of the study cohort and their association with missed appointments and changes in treatment

Sociodemographic and disease- and health-related characteristics

Among 205 participants, 46.8% were female, and the mean age was 55.5 years. Most participants lived in a partnership (64.9%). The mean self-reported BSA was 6.5, the mean DLQI was 4.6 and the mean disease duration was 23.2 years. In total, 78.0% suffered from at least one comorbidity, with psoriatic arthritis (44.9%), arterial hypertension (42.4%) and allergies (26.8%) stated most frequently. On average, patients reported 1.7 comorbidities. Mean self-reported impairment of general health was 1.5 on a 5-point scale (Table 2).

According to subgroup analyses, younger patients were more likely to change therapy (p = 0.01) (Table 2). Participants who missed appointments and those who changed therapy had a significantly higher BSA (p = 0.03 and p = 0.01, respectively) and DLQI (p = 0.01 and p = 0.01, respectively) than their counterparts. Depression (p = 0.001), anxiety disorder (p = 0.012), allergies (p = 0.036) and neoplasia (p = 0.021) were positively associated with missed appointments. Arterial hypertension was negatively associated with therapy change (p = 0.033). Those who missed appointments had a significantly higher number of comorbidities than those who did not miss appointments (p = 0.017). Furthermore, impairment of general health and self-perceived susceptibility to infections were higher in those who changed therapy (p = 0.042 and p = 0.041, respectively) and those who missed consultations (p = 0.022 and p = 0.002, respectively).

Treatment characteristics

All participants obtained antipsoriatic treatment at the time of study participation, most frequently biologicals (71.2%),
followed by topical therapy (59.5%), non-biological systemic therapy (20%) and phototherapy (6.8%). The mean treatment duration was 40.2 months, and mean treatment satisfaction was 4.2 on a 5-point scale. Shorter treatment duration was found in those who changed therapy compared to those who did not change therapy ($p = 0.023$) (table 3).

**Impairment by the COVID-19 pandemic**

Assessed on a 5-point scale from 0 (none) to 4 (very high), the mean level of worry about health because of the pandemic was 1.9 and mean level of concern about continuing the current psoriasis therapy was 0.5 (table 4). Mean fear of more severe COVID-19 due to the current psoriasis therapy was 1.1 and the probability of reducing psoriasis-related physician appointments was 1.0. Participants were most afraid of SARS-CoV-2 infections acquired from other patients (31.2%), followed by infections during travel to appointments (10.7%) and infections transmitted from medical staff (8.3%). Aggravation of psoriasis was reported by 14.2% and an improvement by 3.4% during the pandemic. The vast majority of aggravations (93.1%) were attributed to increased stress. SARS-CoV-2 infections were not detected in any of the participants, but in four household members and 19 close acquaintances.

### Table 2. Sociodemographic and disease- and health-related characteristics of all participants and subgroups with changes in appointments and/or therapy.

| Characteristic | All | Missed appointment | Therapy change |
|---------------|-----|---------------------|----------------|
|               | $n = 205$ | Yes, $n = 40$ | No, $n = 165$ | $p^a$ | Yes, $n = 20$ | No, $n = 185$ | $p^a$ |
| Sex, n (%)    |     |                    |                |      |            |               |      |
| Female        | 96 (46.8) | 18 (45.0) | 78 (47.3) | 0.800 | 12 (60.0) | 84 (45.4) | 0.210 |
| Male          | 109 (53.2) | 22 (55.0) | 87 (52.7) |        | 8 (40.0) | 101 (54.6) |      |
| Age (yrs), mean (SD; min-max) | 55.5 (15.2; 19-91) | 55.6 (14.1;26-85) | 55.5 (15.5;19-91) | 0.970 | 47.2 (14.3;26-70) | 56.4 (15.0;19-91) | 0.010 |
| Partnership, n (%) |     |                    |                |      |            |               |      |
| Singlea       | 72 (35.1) | 14 (35.0) | 58 (35.2) | 0.990 | 7 (35.0) | 65 (35.1) | 0.990 |
| Partnerc      | 133 (64.9) | 26 (65.0) | 107 (64.9) |        | 13 (65.0) | 120 (64.9) |      |
| BSA, mean (SD; min-max) | 6.5 (13.4; 0-80) | 8.0 (13.6; 0-70) | 6.2 (13.4; 0-80) | 0.030 | 9.6 (11.3; 0-50) | 6.2 (13.6; 0-80) | 0.010 |
| DLQI, mean (SD; min-max) | 4.6 (5.6; 0-25) | 6.8 (6.8;0-25) | 4.0 (5.2;0-24) | 0.010 | 10.8 (8.0;0-25) | 3.9 (4.9;0-24) | 0.010 |
| Disease duration (yrs), mean (SD; min-max) | 23.2 (15.4; 1-70) | 26.0 (14.9; 2-55) | 22.3 (15.5; 1-70) | 0.140 | 19.1 (13.4; 3-55) | 23.5 (15.6; 1-70) | 0.260 |
| Comorbidities, n (%) |     |                    |                |      |            |               |      |
| Psoriatic arthritis | 92 (44.9) | 21 (52.5) | 71 (43.0) | 0.280 | 10 (50.0) | 82 (44.3) | 0.628 |
| Arterial hypertension | 87 (42.4) | 17 (42.5) | 70 (42.4) | 0.993 | 4 (20.0) | 83 (44.9) | 0.033 |
| Cardiovascular disease | 26 (12.7) | 7 (17.5) | 19 (11.5) | 0.308 | 1 (5.0) | 25 (13.5) | 0.277 |
| Diabetes mellitus | 31 (12.1) | 6 (15.0) | 25 (15.2) | 0.981 | 1 (5.0) | 30 (16.2) | 0.184 |
| Hyperlipidaemia | 46 (22.4) | 10 (25.0) | 36 (21.8) | 0.675 | 4 (20.0) | 42 (22.7) | 0.783 |
| Depression | 31 (15.1) | 13 (32.5) | 18 (10.9) | 0.001 | 5 (25.0) | 26 (14.1) | 0.194 |
| Anxiety disorder | 13 (6.3) | 6 (15.0) | 7 (4.2) | 0.012 | 3 (15.0) | 10 (5.4) | 0.094 |
| Allergies | 55 (26.8) | 16 (40.0) | 39 (23.6) | 0.036 | 8 (40.0) | 47 (25.4) | 0.162 |
| Chronic bronchitis / asthma | 25 (12.2) | 4 (10.0) | 21 (12.7) | 0.636 | 2 (10.0) | 23 (12.4) | 0.752 |
| Liver disease | 5 (2.4) | 1 (2.5) | 4 (2.4) | 0.978 | 1 (5.0) | 4 (2.2) | 0.434 |
| Renal failure | 4 (2.0) | 2 (5.0) | 2 (1.2) | 0.120 | 1 (5.0) | 3 (1.6) | 0.299 |
| Hypo- or hyperthyroidism | 28 (13.7) | 7 (17.5) | 21 (12.7) | 0.430 | 3 (15.0) | 25 (13.5) | 0.854 |
| Neoplasm | 5 (2.4) | 3 (7.5) | 2 (1.2) | 0.021 | 0 (0.0) | 5 (2.7) | 0.457 |
| Other comorbiditiesd | 30 (14.6) | 9 (22.5) | 21 (12.7) | 0.117 | 4 (20.0) | 26 (14.1) | 0.475 |
| No comorbidity | 45 (22.0) | 6 (13.0) | 39 (23.6) | 0.236 | 5 (25.0) | 40 (21.6) | 0.729 |

| Number of comorbidities, mean (SD; min-max) | 1.7 (1.5; 0-7) | 2.3 (1.8;0-7) | 1.6 (1.5;0-6) | 0.017 | 1.7 (1.5;0-4) | 1.8 (1.6;0-7) | 0.870 |
| Subjective impairment of general health statee, mean (SD; min-max) | 1.5 (1.1; 0-4) | 1.8 (1.1;0-4) | 1.4 (1.1;0-4) | 0.022 | 2.0 (1.3;0-4) | 1.4 (1.1;0-4) | 0.042 |

| Self-perceived susceptibility to infections, n (%) |     |                    |                |      |            |               |      |
| No | 175 (85.4) | 28 (70.0) | 147 (89.1) | 0.002 | 14 (70.0) | 161 (87.0) | 0.041 |
| Yes | 30 (14.6) | 12 (30.0) | 18 (10.9) |        | 6 (30.0) | 24 (13.0) |      |

$^a$ Differences were tested for significance with Chi-square test for binary and categorical variables and Mann-Whitney-U tests for linear variables except age, where t-test was used. $^b$ No partner, divorced or widowed. $^c$ In partnership or married. $^d$ Several participants reported more than one “other comorbidity”. $^e$ Assessed on a 5-point scale (from 0 = none to 4 = very much). BSA: Body Surface Area; DLQI: Dermatology Life Quality Index; max: maximum; min: minimum; n: number; SD: standard deviation; yrs: years.
about continuing their current psoriasis therapy ($p = 0.002$; $p < 0.001$), more afraid of a severe course of COVID-19 due to the current psoriasis therapy ($p = 0.001$ and $n = 0.002$) and more likely to reduce future psoriasis-related appointments because of the pandemic ($p < 0.001$ and $p < 0.001$) than their counterparts (table 4). Changes in psoriasis severity were more frequent in those who missed a consultation ($p = 0.001$) and altered treatment ($p < 0.001$). SARS-CoV-2 infections among close acquaintances and personal protection with face masks were more common among participants who changed their treatment (table 4). Decreased social contact was higher in those who missed a consultation ($p = 0.049$) and altered treatment ($p = 0.010$).

**Determinants identified in multivariate logistic regression models**

Logistic regression analysis confirmed the positive association between DLQI (OR 1.07, $p = 0.044$) and missed appointments. A higher number of comorbidities (OR 1.33, $p = 0.024$) was associated with a greater likelihood of missed appointments (table 5). While those with older age were less likely to change therapy (OR 0.95, $p = 0.026$), higher DLQI (OR 1.18, $p < 0.001$) and greater worry about one’s own health (OR 1.70, $p = 0.027$) were associated with therapy change.

**Discussion**

In contrast to other countries more severely affected by the COVID-19 pandemic, Germany was not threatened by a collapse in the healthcare system during its first wave. This enabled us to continue psoriasis care under extensive preventive measures at our department [19]. In accordance with guidelines and recommendations of German and international societies [11-16], systemic psoriasis therapy was continued for the vast majority of patients after risk-benefit consideration. Moreover, we continued psoriasis clinics under comprehensive precautions, including hygiene and disinfection measures, safety distancing, reduction of the number of patients in waiting areas and obligatory face masks for patients and staff. Our patients were counselled in face-to-face visits scheduled according to individual needs and by telemedicine (i.e. by phone and e-mail), as recommended [11-14]. Fortunately, no SARS-CoV-2 infection has occurred in our psoriasis clinic so far.

**Treatment changes during the pandemic**

Non-adherence to treatment was already common among psoriasis patients before the pandemic [20, 21]. During the pandemic, this can be expected to further decrease due to fear of continuing immunosuppressive drugs and acquiring nosocomial SARS-CoV-2 infections during physicians’ appointments. The rate of treatment alterations in our cohort was <10%, and 40% of the changes were recommended by physicians. However, only half of our participants consulted their physician before changing therapy. In comparison, studies from countries more severely affected by the pandemic reported higher rates of treatment discontinuation. In a French cohort comprising 1,418 patients with psoriasis, 22.4% of the patients on non-biological systemic therapy and 13.8% on biologicals discontinued treatment [22]. According to a retrospective Spanish study, 26.7% of 146 patients stopped treatment with biologicals or small molecules, most frequently upon the recommendation of dermatologists [23]. Even though Greece was not a COVID-19 hot spot, 23.6% of 237 Greek patients with psoriasis changed their systemic medication due to fear of SARS-CoV-2 infection [24]. Conversely, several studies found similar or even lower discontinuation rates than ours. According to a Czech study, none of the patients on biologicals (n = 117) and only 4.3% (2/47) on conventional immunosuppressants discontinued therapy during the pandemic [25]. A Danish survey on patients with atopic dermatitis (n = 68) and psoriasis (n = 233) found a discontinuation rate of 7.3% [26]. In two retrospective investigations on patient-driven

**Table 3. Treatment-related characteristics of all participants and subgroups with changes in appointments and/or therapy.**

| Characteristic                      | All               | Missed appointment | Therapy change |
|------------------------------------|-------------------|-------------------|---------------|
|                                    | $n = 205$         | Yes, $n = 40$  | No, $n = 165$ | $p^c$        | Yes, $n = 20$ | No, $n = 185$ | $p^c$ |
| **Current treatment*, n (%)**      |                   |                   |               |             |
| Topical therapy                    | 122 (59.5)        | 26 (65.0)        | 96 (58.2)     | 0.431        | 15 (75.0)     | 107 (57.8)    | 0.137 |
| Phototherapy                       | 14 (6.8)          | 3 (7.5)          | 11 (6.7)      | 0.851        | 1 (5.0)       | 13 (7.0)      | 0.733 |
| Non-biological systemic therapy    | 41 (20.0)         | 5 (12.5)         | 36 (21.8)     | 0.186        | 1 (5.0)       | 40 (21.6)     | 0.078 |
| Biologicals                        | 146 (71.2)        | 32 (80.0)        | 114 (69.1)    | 0.172        | 18 (90.0)     | 128 (69.2)    | 0.051 |
| TNF-α antagonist                   | 46 (22.4)         | 11 (27.5)        | 35 (21.2)     | 0.898        | 6 (30.0)      | 40 (21.6)     | 0.818 |
| IL-17 inhibitor                    | 50 (24.4)         | 10 (25.0)        | 40 (24.2)     |             | 5 (25.0)      | 45 (24.3)     |             |
| IL-(12)/23 inhibitor               | 50 (24.4)         | 11 (27.5)        | 39 (23.6)     |             | 7 (35.0)      | 43 (23.2)     |             |
| **Treatment duration (months), mean (SD; min-max)** | 40.2 (45.2; 0-222) | 31.2 (33.3; 2-132) | 42.1 (42.3; 0-222) | 0.340 | 20.1 (30.0; 2-120) | 42.2 (46.0; 0-222) | 0.023 |
| **Treatment satisfaction**, mean (SD; min-max)** | 4.2 (1.0; 1-5) | 4.1 (1.0; 2-5) | 4.2 (1.0; 1-5) | 0.290 | 3.7 (1.2; 1-5) | 4.2 (0.9; 1-5) | 0.070 |

*Multiple answers were permitted. For a list of changed therapies see table 1. a Assessed on a 5-point scale from 1 = very dissatisfied to 5 = very satisfied. b Differences were tested for significance with Chi-square test for categorical variables and Mann-Whitney-U tests for linear variables. IL: interleukin; max: maximum; min: minimum; n: number; SD: standard deviation; TNF-α: tumour necrosis factor-α.
### Table 4. Impairment due to the COVID-19 pandemic: changes in appointments and/or therapy.

| Characteristic                                                                 | All          | Missed appointment | Therapy change |
|--------------------------------------------------------------------------------|--------------|--------------------|----------------|
|                                                                               | n = 205      | Yes, n = 40       | No, n = 165    | p<sup>a</sup> | Yes, n = 20 | No, n = 185 | p<sup>a</sup> |
| Level of worry about the one’s own health because of the pandemic<sup>b</sup>, mean (SD; min-max) | 1.9 (1.3; 0–4) | 2.4 (1.3; 0–4) | 1.8 (1.3; 0–4) | 0.010 | 2.8 (1.1; 1–4) | 1.8 (1.3; 0–4) | 0.002 |
| Concerns about continuing the psoriasis therapy during the pandemic<sup>b</sup>, mean (SD; min-max) | 0.5 (1.0; 0–4) | 1.0 (1.4;0–4) | 0.4 (0.8;0–4) | 0.002 | 1.4 (1.5;0–4) | 0.4 (0.9;0–4) | <0.001 |
| Fear of a more severe course of COVID-19 because of the psoriasis therapy<sup>b</sup>, mean (SD; min-max) | 1.1 (1.2; 0–4) | 1.9 (1.5;0–4) | 0.9 (1.1;0–4) | 0.001 | 2.2 (1.6;0–4) | 1.0 (1.1;0–4) | 0.002 |
| Probability of reducing the frequency of future psoriasis-related appointments with physicians because of the pandemic<sup>c</sup>, mean (SD; min-max) | 1.0 (1.3; 0–4) | 2.3 (1.4;0–4) | 0.7 (1.0;0–4) | <0.001 | 2.1 (1.5;0–4) | 0.9 (1.2;0–4) | <0.001 |
| Feared source of infection with SARS-CoV-2<sup>d</sup>, n (%)                 |              |                   |                |
| Medical staff                                                                  | 17 (8.3)     | 9 (22.5)          | 8 (4.9)        | <0.001 | 4 (20.0)     | 13 (7.0)     | 0.046 |
| Other patients                                                                  | 64 (31.2)    | 27 (67.5)         | 37 (22.4)      | <0.001 | 13 (65.0)    | 51 (27.6)    | 0.001 |
| On the way to the appointment                                                   | 22 (10.7)    | 9 (22.5)          | 13 (7.9)       | 0.007  | 4 (20.0)     | 18 (9.7)     | 0.159 |
| Change in psoriasis severity during the pandemic, n (%)                          |              |                   |                |
| No change                                                                      | 169 (82.4)   | 25 (62.5)         | 144 (87.3)     | 0.001  | 10 (50.0)    | 159 (86.0)   | <0.001 |
| Improvement                                                                    | 7 (3.4)      | 3 (7.5)           | 4 (2.4)        |        | 0 (0.0)      | 7 (3.8)      |        |
| Aggravation                                                                    | 29 (14.2)    | 12 (30.0)         | 17 (10.3)      |        | 10 (50.0)    | 19 (10.3)    |        |
| Confirmed SARS-CoV-2 infection, n (%)                                          |              |                   |                |
| Participants                                                                   | 0 (0)        | 0 (0.0)           | 0 (0.0)        | 0.384  | 0 (0.0)      | 0 (0.0)      | 0.005 |
| Household members                                                               | 4 (2.0)      | 1 (2.5)           | 3 (1.8)        |        | 0 (0.0)      | 4 (2.2)      |        |
| Close acquaintances                                                            | 19 (9.3)     | 6 (15.0)          | 13 (7.9)       | 6 (30.0) | 13 (7.0)    |        |
| Decrease in social contact<sup>b</sup>, mean (SD; min-max)                      | 2.9 (1.3; 0–4) | 3.2 (1.3; 0–4) | 2.8 (1.3; 0–4) | 0.049  | 3.5 (1.1; 0–4) | 2.8 (1.3; 0–4) | 0.010 |
| Face mask use, n (%)                                                           |              |                   |                |
| No mask                                                                        | 55 (26.8)    | 6 (15.0)          | 49 (29.7)      | 0.136  | 3 (15.0)     | 52 (28.1)    | 0.039 |
| Yes, simple mask                                                                | 130 (63.4)   | 29 (72.5)         | 101 (61.2)     | 4 (20.0) | 118 (63.8) | 118 (63.8) |
| Yes, FFP2/FFP3 mask                                                             | 20 (9.8)     | 5 (12.5)          | 15 (9.1)       |        | 15 (8.1)     |        |

<sup>a</sup> Differences were tested for significance with Chi-square test for categorical variables and Mann-Whitney-U tests for linear variables. <sup>b</sup> Assessed on a 5-point scale from 0 = none to 4 = very much. <sup>c</sup> Assessed on a 5-point scale from 0 = in no case to 4 = definitely. <sup>d</sup> Feared source of infection regarding less psoriasis-related appointments with physicians in the future. Multiple answers were permitted. Max: maximum; min: minimum; n: number; SD: standard deviation.

### Table 5. Logistic regression models including potential determinants for missed appointment and therapy change.

| Characteristic                                                                 | Missed appointment<sup>a</sup> | Therapy change<sup>a</sup> |
|--------------------------------------------------------------------------------|-------------------------------|--------------------------|
|                                                                               | OR<sup>a</sup> 95% CI p       | OR<sup>a</sup> 95% CI p  |
| Male<sup>b</sup>                                                               | 1.15 (0.55–2.38) 0.711 0.38  | 0.12–1.17 0.092          |
| Age                                                                           | 0.99 (0.96–1.02) 0.539 0.95  | 0.91–0.99 0.026          |
| DLQI                                                                          | 1.07 (1.00–1.14) 0.044 1.18  | 1.08–1.28 <0.001         |
| BSA                                                                           | 1.00 (0.97–1.03) 0.889 0.98  | 0.94–1.02 0.422          |
| Number of comorbidities                                                       | 1.33 (1.04–1.71) 0.024 0.98  | 0.65–1.47 0.910          |
| Systemic therapy<sup>c</sup>                                                  | 0.89 (0.30–2.69) 0.842 0.29  | 0.03–2.66 0.273          |
| Worry about one’s own health                                                  | 1.25 (0.93–1.68) 0.140 1.70  | 1.06–2.73 0.027          |

<sup>a</sup> Dependent variable: missed appointment or therapy change, respectively. All independent variables were integrated simultaneously into the model. Reference categories: <sup>b</sup> female, <sup>c</sup> no systemic therapy. Other variables were incorporated as linear values. Significant findings are highlighted in bold. BSA: Body Surface Area; CI: confidence interval; DLQI: Dermatology Life Quality Index; OR: Odds Ratio.
discontinuation from Canada, only 0.5% of the patients on biologicals (7/1390) [27] and 0% (0/188) on apremilast [28] interrupted therapy. A phone survey in an Italian region severely affected by the pandemic revealed a surprisingly low discontinuation rate of only 5.2% (27/515) among biological users [29]. Discrepancies between discontinuation rates may be explained by national or regional differences in the number of SARS-CoV-2 infections, dynamics of the pandemic, resources of health care systems, support provided by medical caregivers, lockdown regulations, legal requirements, reporting in the media and socio-cultural habits, as well as by differences in the study design.

Missed appointments
Almost 20% of our responders missed at least one psoriasis-related appointment, most frequently on their own request due to fear of SARS-CoV-2 infection. To continue psoriasis care that conforms to guidelines, considering these concerns, dermatologists should implement modalities such as teleconsultations and digital prescriptions when feasible [16].

Impact factors associated with treatment changes and missed appointments
Patient characteristics
Numerous patient- and health-related determinants on change in treatment and/or appointments were identified in our cohort. Younger participants were more likely to change therapy, although older age is a known risk factor for severe COVID-19 courses. However, older patients were shown to be more compliant with treatment than younger ones in previous studies, which might explain this observation [20, 30]. Furthermore, greater impairment of general health, susceptibility to infections, a higher number of comorbidities and particular diseases (depression, anxiety disorder, allergies and neoplasia) were associated with a higher probability of changing therapy and/or missing appointments. We assume that all of these factors were associated with greater fear of a SARS-CoV-2 infection. Neoplasias [31] as well as several psoriasis-associated comorbidities, such as cardiovascular diseases, diabetes and metabolic syndrome [32], are known to contribute to an increased risk of severe COVID-19 courses. Depression and anxiety disorders likely potentiate the fear of SARS-CoV2 infection. Interestingly, some studies suggest that self-reported allergies are linked to an anxious personality [33], which could explain the observation that allergies were associated with a higher probability of missed appointments.

Disease and treatment characteristics
Participants who changed therapy or missed appointments had a higher BSA and DLQI than others and experienced aggravation of psoriasis more often in our study. According to an Italian telephone survey conducted in May 2020, 27.9% of 226 patients described worsening of the disease, with a correlation to drug withdrawal and impairment of psychological status [34]. Clearly, flares of psoriasis may be a consequence of interrupted treatments and/or reduced appointments. In addition, psychological distress due to the pandemic may contribute to worsening of the psoriasis and impairment of life quality. Patients suffering from stress were reported to experience psoriasis as a greater burden and to overestimate its severity [35]. Furthermore, shorter treatment duration correlated with a higher likelihood of changing therapy, possibly because patients with a shorter treatment experience are less confident with their therapy.

Patient needs during the pandemic
Our results highlight the necessity to address individual needs, concerns and fears of psoriasis patients during the pandemic in order to identify obstacles to compliance and to find individual solutions. Physicians need to counsel patients even more intensively than usual in these times regarding benefits and risks of systemic treatments. While there was uncertainty about the influence of systemic antipsoriatic drugs on COVID-19 at the beginning of the pandemic, recent studies have not shown an increased risk of hospitalization or death due to COVID-19 in psoriasis patients with systemic therapies [32, 36]. Inhibition of TNF-α and IL-17 has even been suggested to be protective against the cytokine storm in critically ill COVID-19 patients [37–39].

Limitations
Limitations of our study are the monocentric setting, the contact method and the patient-reported nature of the survey. Our cohort merely included patients from a German tertiary care centre who were contacted by ordinary mail. Only 36.1% of questionnaires were returned, possibly resulting in selection bias. However, the sex distribution of those who were contacted and those who participated in our study was similar (41.7% vs. 46.8% females), although, in general, females are more prone to participate in surveys. It is conceivable that comorbidities were under- or overestimated because they were self-reported by the participants. Depression was not validated by a professional psychological scale or score. Treatment satisfaction, general health, fear of SARS-CoV-2 infection and other COVID-19-related items were assessed with 5-point scales and not with more specific scores in order to limit the length of the questionnaire. Discontinuation rates and missed appointments may have been affected by the treating physician and institution. Furthermore, we did not investigate how information from media, patient organizations or internet platforms influenced changes in treatment and appointments. Evidently, discontinuation or cancellation rates may vary dependent on the time point of data collection and the dynamics of the pandemic. Our survey was conducted immediately after the first wave of COVID-19 in Germany, during which less than 200,000 persons were tested positive for SARS-CoV-2. Fortunately, none of our participants suffered from COVID-19 during the first wave. Thus, we were not able to take psoriasis patients infected with COVID-19 into account in our study.
Conclusions

In this study, we identified several patient-related key drivers of changes in psoriasis care during the COVID-19 pandemic, in particular, health-related characteristics and a high level of concern and anxiety due to the pandemic. Changes in appointments and treatment were associated with higher psoriasis severity scores and more frequent disease aggravation. Clearly, our results should be verified in a larger and more diverse sample and in a multicentre setting before general conclusions can be drawn. However, we recommend contacting patients who miss appointments, to enquire about their well-being, disease activity, compliance with treatment, reasons for missed appointments and/or treatment changes, as well as special needs, wishes and concerns during the pandemic. Tailoring psoriasis care to individual requirements is even more crucial during the pandemic to protect physical and mental well-being of patients.

Disclosures. Financial support: none. Conflicts of interest: N. Ninoua, F. Roehrich and K. Diehl declare no conflict of interest. W. K. Peitsch served as investigator for AbbVie, Array Biopharma, Boehringer Ingelheim, Eli Lilly, Janssen-Cilag, MSD, Novartis, Pfizer and UCB Pharma, was a member of advisory boards for BMS, Eli Lilly, LEO Pharma, MSD, Novartis, Pfizer, Roche and UCB Pharma, obtained honoraria from ALK-Abello, AbbVie, Biotest, BMS, Janssen-Cilag, MSD, Novartis, Pfizer, Dr. Pfleger and Roche, and received support for conferences from AbbVie, Actelion, ALK-Abello, Alma Lasers, Almirall Hermal, ARC Lasers, Asclepius, Beiersdorf, BMS, Celgene, Dermapharm, Dermasence, Eli Lilly, Galderma, GSK, Immuncore, Janssen-Cilag, L’Oreal, La Roche Posay, LEO Pharma, Medac, MSD, Mylan, Novartis, Pierre Fabre, P&M Cosmetics, Pfizer, Roche, Sanofi and Sun Pharma. M.-L. Schaarschmidt has been an advisor and/or received speakers’ honoraria and/or received grants and/or participated in clinical trials for the following companies: Abbvie, Allmirall, Biogen Inc., Boehringer-Ingelheim, Celgene, Eli Lilly, Janssen-Cilag GmbH, Merck Serono GmbH, MSD SHARP & DOHME GmbH, Novartis Pharma GmbH and UCB. The study was performed without support from the pharmaceutical industry, and the conflicts of interest have no impact on the content of the manuscript.

Supplementary data

Supplementary data associated with this article can be found, in the online version, at 10.1684/ ejd.2021.4016. File S1: Questionnaire.
Table S1: Treatment changes due to the pandemic.

References

1. WHO Coronavirus Disease [COVID-19] Dashboard. Geneva: World Health Organization, 2020. Available at: https://covid19. who.int/.[accessed 15 Feb 2021].

2. Amin M, Lee EB, Tsai TF, Wu JJ. Psoriasis and co-morbidity. Acta Derm Venereol 2020; 100: adv00033.

3. Schaarschmidt ML, Herr R, Gutknecht M, et al. Patients’ and physicians’ preferences for systemic psoriasis treatments: a nationwide comparative discrete choice experiment (PsOCompare). Acta Derm Venereol 2018; 98: 200-5.

4. Reid C, Griffiths CEM. Psoriasis and treatment: past, present and future aspects. Acta Derm Venereol 2020; 100: adv00032.

5. Bardazzi F, Loi C, Sacchelli L, Di Altobrando A. Biologic therapy for psoriasis during the covid-19 outbreak is not a choice. J Dermatolog Treat 2020; 31: 320-1.

6. Bashyam AM, Feldman SR. Should patients stop their biologic treatment for psoriasis during the COVID-19 pandemic. J Dermatolog Treat 2020; 31: 317-8.

7. Cohen JM, Perez-Chada LM, De Kouckovsky D, Gehlhausen JR. Psoriasis and COVID-19: a multifactorial consideration. J Dermatolog Treat 2020; DOI: 10.1080/09568164.2020.1782818. Online ahead of print.

8. Conforti C, Guiffrida R, Dianzani C, Di Meo N, Zalaudek I. COVID-19 and psoriasis: is it time to limit treatment with immunosuppressants? A call for action. Dermatol Ther 2020; e13298. doi: 10.1111/dth.13298. Online ahead of print.

9. Lebwohl M, Rivera-Oyola R, Murrell DF. Should biologics for psoriasis be interrupted in the era of COVID-19? J Am Acad Dermatol 2020; 82: 1217-8.

10. Price KN, Frew JW, Hsiao JL, Shi VY. COVID-19 and immunomodulator/immunosuppressant use in dermatology. J Am Acad Dermatol 2020; 82: e173-5.

11. American Academy of Dermatology Association. Guidance on the use of medications during COVID-19 outbreak. Available at: https://www.aad.org/member/practice/coronavirus/clinical-guidance/biologics.[accessed 15 Feb 2021].

12. EADV Psoriasis Task Force/Skin Inflammation & Psoriasis Foundation COVID-19 Task Force Guidance for Management of Psoriasis Atopic Dermatitis During the Pandemic: Version 1. Available at: https://ilds.org/wp-content/uploads/2020/06/ILDS-Guidance-on-the-use-of-systemic-therapy-during-the-COVID-19-pandemic-Update-May-2020.pdf.[accessed 15 Feb 2021].

13. International League of Dermatological Societies. Guidance on the Use of Systemic Therapy for Patients with Psoriasis/Atopic Dermatitis During the Covid-19 [Sars-CoV-2, Coronavirus] Pandemic. [Updated May 2020]. Available at: https://ilds.org/wp-content/uploads/2020/06/ILDS-Guidance-on-the-use-of-systemic-therapy-during-the-COVID-19-pandemic-Update-May-2020.pdf.[accessed 15 Feb 2021].

14. Task force of the advisory boards of PsoBest, PsoNet and Deutscher Psoriasisbund e.V. Recommendations for systemic therapy in persons with psoriasis during the pandemic phase of SARS-CoV-2 [corona virus]. Available at: https://www.psonet.de/wp-content/uploads/Rutschreien/PsoBestPsoNetCoronafinalengl.1.1.pdf.[accessed 15 Feb 2021].

15. Gelfand JM, Armstrong AW, Bell S, et al. National Psoriasis Foundation COVID-19 Task Force Guidance for Management of Psoriatic Disease During the Pandemic: Version 1. J Am Acad Dermatol 2020; 83: 1704-16.

16. Gelfand JM, Armstrong AW, Bell S, et al. National Psoriasis Foundation COVID-19 Task Force Guidance for Management of Psoriatic Disease During the Pandemic: Version 2 - Advances in Psoriatic Disease Management, COVID-19 Vaccines, and COVID-19 Treatments. J Am Acad Dermatol 2021. doi: 10.1016/j.jaad.2020.12.058. Online ahead of print.

17. Gisondi P, Piasecki S, Conti A, Naldi L. Dermatologists and SARS-CoV-2: the impact of the pandemic on daily practice. J Eur Acad Dermatol Venereol 2020; 34: 1196-201.

18. Mrowietz U, Kragballe K, Reich K, et al. Definition of treatment goals for moderate to severe psoriasis: a European consensus. Arch Dermatol Res 2011; 303: 1-10.
19. Wollina U. Challenges of COVID-19 pandemic for dermatology. Dermatol Ther 2020; e13430. doi: 10.1111/dth.13430 [Online ahead of print].
20. Richards HL, Fortune DG, O’Sullivan TM, Main CJ, Griffiths CE. Patients with psoriasis and their compliance with medication. J Am Acad Dermatol 1999; 41: 581-3.
21. Thorneloe RJ, Bundy C, Griffiths CE, Ashcroft DM, Cordingley L. Adherence to medication in patients with psoriasis: a systematic literature review. Br J Dermatol 2013; 168: 20-31.
22. Fougerousse AC, Perrussel M, Bécherel PA, et al. Systemic or biologic treatment in psoriasis patients does not increase the risk of a severe form of COVID-19. J Eur Acad Dermatol Venereol 2020. doi: 10.1111/jdv.16761 (Online ahead of print).
23. Rodríguez-Villa Lario A, Vega-Díez D, González-Cañete M, et al. Patient’s perspective: psychological burden of the COVID-19 pandemic in 146 psoriatic patients treated with biological drugs and small molecules in real clinical practice. J Dermatolog Treat 2020. doi: 10.1080/09546634.2020.1790485 (Online ahead of print).
24. Vakirlis E, Bakirtzi K, Papadimitriou I, et al. Treatment adherence in psoriatic patients during COVID-19 pandemic: Real-world data from a tertiary hospital in Greece. J Eur Acad Dermatol Venereol 2020. doi: 10.1111/jdv.16759 [Online ahead of print].
25. Rob F, Hugo J, Tivadar S, et al. Compliance, safety concerns and anxiety in patients treated with biologics for psoriasis during the COVID-19 pandemic national lockdown: a multicenter study in the Czech Republic. J Eur Acad Dermatol Venereol 2020. doi: 10.1111/jdv.16771, Online ahead of print.
26. Dyrberg Loft N, Halling AS, Iversen L, et al. Concerns related to the COVID-19 pandemic in adult patients with atopic dermatitis and psoriasis treated with systemic immunomodulatory therapy: a Danish questionnaire survey. J Eur Acad Dermatol Venereol 2020. doi: 10.1111/jdv.16863, Online ahead of print.
27. Georgakopoulos JR, Yeung J. Rate of patient-driven biologic treatment discontinuation during the COVID-19 pandemic in 2 academic hospital clinics at the University of Toronto. J Cutan Med Surg 2020; 24: 424-5.
28. Georgakopoulos JR, Vender R, Yeung J. Patient-driven discontinuation of apremilast during the COVID-19 pandemic in two Canadian academic hospital clinics and one community practice. J Cutan Med Surg 2020; 24: 418-9.
29. Burlando M, Carmisciano L, Cozzani E, Parodi A. A survey of psoriasis patients on biologics during COVID-19: a single centre experience. J Dermatolog Treat 2020. doi: 10.1080/09546634.2020.1770165 (Online ahead of print).
30. Rolnick SJ, Pawloski PA, Hedblom BD, Asche SE, Bruzek RJ. Patient characteristics associated with medication adherence. Clinical Med Res 2013; 11: 54-65.
31. Wang H, Zhang L. Risk of COVID-19 for patients with cancer. Lancet Oncol 2020; 21: e181.
32. Gisondi P, Zaza G, Del Giglio M, Rossi M, Iacono V, Girolomoni G. Risk of hospitalization and death from COVID-19 infection in patients with chronic plaque psoriasis receiving a biologic treatment and renal transplant recipients in maintenance immunosuppressive treatment. J Am Acad Dermatol 2020; 83: 285-7.
33. Patern SB, Williams JV. Self-reported allergies and their relationship to several Axis I disorders in a community sample. Int J Psychiatry Med 2007; 37: 11-22.
34. Pirro F, Caldorola G, Chiricozzi A, et al. The impact of COVID-19 pandemic in a cohort of Italian psoriatic patients treated with biological therapies. J Dermatolog Treat 2020. doi: 10.1080/09546634.2020.1800578 (Online ahead of print).
35. Rouset L, Haloua B. Stress and psoriasis. Int J Dermatol 2018; 57: 1165-72.
36. Carugno A, Gambini DM, Raponi F, et al. COVID-19 and biologics for psoriasis: a high-epidemic area experience-Bergamo, Lombardy, Italy. J Am Acad Dermatol 2020; 83: 2924.
37. Feldmann M, Maini RN, Woody JN, et al. Trials of anti-tumour necrosis factor therapy for COVID-19 are urgently needed. Lancet 2020; 395: 1407-9.
38. Schett G, Sticherling M, Neurath MF. COVID-19: risk for cytokine targeting in chronic inflammatory diseases? Nat Rev Immunol 2020; 20: 271-2.
39. Zumla A, Hui DS, Azhar EI, Memish ZA, Mauerer M. Reducing mortality from 2019-nCoV: host-directed therapies should be an option. Lancet 2020; 395: 635-6.