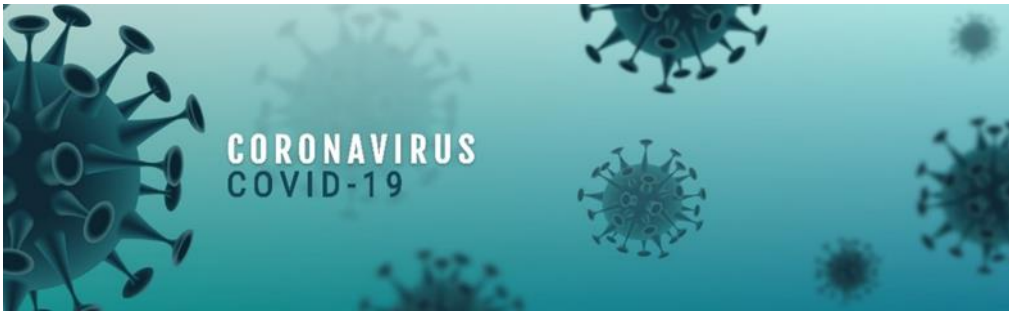
HTA Austria
Austrian Institute for
Health Technology Assessment
GmbH

Covid-19



HSS/ Horizon Scanning

Living Document **V10 January** 2021

AIHTA Policy Brief Nr.: 002
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Living Document **V10 January** 2021

Vienna, January 2021

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Die **AIHTA Policy Briefs** erscheinen unregelmäßig und dienen der Veröffentlichung der Forschungsergebnisse des Austrian Institute for Health Technology Assessment.

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Content

Figures

Tables

History of Changes	V010 January 2021
January 2021	Addition chapter on Ivermectin (chapter 3.27) and Aspirin (chapter 3.28)
January 2021	Update Methodology (1.2)
January 2021	Update Vaccine (chapter 2)
January 2021	Remdesivir (chapter 3.1) – no changes
January 2021	Update Favipiravir (chapter 3.3)
January 2021	Darunavir (chapter 3.4) – no changes
January 2021	Update Camostat Mesilate (chapter 3.7)
January 2021	APN01/rhACE2 (chapter 3.8) – no changes
January 2021	Update Tocilizumab (chapter 3.9)
January 2021	Update Sarilumab (chapter 3.10)
January 2021	Update Interferon beta (chapter 3.11)
January 2021	Update Concalescent plasma (chapter 3.12)
January 2021	Update Plasma derived medicinal products (chapter 3.13) – REGN-COV2; LY-CoV555 and LY-CoV016; AZD7422
January 2021	Combination therapy (chapter 3.14) – no changes
January 2021	Solnatide (chapter 3.15) – no changes
January 2021	Update Umifenovir (chapter 3.16)
January 2021	Update Dexamethasone and other corticosteroids (chapter 3.17)
January 2021	Update Anakinra (chapter 3.18)
January 2021	Update Colchicine (chapter 3.19)
January 2021	Nafamostat (chapter 3.20) – no changes
January 2021	Gimsilumab (chapter 3.21) – no changes
January 2021	Canakinumab (chapter 3.22) – no changes
January 2021	Lenzilumab (chapter 3.23) – no changes
January 2021	Update Vitamin D (chapter 3.24)
January 2021	Update Baricitinib (chapter 3.25)
January 2021	Molnupiravir (chapter 3.26) – no changes

1 Background: policy question and methods

1.1 Policy Question

On March 30th 2020, a request was raised by the Austrian Ministry of Health (BMASGK), the Health Funds of the Regions and the Federation of Social Insurances to set up a Horizon Scanning ystem (HSS) for medicines and vaccines. The establishment of a HSS/ Horizon Scanning System for Covid-19 interventions has the intentions of

März 2020:
Österr. Politik empfiehlt Aufbau von HSS zu Covid-19

Information zu
*** Status F&E**
*** Evidenz-basierter Einkauf**

a. informing health policy makers at an early stage which interventions (vaccinations and drugs) are currently undergoing clinical trials and
b. monitoring them over the next few months in order to support evidence-based purchasing, if necessary.

1.2 Methodology

To respond to this request,

mehrstufige Methodik

1. As a first step an inventory, based on international sources, is built.
2. As a second step, selective searches by means of searches in study registries are carried out for information on clinical studies in humans and the state of research.
3. This information forms the basis for "vignettes" (short descriptions) for those products that are already in an "advanced" stage.
4. Subsequently, the products are monitored with regard to the status of the clinical studies up to approval and finally evaluated for their benefit and harm.

Bestandsaufnahme
selektive Suche
Vignetten
Monitoring

All work steps are conducted in close international (European) cooperation.

internationale/ europ. Zusammenarbeit

- Version 1 (V1, April 2020): inventory + vignettes for most advanced
- Version 2+: monthly monitoring and updates

Ongoing trials are reported in V1, April 2020 - V3, June 2020 of this Document and in the living documents - EUnetHTA (Covid-19 Rolling Collaborative Reviews: https://eunethta.eu/rcr01-rcrxx/).

From V4 July, 2020 of this HSS/ Horizon Scanning Document, only completed, terminated, withdrawn and suspended interventional clinical trials from ClinicalTrials.gov and EUdraCT registers are reported. From Version 8 November, 2020 only terminated, withdrawn and suspended interventional clinical trials are reported.

From V5, August 2020 of this HSS/ Horizon Scanning Document only the best available evidence will be presented in.

V1-V3: auch laufende Studien - Verweis auf EUnetHTA
V4: nur abgeschlossene (oder beendete) Interventionsstudien aus 2 Studienregistern
ab V5: nur mehr best verfügbare Evidenz

Table 1.2-1: International Sources

Primary sources	Link
WHO Drugs: Vaccines:	https://www.who.int/teams/blueprint/covid-19 https://www.who.int/blueprint/priority-diseases/key-action/Table_of_therapeutics_Appendix_17022020.pdf?ua=1 https://www.who.int/who-documents-detail/covid-19-candidate-treatments https://www.who.int/who-documents-detail/draft-landscape-of-covid-19-candidate-vaccines
Danish Medicine Agency Drugs: Vaccines:	https://laegemiddelstyrelsen.dk/da/nyheder/temaer/ny-coronavirus-covid-19/~/media/5B83D25935DF43A38FF823E24604AC36.ashx https://laegemiddelstyrelsen.dk/da/nyheder/temaer/ny-coronavirus-covid-19/~/media/3A4B7F16D0924DD8BD157BBE17BFED49.ashx
Pang et al. 2020 [1] Drugs: Vaccines:	https://www.mdpi.com/2077-0383/9/3/623 Table 5+6, Table 3+4
SPS HS-report (UK)	unpublished
Secondary sources	
VfA/ Verband Forschender Arzneimittelhersteller Drugs: Vaccines:	https://www.vfa.de/de/arzneimittel-forschung/woran-wir-forschen/therapeutische-medikamente-gegen-die-coronavirusinfektion-covid-19 https://www.vfa.de/de/arzneimittel-forschung/woran-wir-forschen/impfstoffe-zum-schutz-vor-coronavirus-2019-ncov
EMA/ Europen Medicines Agency Medicines:	https://www.ema.europa.eu/ https://www.ema.europa.eu/en/medicines/medicines-under-evaluation
FDA/US Food and Drug Administration	https://www.fda.gov/emergency-preparedness-and-response/counterterrorism-and-emerging-threats/coronavirus-disease-2019-covid-19
Trial Registries	
US National Library of Medicine European Union Drug Regulating Authorities Clinical Trials Database WHO International Clinical Trials Registry Platform TrialsTracker	https://clinicaltrials.gov/ https://eudract.ema.europa.eu/ https://www.who.int/ictrp/en/ http://Covid-19.trialstracker.net/
Up-to-date information on clinical trials and literature searching resources relating to COVID-19	
Cochrane COVID-19 Study Register 21/04.20	https://covid-19.cochrane.org/
Living mapping of research and a living systematic review	https://covid-nma.com/ https://covid-nma.com/dataviz/
Dynamic meta-analysis of evidences about drug efficacy and safety for COVID19 - meta/Evidence – COVID-19	http://metaevidence.org/COVID19.aspx
CORDITE (CORona Drug InTEractions database)	https://cordite.mathematik.uni-marburg.de/#/
Living listing of interventional clinical trials in Covid-19/2019-nCoV produced by the Anticancer Fund	http://www.redo-project.org/covid19db/; http://www.redo-project.org/covid19_db-summaries/
Global Coronavirus COVID-19 Clinical Trial Tracker	https://www.covid-trials.org/
LitCovid	https://www.ncbi.nlm.nih.gov/research/coronavirus/
UK NIHR Innovation Observatory NIHR COVID-19 Studies COVID-19 Therapeutics Dashboard COVID-19: a living systematic map of the evidence	https://www.nihr.ac.uk/covid-studies/ http://www.io.nihr.ac.uk/report/covid-19-therapeutics/ http://eppi.ioe.ac.uk/cms/Default.aspx?tabid=3765
WHO COVID-19 Database new search interface	https://www.who.int/emergencies/diseases/novel-coronavirus-2019/global-research-on-novel-coronavirus-2019-ncov
COVID-evidence Database	https://covid-evidence.org/database
Medical Library Association – COVID-19 Literature search strategies	https://www.mlanet.org/page/covid-19-literature-searching

Centre of Evidence Based Dermatology (CEBD) - Coronavirus Dermatology Online Resource	https://www.nottingham.ac.uk/research/groups/cebd/resources/Coronavirus-resource/Coronavirushom
Ovid Expert Searches for COVID-19	http://tools.ovid.com/coronavirus/
EBSCO Covid-19 Portal Literature searching section of portal Information portal	 https://covid-19.ebscomedical.com/research https://covid-19.ebscomedical.com/
NIH COVID-19 Treatment Guidelines. 2020.	https://covid19treatmentguidelines.nih.gov/introduction/
Tertiary sources	
NIPHNO	https://www.fhi.no/en/qk/systematic-reviews-hta/map/
INAHTA	http://www.inahta.org/covid-19-inahta-response/
EUnetHTA Covid-19 Rolling Collaborative Reviews (RCR)	https://eunethta.eu/rcr01-rcrxx/

"lebende" Dokumente mit up-to-date Informationen

Several organisations and international teams of researchers are providing up-to-date information through living listing of interventional clinical trials in Covid-19/2019-nCoV and literature resources (Table 1.2-1) [2-4] [2]. A short description of two of such databases is presented below.

Kartierung von laufenden RCTs

Boutron et al., 2020 [3] are performing a living mapping of ongoing randomized trials, followed by living systematic reviews with pairwise meta-analyses and when possible, network meta-analyses focusing on two main questions: the effectiveness of preventive interventions for COVID-19 and the effectiveness of treatment interventions for COVID-19 (Figure 1.2-1).

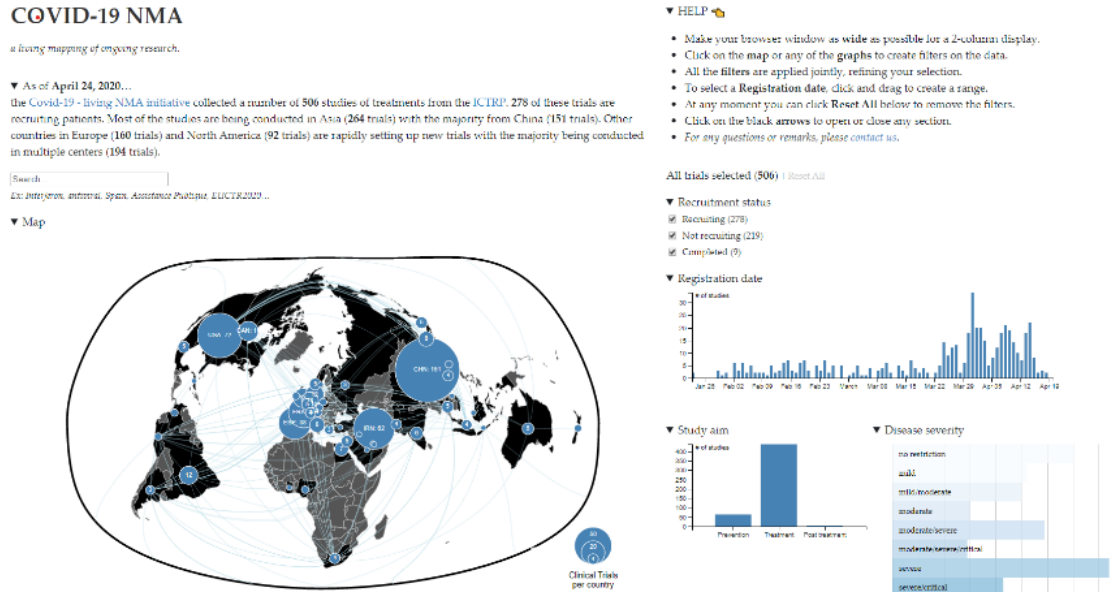

Figure 1.2-1: A living mapping of ongoing randomized trials, living systematic reviews with pairwise meta-analyses and network meta-analyses

Clinical Trial Tracker real-time dashboard

Thorlund et al., 2020 [4] developed a COVID-19 clinical trials registry to collate all trials related to COVID-19: Global Coronavirus COVID-19 Clinical Trial Tracker. Data is pulled from the International Clinical Trials Registry Platform, including those from the Chinese Clinical Trial Registry, ClinicalTrials.gov, Clinical Research Information Service - Republic of Korea, EU Clinical Trials Register, ISRCTN, Iranian Registry of Clinical Trials, Japan Primary Registries Network, and German Clinical Trials Register (Figure 1.2-2). They also use content aggregator services, such as LitCovid, to ensure that their data acquisition strategy is complete [5].

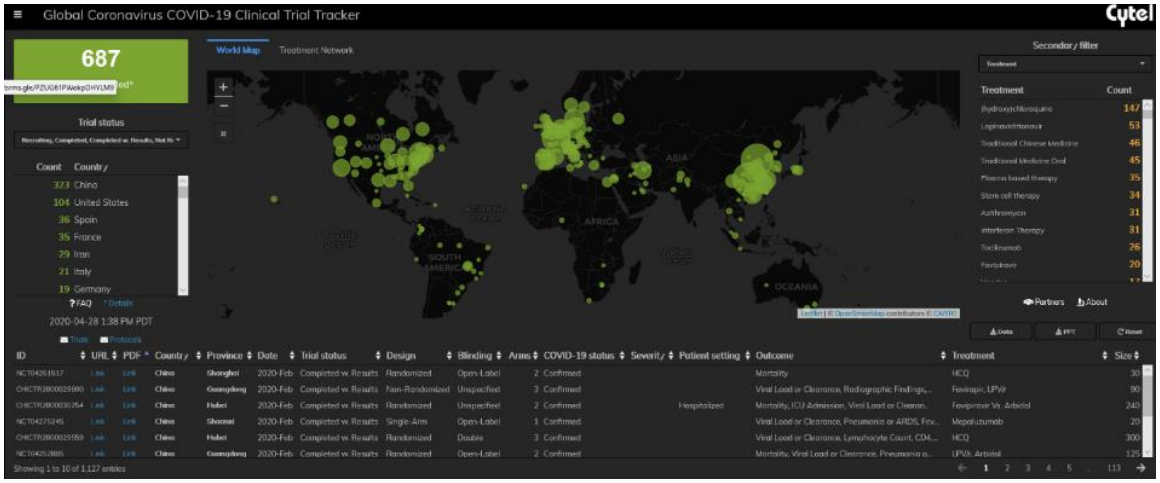

Figure 1.2-2: Global Coronavirus COVID-19 Clinical Trial Tracker - a real-time dashboard of clinical trials for COVID-19

1.3 Selection of Products for "Vignettes"

The following products have been selected for further investigation (searches in registry databases and description as "vignettes") for the following reasons:

Vignetten zu Produkte, in "fortgeschrittenen" Stadien oder

- most advanced in clinical research in humans
- most often discussed in clinical journals as potential candidates

häufig diskutiert/ publiziert

The full inventory (list) can be found in Part 2 - Appendix A-1: vaccines, A-2, therapeutics, A3-EudraCT registry studies.

From January 2021 (v10) only vaccines for which the European Commission (EC) concluded contracts with their manufactures to build a diversified portfolio of COVID-19 vaccines for EU citizens, will be presented in detail.

v10: nur Impfstoffe, für die EC Verträge abgeschlossen hat/ abschließt

2 Results: Vaccines

Conditional Approval von EMA für 2 Impfstoffe: Comirnaty® (BioNTech) Moderna

As of 12 January 2021, the **European Commission** (EC) has given the **conditional** marketing authorisation for the vaccines developed by BioNTech and Pfizer – **Comirnaty® (vaccine efficacy 94.6%)** on 21 December 2020, and **Moderna – COVID-19 Vaccine Moderna (vaccine efficacy 94.1%)** on 6 January 2021, following EMA positive assessment of its safety and efficacy.

Rolling Reviews bei EMA: J&J, AstraZeneca

On January 12 2021 EMA received an application for conditional marketing authorisation (CMA) for a COVID-19 vaccine developed by AstraZeneca and Oxford University. No other vaccine producer has formally applied for a marketing authorisation to EMA. In order to accelerate the process, **EMA** has started **rolling reviews** on the vaccines produced by **Johnson & Johnson/ Janssen Pharmaceuticals** and **AstraZeneca** [29, 30]. On October 01, 2020 EMA announced that **EMA**'s human medicines committee (CHMP) has started the first '**rolling review**' of University of **Oxford/AstraZeneca** vaccine [16]. On December 01, 2020 **EMA** announced that EMA's human medicines committee (CHMP) has started a '**rolling review**' of **Janssen-Cilag** International N.V COVID-19 Ad26.COV2.S vaccine [28].

EC Verträge mit 6 Firmen

1 weitere in Verhandlung

As of 8 January 2021, the EC concluded **contracts with different vaccine manufactures** to build a diversified portfolio of COVID-19 vaccines for EU citizens: with **AstraZeneca** (400 million doses), **Sanofi-GSK** (300 million doses), **Johnson and Johnson** (400 million doses), **BioNTech-Pfizer** (600 million doses), **CureVac** (405 million doses) and **Moderna** (160 million doses). The EC has concluded exploratory talks with the pharmaceutical company **Novavax** with a view to purchasing up to 200 million doses, https://ec.europa.eu/commission/presscorner/detail/en/QANDA_20_2467

6 Impfstoffe in Phase 3 und 1 in Phase 1/2

As of **January 6, 2021, out of** these seven **COVID-19 candidate vaccines contracted for EU, six are investigated in phase 3 RCTs, and one in phase 1/2 study:**

1. **Moderna Therapeutics/NIAID** (RNA LNP-encapsulated mRNA vaccine encoding S protein);
2. **University of Oxford/AstraZeneca** (Non-Replicating Viral Vector ChAdOx1 (AZD1222) vaccine);
3. **BioNTech/Fosun Pharma/Pfizer** (RNA 3 LNP-mRNAs vaccine);
4. **Janssen Pharmaceuticals/Johnson & Johnson** (Non-Replicating Viral Vector Ad26COVS1 vaccine);
5. **Novavax** (Protein Subunit, VLP-recombinant protein nanoparticle vaccine + Matrix M);
6. **CureVac** (RNA based vaccine, CVnCov2) vaccine, all in phase 3 RCTs and
7. **Sanofi-GSK** (Protein Subunit, with adjuvant 1 vaccine), in phase 1/2.

For these 7 coronavirus vaccines, the following articles were published with results related to early phases vaccine trials (phase 1, 1/2 or phase 2) or phase 2/3 and phase 3 trials:

12 Publikationen zu Impfstudien

1. Three on **Moderna Therapeutics/NIAID** vaccine: a preliminary report with the results from the phase 1 study (NCT04283461) [6],

2. The results from the expanded phase 1 study (NCT04283461) in older adults [7] and
3. The results from phase 3 RCT (NCT04470427) [8];
4. One on **Novavax** vaccine: the results from the phase 1/2 RCT (NCT04368988) [11];
5. Four on **Oxford/Astra Zeneca** vaccine: a preliminary report with the results from phase 1/2 single-blind, RCT (ISRCTN 15281137/NCT04324606/EudraCT 2020-001072-15) [12],
6. A report from the same RCT, on subgroups of volunteeres who were subsequesntly allocated to recive a homologous full-dose or half-dose ChAdOx1 booster vaccine 56 d following prime vaccination [13],
7. Pooled interim analysis phase 2/3 trials (ISRCTN89951424, NCT04324606, NCT04400838, and NCT04444674) [14], and
8. Phase 2 component of phase 2/3 trial COV002 (ISRCTN90906759, NCT04400838) [15];
9. Four on **BioNTech/Fosun Fharma/Pfizer** vaccine**:** Three with results from two phase 1/2 trials on **BNT162b1** vaccine, one in US (NCT04368728/EudraCT 2020-001038-36) [17], and
10. One in Germany (NCT04380701, EudraCT 2020-001038-36) [18] as well as
11. Additional safety and immunogenicity results from the US phase 1 trial (NCT04368728/EudraCT 2020-001038-36) [52, 53] and
12. One pivotal RCT efficacy trial on BNT162b2 (NCT04368728) [19].

Regulatory Guidances and position paper:

Positionspapier der Internationalen Regulatoren zu Impfstudien

stringente klinische Studien vonnöten !

On 09/07/2020, Medicines Regulatory Authorities published the report related to phase 3 COVID-19 vaccine trials [24]. They stressed the need for large phase 3 clinical trials that enroll many thousands of people, including those with underlying medical conditions, to generate relevant data for the key target populations. Broad agreement was achieved that clinical studies should be designed with stringent success criteria that would allow a convincing demonstration of the efficacy of COVID-19 vaccines.

On November 11, 2020 EMA publishes safety monitoring plan and guidance on risk management planning for COVID-19 vaccines, https://www.ema.europa.eu/en/news/ema-publishes-safety-monitoring-plan-guidance-risk-management-planning-covid-19-vaccines.

Table 2-1: Vaccines contracted for EU in the R&D pipeline (Phase 1 - Phase 3 clinical trials, not preclinical stages), January 6, 2021

Source: Adapted from DRAFT landscape of COVID-19 candidate vaccines – 6 January 2021
https://www.who.int/publications/m/item/draft-landscape-of-covid-19-candidate-vaccines

Vaccine platform description	Vaccine platform description	Number of doses	Developers	Phase	Phase 1	Phase 1/2	Phase 2	Phase 2/3	Phase 3
Viral vector (Non-replicating)	ChAdOx1-S - (AZD1222) (Covishield)	1-2 IM	**AstraZeneca + University of Oxford**	Phase 3	PACTR202005681895696	PACTR202006922165132	NCT04686773	NCT04400838	ISRCTN89951424
						2020-001072-15		EUCTR2020-001228-32-GB	NCT04516746
						Interim Report			NCT04540393
						NCT04568031			NCT04536051
						Study Report			EUCTR2020-005226-28-DE
						NCT04444674			
						NCT04324606		CTRI/2020/08/027170	
						Study Report			
						Study Report			
						NCT04684446			
Viral vector (Non-replicating)	Ad26.COV2.S	1-2 IM	**Janssen Pharmaceutical**	Phase 3	NCT04509947	NCT04436276	EUCTR2020-002584-63-DE		NCT04505722
							NCT04535453		NCT04614948
									EUCTR2020-003643-29-DE
									EUCTR2020-003643-29-BE

Protein subunit	SARS-CoV-2 rS/Matrix M1-Adjuvant (Full length recombinant SARS CoV-2 glycoprotein nanoparticle vaccine adjuvanted with Matrix M)	2 IM	**Novavax**	Phase 3		NCT04368988	NCT04533399		NCT04611802
						Study Report	PACTR202009726132275		EUCTR2020-004123-16-GB
									NCT04583995
RNA based vaccine	mRNA -1273	2 IM	**Moderna + National Institute of Allergy and Infectious Diseases (NIAID)**	Phase 3	NCT04283461		NCT04405076	NCT04649151	NCT04470427
					Interim Report				Study Report
					Study Report				
RNA based vaccine	BNT162 (3 LNP-mRNAs)	2 IM	**BioNTech + Fosun Pharma ; Jiangsu Provincial Center for Disease Prevention and Control + Pfizer**	Phase 2/3	NCT04523571	2020-001038-36	NCT04649021	NCT04368728	
					ChiCTR2000034825	NCT04588480		Study Report	
						NCT04380701		Study Report	
						Study Report			
						NCT04537949			
						EUCTR2020-003267-26-DE			
						Study Report			
RNA based vaccine	CVnCoV Vaccine	2 IM	**CureVac AG**	Phase 3	NCT04449276		NCT04515147	NCT04652102	NCT04674189
							PER-054-20	EUCTR2020-003998-22-DE	

Protein subunit	SARS-CoV-2 vaccine formulation 1 with adjuvant 1 (S protein (baculovirus production)	2 IM	**Sanofi Pasteur + GSK**	Phase 1/2		NCT04537208			

2.1 Moderna Therapeutics—US National Institute of Allergy

About the vaccine

mRNA-1273
collab mit NIAID/CEPI

The **mRNA-1273** vaccine candidate developed by ModernaTX, Inc. in collaboration with NIAID and sponsored by NIAID/CEPI is an LNP-encapsulated mRNA-based vaccine (mRNA-1273) intended for prevention through full-length, perfusion stabilized spike (S) protein of SARS-CoV-2 that is the key into the human cell [31].

Conditional marketing authorisation in EU

vorläufige Zulassung am 6. Jänner 2021

The **European Commission** has given the **conditional marketing authorisation** for the Moderna vaccine (**COVID-19 Vaccine Moderna**) on **6 January 2021**, following EMA positive assessment of its safety and efficacy. Vaccine demonstrated a **94.1% efficacy** in the trial, with 90.9% efficacy in participants at risk of severe COVID-19, including those with chronic lung disease, heart disease, obesity, liver disease, diabetes or HIV infection.

≥ 18 Jahre,
2 Dosen in Interval von 28 Tagen

It is **indicated** for active immunisation to prevent COVID-19 caused by SARS-CoV-2 in individuals 18 years of age and older, as a course of 2 doses (0.5 mL each). It is recommended to administer the second dose 28 days after the first dose. There are no data available on the interchangeability of COVID-19 Vaccine Moderna with other COVID-19 vaccines to complete the vaccination course. Individuals who have received the first dose of COVID-19 Vaccine Moderna should receive the second dose of COVID-19 Vaccine Moderna to complete the vaccination course. Individuals may not be fully protected until 14 days after their second dose. Contraindications are hypersensitivity to the active substance or to any of the excipients listed in SmPC document [32].

Nebenwirkungen

The **most frequently reported adverse reactions** were pain at the injection site (92%), fatigue (70%), headache (64.7%), myalgia (61.5%), arthralgia (46.4%), chills (45.4%), nausea/vomiting (23%), axillary swelling/tenderness (19.8%), fever (15.5%), injection site swelling (14.7%) and redness (10%). Adverse reactions were usually mild or moderate in intensity and resolved within a few days after vaccination. A slightly lower frequency of reactogenicity events was associated with greater age. Overall, there was a higher incidence of some adverse reactions in younger age groups: the incidence of axillary swelling/tenderness, fatigue, headache, myalgia, arthralgia, chills, nausea/vomiting and fever was higher in adults aged 18 to <65 years than in those aged 65 years and above. Local and systemic adverse reactions were more frequently reported after Dose 2 than after Dose 1. Anaphylaxis has been reported. Appropriate medical treatment and supervision should always be readily available in case of an anaphylactic reaction following administration of the vaccine. Close observation for at least 15 minutes is recommended following vaccination. The second dose of the vaccine should not be given to those who have experienced anaphylaxis to the first dose of COVID-19 Vaccine Moderna.

Dauer des Schutzes noch unbekannt

The **duration of protection** afforded by the vaccine is unknown as it is still being determined by ongoing clinical trials. Vaccine should be stored in a freezer frozen between -25°C to -15°C (shelf life unopened vial: 7 months). The unopened vaccine may be stored refrigerated at 2°C to 8°C, protected from light, for maximum 30 days. Once thawed the vaccine should not be re-

frozen. The unopened vaccine may be stored at 8°C to 25°C up to 12 hours after removal from refrigerated conditions [32].
Efficacy and safety results from phase 3 RCT published by Baden et al. 2020 [8] are presented in Results of publications sub-section below.

Phase 1:
45 gesunde Erwachsene
Juni 2021

Phase 1 trial with 45 healthy participants (NCT04283461) is ongoing. Participants are split to 3 groups where they receive two injections of low (25 mcg), medium (100 mcg) or high doses (250 mcg) of mRNA-1273 and are monitored for any AEs and immune response [33]. The Phase I safety study should be completed by June 2021.

Phase 2a:
bis August 2021

A **phase 2a**, randomized, observer-blind, placebo controlled, dose-confirmation study to evaluate the safety, reactogenicity, and immunogenicity of mRNA-1273 vaccine in adults aged 18 years and older (NCT04405076) is underway. This Phase 2 study should be completed by August 2021.

Phase 3 Studienprotokoll
RCT mt ca 30.000
Teilnehmer*innen

The randomized, **phase 3,** 1:1 placebo-controlled trial is currently ongoing (NCT04470427). It is expected to include approximately 30,000 participants enrolled in the U.S.

Results of publications

Dec. 2020:
COVE, 30.000
Teilnehmer*innen
94,1% Wirksamkeit
basierend auf primärer
Datenanalyse
196 Infektionen
185 in KG: 11 in IG

On December 30, 2020, Baden et al. 2020 [8] published results from primary efficacy analysis of the **phase 3 COVE study** (NCT04470427) enrolled 30,420 participants ages 18 and older in the U.S. Primary analysis was based on 196 cases, of which 185 cases of COVID-19 were observed in the placebo group versus 11 cases observed in the mRNA-1273 group, a point estimate of **vaccine efficacy of 94.1%**. Efficacy was similar across key secondary analyses, including assessment 14 days after the first dose, analyses that included participants who had evidence of SARS-CoV-2 infection at baseline, and analyses in participants 65 years of age or older. A secondary endpoint analyzed severe cases of COVID-19 and included 30 severe cases in this analysis. All 30 cases occurred in the placebo group and none in the mRNA-1273 vaccinated group; one COVID-19-related death occurred in the placebo group. Related to safety, moderate, transient reactogenicity after vaccination occurred more frequently in the mRNA-1273 group. Serious adverse events were rare, and the incidence was similar in the two groups.

2.2 University of Oxford/ Astra Zeneca

About the vaccine

ChAdOx1 nCoV-19

The **ChAdOx1 nCoV-19** (AZD1222, AstraZeneca licensed from Oxford University) vaccine candidate developed by the Jenner Institute at Oxford University is based on a non-replicating viral vector. A chimpanzee adenovirus platform is hereby used [38, 39]. The vaccine candidate uses a genetically modified safe adenovirus that may cause a cold-like illness. The intended prevention is through the modified adenovirus producing Spike proteins, eventually leading to the formation of antibodies to the coronavirus's Spike proteins [38].

Estimated timeline for approval

The **EMA** is currently assessing data on the vaccine as part of a **rolling review**.

Currently, the first clinical **phase 1/2** single-blinded, placebo-controlled, multi-centre randomised controlled trial to test efficacy, safety and immunogenicity of ChAdOx1 nCoV-19 in 510 healthy adults is ongoing (ISRCTN 15281137/NCT04324606/EudraCT 2020-001072-15). The primary endpoints are number of virologically confirmed symptomatic cases/symptomatic cases of COVID-19 (efficacy) and occurrence of serious adverse events (safety), measured within six months and an optional follow-up visit is offered at day 364. The study is estimated to be completed in May 2021 [40].

Phase 1/2:
510 gesunde Erwachsene

bis Mai 2021

Phase 2b/3 study (EUdraCT 2020-001228-32/NCT04400838) is ongoing; the primary endpoint is virologically confirmed (PCR positive) symptomatic COVID-19 infection.

Phase 2b/3 :
laufend

Phase 3 RCT (ISRCTN89951424) is ongoing in Brazil and South Africa, with another country in Africa set to follow, as well as a trial in the US (NCT04516746) [41]. Participants are randomly allocated to receive the investigational vaccine or a well-established meningitis vaccine. Volunteers will be followed for 12 months, and they will be tested for COVID-19 if they develop any symptoms which may represent COVID-19 disease[42]. The study is estimated to be completed in July 2021.

Phase 3 RCT
Brazilien, Südafrika, USA
12-Monate Follow-Up

Ende Juli 2021

Results of publications

A preliminary report with the results from **phase 1/2** RCT (ISRCTN 15281137/NCT04324606/EudraCT 2020-001072-15) was published [12]. 1077 participants were enrolled and assigned to receive either ChAdOx1 nCoV-19 (n=543) or MenACWY (n=534), ten of whom were enrolled in the non-randomised ChAdOx1 nCoV-19 prime-boost group. Local and systemic reactions were more common in the ChAdOx1 nCoV-19 group (all $p<0{\cdot}05$). There were no serious adverse events related to ChAdOx1 nCoV-19. In the ChAdOx1 nCoV-19 group, spike-specific T-cell responses peaked on day 14 (median 856 spot-forming cells per million peripheral blood mononuclear cells, IQR 493–1802; n=43). Anti-spike IgG responses rose by day 28 (median 157 ELISA units [EU], 96–317; n=127), and were boosted following a second dose (639 EU, 360–792; n=10). Neutralising antibody responses against SARS-CoV-2 were detected in 32 (91%) of 35 participants after a single dose when measured in MNA80 and in 35 (100%) participants when measured in PRNT50. After a booster dose, all participants had neutralising activity (nine of nine in MNA 80 at day 42 and ten of ten in Marburg VN on day 56). Neutralising antibody responses correlated strongly with antibody levels measured by ELISA ($R^2=0{\cdot}67$ by Marburg VN; $p<0{\cdot}001$). Barret et al. 2020 [13] published interim results related to safety and exploratory humoral and cellular immunogenicity of the vaccine, from subgroups of volunteers in above mentioned **phase 1/2** RCT (ISRCTN 15281137/NCT04324606/EudraCT 2020-001072-15), who were subsequently allocated to receive a homologous full-dose (SD/SD D56; n=20) or half-dose (SD/LD D56; n=32) ChAdOx1 booster vaccine 56 d following prime vaccination. Authors demonstrate that a booster dose of ChAdOx1 nCoV-19 is safe and better tolerated than priming doses. Using a systems serology approach they also demonstrate that anti-spike neutralizing antibody titers, as well as Fc-mediated functional antibody responses, including antibody-dependent neutrophil/ monocyte phagocytosis, complement activation and natural killer cell activation, are substantially enhanced by a booster dose of vaccine. A booster dose of vaccine induced stronger antibody responses than a dose-sparing half-dose boost, although the magnitude of T cell responses

vorläufige Publikation
Phase 1/2:
1.077 Teilnehmer*innen

Antikörper-Response bei 91% bis 100% der Teilnehmer*innen

Booster von Vorteil für Antikörperbildung

did not increase with either boost dose. These data support the two-dose vaccine regime that is now being evaluated in phase 3 clinical trials.

Voysey et al. 2020 [12] published results from a pooled interim analysis of four ongoing blinded, randomised, controlled, **phase 2/3 trials** done across the UK, Brazil, and South Africa (ISRCTN89951424, NCT04324606, NCT04400838, and NCT04444674). Participants aged 18 years and older were randomly assigned (1:1) to ChAdOx1 nCoV-19 vaccine or control (meningococcal group A, C, W, and Y conjugate vaccine or saline). Participants in the ChAdOx1 nCoV-19 group received two doses; a subset in the UK trial received a half dose as their first dose (low dose) and a standard dose as their second dose (LD/SD cohort). The primary efficacy analysis included symptomatic COVID-19 in seronegative participants with a nucleic acid amplification test-positive swab more than 14 days after a second dose of vaccine. 23,848 participants were enrolled and 11,636 participants (7548 in the UK, 4088 in Brazil) were included in the interim primary efficacy analysis. In participants who received two standard doses, vaccine efficacy was 62·1% (95% CI 41·0–75·7; 27 [0·6%] of 4440 in the ChAdOx1 nCoV-19 group vs 71 [1·6%] of 4455 in the control group) and in participants who received a low dose followed by a standard dose, efficacy was 90·0% (67·4–97·0; three [0·2%] of 1367 vs 30 [2·2%] of 1374; pinteraction=0·010). Overall vaccine efficacy across both groups was 70·4% (95·8% CI 54·8–80·6; 30 [0·5%] of 5807 vs 101 [1·7%] of 5829).

Phase 2/ 3 Interimanalyse basierend auf 11.636 Teilnehmer*innen

2 Standard-Dosen: 62,1% Wirksamkeit

1 niedrige Dosis + 1 Standard Dosis: 90% Wirksamkeit

zusammen: 70,4%

From 21 days after the first dose, there were ten cases hospitalised for COVID-19, all in the control arm; two were classified as severe COVID-19, including one death. There were 74,341 person-months of safety follow-up (median 3·4 months, IQR 1·3–4·8): 175 severe adverse events occurred in 168 participants, 84 events in the ChAdOx1 nCoV-19 group and 91 in the control group. Three cases of transverse myelitis were initially reported as suspected unexpected serious adverse reactions, with two in the ChAdOx1 nCoV-19 vaccine study arm, triggering a study pause for careful review in each case. Independent clinical review of these cases has indicated that one in the experimental group and one in the control group are unlikely to be related to study interventions, but a relationship remained possible in the third case. Careful monitoring of safety, including neurological events, continues in the trials. The vaccine can be stored and distributed at 2–8°C.

hospitalsierte Patient*innen: nur in KG

NW: gleich verteilt in KG vs. IG

3 Fälle von Transverser Myelitis (2 in IG, 1 KG) unwahrscheinlich, dass mit Impfung assoziiert Monitoring !

In summary, ChAdOx1 nCoV-19 has an acceptable safety profile and is efficacious against symptomatic COVID-19, with no hospital admissions or severe cases reported in the ChAdOx1 nCoV-19 arm. The vaccine can be stored and distributed at 2–8°C, making it particularly suitable for global distribution.

gute Verträglichkeit, Aufbewahrung 2–8°C

Ramasamy et al. 2020 [15] published results from the **phase 2** component of a single-blind, randomised, controlled, phase 2/3 trial -COV002 (ISRCTN90906759, NCT04400838), healthy adults aged 18 years and older were enrolled at two UK clinical research facilities, in an age-escalation manner, into **18–55 years**, **56–69 years**, and **70 years** and older immunogenicity subgroups. The specific objectives of this report were to assess the safety and humoral and cellular immunogenicity of a single-dose and two-dose schedule in adults older than 55 years. 560 participants were enrolled: 160 aged 18–55 years (100 assigned to ChAdOx1 nCoV-19, 60 assigned to MenACWY), 160 aged 56–69 years (120 assigned to ChAdOx1 nCoV-19: 40 assigned to MenACWY), and 240 aged 70 years and older (200 assigned to ChAdOx1 nCoV-19: 40 assigned to MenACWY). **Local and**

Phase 2 in 3 Kohorten 18-55J, 56-69J, >70J RCT 560 Teilnehmer*innen

Studie zur Sicherheit

lokale und systemische Reaktionen

häufiger in IG als in KG

systemic reactions were more common in participants given ChAdOx1 nCoV-19 than in those given the control vaccine, and similar in nature to those previously reported (injection-site pain, feeling feverish, muscle ache, headache), but were less common in older adults (aged ≥56 years) than younger adults. In those receiving two standard doses of ChAdOx1 nCoV-19, after the prime vaccination local reactions were reported in 43 (88%) of 49 participants in the 18–55 years group, 22 (73%) of 30 in the 56–69 years group, and 30 (61%) of 49 in the 70 years and older group, and systemic reactions in 42 (86%) participants in the 18–55 years group, 23 (77%) in the 56–69 years group, and 32 (65%) in the 70 years and older group.

schwerwiegende Nebenwirkungen: keine, die auf Impfung zurückzuführen ist

As of Oct 26, 2020, 13 **serious adverse** events occurred during the study period, none of which were considered to be related to either study vaccine. In participants who received two doses of vaccine, median anti-spike SARS-CoV-2 IgG responses 28 days after the boost dose were similar across the three age cohorts (standard-dose groups: 18–55 years, 20 713 arbitrary units [AU]/mL [IQR 13 898–33 550], n=39; 56–69 years, 16170 AU/mL [10233–40353], n=26; and ≥70 years 17561 AU/mL [9705–37 796], n=47; p=0·68). Neutralising antibody titres after a boost dose were similar across all age groups (median MNA80 at day 42 in the standard-dose groups: 18–55 years, 193 [IQR 113–238], n=39; 56–69 years, 144 [119–347], n=20; and ≥70 years, 161 [73–323], n=47; p=0·40). By 14 days after the boost dose, 208 (>99%) of 209 boosted participants had neutralising antibody responses. T-cell responses peaked at day 14 after a single standard dose of ChAdOx1 nCoV-19 (18–55 years: median 1187 spot-forming cells [SFCs] per million peripheral blood mononuclear cells [IQR 841–2428], n=24; 56–69 years: 797 SFCs [383–1817], n=29; and ≥70 years: 977 SFCs [458–1914], n=48).

gut verträglich, gute Immunantworten in allen 3 Kohorten

In summary, in this clinical trial of a vaccine against SARS-CoV-2 tested in an older adult population (aged 18–55 years, 56–69 years, and ≥70 years), the vaccine was safe and well tolerated, with reduced reactogenicity in older adults. Antibody responses against the SARS-CoV-2 spike protein were induced in all age groups and were boosted and maintained at 28 days after booster vaccination, including in the 70 years and older group. Cellular immune responses were also induced in all age and dose groups, peaking at day 14 after vaccination.

2.3 BioNTech/Fosun Pharma/Pfizer

About the vaccine

BNT-162

The **BNT-162** vaccine candidate developed by BioNTech in collaboration with Fosun Pharma and Pfizer is an mRNA platform-based vaccine expressing codon-optimized undisclosed SARS-CoV-2 protein(s) encapsulated in 80-nm ionizable cationic lipid/ phosphatidylcholine/ cholesterol/ polyethylene glycol–lipid nanoparticles [43].

Conditional marketing authorisation in EU

vorläufige Zulassung am 21. Dezember 2020

The **European Commission** has given the **conditional marketing authorisation** for the vaccines developed by BioNTech and Pfizer (Comirnaty vaccine, a COVID-19 mRNA vaccine, BioNTech Manufacturing GmbH/Pfizer Manufacturing Belgium NV, previously BNT162b2,) on **21 December 2020**, following EMA positive assessment of its safety and efficacy. Vaccine **efficacy** in the trial was **94.6**%, with similar efficacy point

estimates across genders, ethnic groups, and participants with medical comorbidities associated with high risk of severe COVID-19.

Comirnaty®
≥ 16 Jahre,
2 Dosen in Interval von 21 Tagen

Comirnaty® is **indicated** for active immunisation to prevent COVID-19 caused by SARS-CoV-2 virus, in **individuals 16 years of age and older**. Each vial contains 6 doses of the vaccine. Comirnaty is administered intramuscularly after dilution as a course of **2 doses** (0.3 mL each) at least 21 days apart. There are no data available on the interchangeability of Comirnaty with other COVID-19 vaccines to complete the vaccination course. Individuals who have received 1 dose of Comirnaty should receive a second dose of Comirnaty to complete the vaccination course. Comirnaty should be administered intramuscularly.

Nebenwirkungen

Contraindications are hypersensitivity to the active substance or to any of the excipients (ALC-0315, ALC-0159, DSPC, cholesterol, potassium chloride, potassium dihydrogen phosphate, sodium chloride, disodium phosphate dihydrate, sucrose, water for injections). The most frequent **adverse reactions** in participants 16 years of age and older were injection site pain (> 80%), fatigue (> 60%), headache (> 50%), myalgia and chills (> 30%), arthralgia (> 20%), pyrexia and injection site swelling (> 10%) and were usually mild or moderate in intensity and resolved within a few days after vaccination. A slightly lower frequency of reactogenicity events was associated with greater age. Events of anaphylaxis have been reported. Appropriate medical treatment and supervision should always be readily available in case of an anaphylactic reaction following the administration of the vaccine. Close observation for at least 15 minutes is recommended following vaccination. A second dose of the vaccine should not be given to those who have experienced anaphylaxis to the first dose of Comirnaty.

Herausforderung: Aufbewahrung bei 90 °C to -60 °C

Vaccine should be **stored**. in a freezer at -90 °C to -60 °C. Vials removed from frozen storage (< -60 °C) may be at room temperature (< 25 °C) for up to 3 minutes to remove vials or for transfer between ultra-low-temperature environments. Once a vial is removed from the vial tray, it should be thawed for use. After vial trays are returned to frozen storage following room temperature exposure, they must remain in frozen storage for at least 2 hours before they can be removed again. Detailed special precautions for disposal and other handling should be found in product information document [44]

Phase 1 / 2 mehrstufiges Studiendesign

Phase 1/ 2 (Deutschland)

November 2022

A **phase 1/2**, randomized, placebo-controlled, triple-blind, dose-finding, and vaccine candidate-selection study in healthy adults in the US as well as in Germany [45] (**NCT04368728**/EudraCT 2020-001038-36). The study evaluates the safety, tolerability, immunogenicity, and potential efficacy of up to 4 different SARS-CoV-2 RNA vaccine candidates against (COVID-19 BNT162a1, BNT162b1, BNT162b2, and BNT162c2): as a 2-dose or single-dose schedule; at up to 3 different dose levels; in 3 age groups (18 to 55 years of age, 65 to 85 years of age, and 18 to 85 years of age. The study consists of 3 stages: Stage 1: to identify preferred vaccine candidate(s), dose level(s), number of doses, and schedule of administration (with the first 15 participants at each dose level of each vaccine candidate comprising a sentinel cohort); Stage 2: an expanded-cohort stage; and Stage 3; a final candidate/dose large-scale stage. Study NCT04380701 is located in Germany.

Phase 2/3 RCT läuft derzeit

Phase 2/3 RCT is ongoing (**NCT04368728**/EudraCT 2020-002641-42) with aim to describe the safety, tolerability, immunogenicity and efficacy of RNA vaccine candidate against COVID-19 in healthy adults (Argentina, Brazil, South Africa, Turkey, US). The candidate selected for evaluation in Phase 2/3

is BNT162b2 (mid-dose). Estimated number of participants is 43998, and completion study date December 2022 [9].

Results of publications

Polack et al. 2020 [19] published results from the **phase 2/3 part** of a global phase 1/2/3, ongoing multinational, placebo-controlled, observer-blinded, pivotal efficacy trial (**NCT04368728**) [19], with randomly assigned persons 16 years of age or older in a 1:1 ratio to receive two doses, 21 days apart, of either placebo or the BNT162b2 vaccine candidate (30 µg per dose). 43,448 received injections: 21,720 with BNT162b2 and 21,728 with placebo. There were 8 cases of Covid-19 with onset at least 7 days after the second dose among participants assigned to receive BNT162b2 and 162 cases among those assigned to placebo; BNT162b2 was **95% effective** in preventing Covid-19 (95% credible interval, 90.3 to 97.6). Similar vaccine efficacy (generally 90 to 100%) was observed across subgroups defined by age, sex, race, ethnicity, baseline body-mass index, and the presence of coexisting conditions. Among 10 cases of severe Covid-19 with onset after the first dose, 9 occurred in placebo recipients and 1 in a BNT162b2 recipient. The **safety profile** of BNT162b2 was characterized by short-term, mild-to-moderate pain at the injection site, fatigue, and headache. The incidence of serious adverse events was low and was similar in the vaccine and placebo groups.

Phase 2/ 3
43.448 Teilnehmer*innen

8 IG vs. 162 KG Infektionen

95% Wirksamkeit

nur milde bis moderate Newbenwirkungen

gut verträglich

2.4 Janssen Pharmaceutical/ Johnson & Johnson

About the vaccine

The Janssen Pharmaceutical Companies of Johnson & Johnson developed the investigational vaccine (also known as Ad.26.COV2.S), a recombinant vector vaccine that uses a human adenovirus to express the SARS-CoV-2 spike protein in cells.

Ad.26.COV2.S

Estimated timeline for approval

The EMA is currently assessing data on the vaccine as part of a rolling review.

Janssen Pharmaceutical registered **phase 3**, randomised controlled trial (NCT04505722) to demonstrate the efficacy of Ad26.COV2.S in the prevention of molecularly confirmed moderate to severe/critical COVID-19, compared to placebo, in SARS-CoV-2 adult participants. Estimated enrollment is 60,000 participants, with study completion day in March 2023.

im Rolling Review bei EMA

Phase 3 RCT mit 60.000 Teilnehmer*innen

März 2023

Results of publications

Sadoff et al. 2020 [50] reported, as preprint, interim results of a **phase 1/2**, double-blind, randomized, placebo-controlled trial related to safety and immunogenicity of the Ad26.COV2.S COVID-19 vaccine candidate (NCT04436276) in healthy adults. Ad26.COV2.S was administered at a dose level of 5x1010 or 1x1011 viral particles (vp) per vaccination, either as a single dose or as a two-dose schedule spaced by 56 days in healthy adults (18-55 years old; cohort 1a & 1b; n= 402 and healthy elderly >65 years old; cohort 3; n=394). In cohorts 1 and 3 solicited local adverse events were observed in 58% and 27% of participants, respectively. Solicited systemic adverse events were reported in 64% and 36% of participants, respectively.

Phase 1/ 2
2 Dosierungen
2 Intervalle
3 Kohorten

2.5 Novavax

About the vaccine

CEPI
Matrix-M™

The Novavax COVID-19 vaccine being developed by Novavax and co-sponsored by CEPI [51] is a recombinant protein nanoparticle technology platform that is to generate antigens derived from the coronavirus spike (S) protein [52]. Matrix-M™ is Novavax patented saponin-based adjuvant that has the potential to boost the immune system by stimulating the entry of antigen-presenting cells into the injection site and enhancing antigen presentation in local lymph nodes, boosting immune responses [53, 54].

Estimated timeline for approval

Phase 1:
131 gesunde Erwachsene

Juli 2021

The **phase 1/2**, randomized, placebo-controled, triple-blind, parallel assignment clinical trial (NCT04368988) in 131 healthy adults aims to evaluate the immunogenicity and safety of SARS-CoV-2 rS nanoparticle vaccine with or without Matrix-M adjuvant in healthy participants ≥ 18 to 59 years of age [37, 55-57]. This RCT will be conducted from May 15, 2020 to July 31, 2021. Estimated Primary Completion Date is December 31, 2020.

Phase 2b RCT
2.904 Südafrika
bis 2021

A **phase 2b** RCT trial (NCT04533399) aims to evaluate the effectiveness and safety in South Africans adults; 2904 participants are planned to enrolled, with estimated primary completion date in November 2021 [37].

Phase 3
9.000 Teilnehmer*innen
in UK

A **phase 3** RCT (EUdraCT 2020-004123-16) is ongoing, in healthy adults in the UK. Main aim is to demonstrate the efficacy of SARS-CoV-2 rS with Matrix-M1 adjuvant in the prevention of virologically confirmed (by polymerase chain reaction [PCR]) to SARS-CoV-2, symptomatic COVID-19, when given as a 2-dose vaccination regimen, as compared to placebo, in serologically negative (to SARS-CoV-2) adult participants. 9000 participants are planned to enrolled.

Results of publications

Publikation der Phase 1/2

keine schwerwiegenden
NW beobachtet

A results from above mentioned randomized, placebo-controlled, **phase 1/2 trial** to evaluate the safety and immunogenicity of the rSARS-CoV-2 vaccine (in 5-µg and 25-µg doses, with or without Matrix-M1 adjuvant, and with observers unaware of trial-group assignments) in 131 healthy adults were published [11]. In phase 1, vaccination comprised two intramuscular injections, 21 days apart. After randomization, 83 participants were assigned to receive the vaccine with adjuvant and 25 without adjuvant, and 23 participants were assigned to receive placebo. No serious adverse events were noted. Unsolicited adverse events were mild in most participants; there were no severe adverse events. The two-dose 5-µg adjuvanted regimen induced geometric mean anti-spike IgG (63,160 ELISA units) and neutralization (3906) responses that exceeded geometric mean responses in convalescent serum from mostly symptomatic Covid-19 patients (8344 and 983, respectively).

2.6 CureVac

About the vaccine

mRNA

The vaccine candidate CVnCoV, developed by CureVac, is a protamine-complexed mRNA-based vaccine expressing undisclosed SARS-CoV-2 protein(s). Each CureVac product is a tailored molecular creation that contains 5' and 3' untranslated regions and the open reading frame to make sure translation of the messenger RNA (mRNA) sequence results in appropriate levels of proteins in the body. This means that CureVac's technology uses mRNA as a data carrier in order to train the human body to produce ideal levels of proteins. Thereby the immune system is stimulated and can respond to antigens. [58, 59].

Jänner 2021: CureVac kooperiert mit Bayer

CureVac and Bayer joint forces in January 2021 on COVID-19 vaccine candidate CVnCoV to ramp up the production and distribution of vaccine. Vaccine remains stable and within defined specifications for at least three months when stored at a standard refrigerator temperature of +5°C (+41°F) and for up to 24 hours as ready-to-use vaccine when stored at room temperature, https://www.curevac.com/en/covid-19/.

Estimated timeline for approval

Phase 1: Beginn klinische Studie: Sommer 2020

Phase 1 (NCT04449276) study aims to evaluate the safety and reactogenicity profile after 1 and 2 dose administrations of CVnCoV at different dose levels. Is is funded by Coalition for Epidemic Preparedness Innovations (CEPI), and located in Belgium and Germany. More then 250 healthy participants are enrolled in the trial. Preliminary results reported as preprint in November 2020 strongly supported the decision to advance a 12μg dose in the pivotal phase 2b/3 study [60], https://www.curevac.com/en/covid-19/.

Phase 2

Phase 2, RCT (NCT04515147) initiated in September 2020 aims to evaluate the safety and reactogenicity profile after 1 and 2 dose administrations of investigational SARS-CoV-2 mRNA vaccine (CVnCoV) at different dose levels and to evaluate the humoral immune response after 1 and 2 dose administrations of CVnCoV. 691 participants are planned to be enroll in the trial, with estimated study completion date in November 2021 [37].

Phase 2/3

Pivotal **phase 2b/3** study (NCT04652102/EUdraCT 2020-00399822), initiated in December 2020, assesses a 12μg dose of CVnCoV in two parts: an initial phase 2b trial which is expected to seamlessly merge into a phase 3 efficacy trial. Both the phase 2b and phase 3 trials are randomized, observer-blind, placebo-controlled studies in adults over 18 years of age or older. While the objective of the phase 2b study is to further characterize the safety, reactogenicity and immunogenicity of CVnCoV, the phase 3 assesses CVnCoV efficacy. Subjects will be enrolled at multiple sites and vaccinations follow a two-dose schedule on day 1 and day 29 of either CVnCoV or a placebo. In total, more than 35,000 participants will be included in the phase 2b/3 HERALD study at multiple sites in Europe and Latin America, https://www.curevac.com/en/covid-19/.

Phase 3

A **phase 3** RCT (NCT04674189), which is not yet recruiting the healthy volunteers, aims to evaluate the safety and immunogeneity of CVnCoV vaccine in adult health care workers in Germany. Estimated enrollments is 2520 participants, with estimated primary completion date in June 2021. [37]

Results of publications

Preliminary results related to **phase 1** (NCT04449276) reported as **preprint** in November 2020 showed that two doses of CVnCoV ranging from 2 µg to 12 µg per dose, administered 28 days apart were safe. No vaccine-related serious adverse events were reported. There were dose-dependent increases in frequency and severity of solicited systemic adverse events, and to a lesser extent of local reactions, but the majority were mild or moderate and transient in duration. Median titers measured in assays two weeks after the second 12 µg dose were comparable to the median titers observed in convalescent sera from COVID-19 patients. Seroconversion (defined as a 4-fold increase over baseline titer) of virus neutralizing antibodies two weeks after the second vaccination occurred in all participants who received 12 µg doses [60].

Phase 1: akzeptable Sicherheitsdaten

2.7 Sanofi and GSK

About the vaccine

In April 2020, Sanofi and GSK agreed to develop an adjuvanted vaccine for COVID-19, using innovative technology from both companies. Sanofi through its S-protein COVID-19 antigen, based on recombinant DNA technology (this technology has produced an exact genetic match to proteins found on the surface of the virus, and the DNA sequence encoding this antigen has been combined into the DNA of the baculovirus expression platform, the basis of Sanofi's licensed recombinant influenza product in the US). GSK through its proven pandemic adjuvant technology which can be of particular importance in a pandemic situation since it may reduce the amount of vaccine protein required per dose, allowing more vaccine doses to be produced and therefore contributing to protect more people. Development of the recombinant-based COVID-19 vaccine candidate is being supported through funding and a collaboration with the Biomedical Advanced Research and Development Authority (BARDA), part of the office of the Assistant Secretary for Preparedness and Response at the U.S. Department of Health and Human Services, https://www.sanofi.com/en/media-room/press-releases/2020/2020-04-14-13-00-00.

Protein subunit

Estimated timeline for approval

On December 11, 2020 Sanofi and GSK announced a delay in their adjuvanted recombinant protein-based COVID-19 vaccine program to improve immune response in older adults. https://www.sanofi.com/en/media-room/press-releases/2020/2020-12-11-07-00-00.

Phase 1/2

Phase 1/2 study

The interim RCT, **phase 1/2** results (NCT04537208, not yet published in scientific journal) showed a level of neutralising antibody titers after two doses comparable to sera from patients who recovered from COVID-19, a balanced cellular response in adults aged 18 to 49 years, but insufficient neutralising antibody titers in adults over the age of 50. The candidate showed transient but higher than expected levels of reactogenicity likely due to the suboptimal antigen formulation, with no serious adverse events related to the vaccine candidate. The most favorable results were observed in the group which tested the highest antigen concentration, combined with the GSK adjuvant, showing neutralisation titers in 88% of participants. Seroconversion

Zwischenauswertung

Antikörperbildung am besten bei 18-49 J,

weniger bei ≥ 50 J oder gar bei ≥ 60 J

was observed in 89.6% of the 18 to 49 age group; 85% in the >50 age group; and 62.5% in the >60 age group.

Phase 2b and phase 3 studies

Phase 2b in Planung
Phase 3: Q2 2021

Zulassung ev. Q4 2021

The Companies plan a **phase 2b** study with an improved antigen formulation expected to start in February 2021. The study will include a proposed comparison with an authorized COVID-19 vaccine. If data are positive, a global **phase 3** study could start in Q2 2021. Positive results from this study would lead to regulatory submissions in the second half of 2021, hence **delaying the vaccine's potential availability from mid-2021 to Q4 2021,** https://www.sanofi.com/en/media-room/press-releases/2020/2020-12-11-07-00-00.

3 Results: Therapeutics

Current therapeutic management of patients with COVID-19 (outpatients and hospitalised patients): Summary

derzeitige Therapien im Management von Covid-19 Patient*innen

zugelassen:

Dexamethasone (und andere Korikosteroide)

von WHO & US COVID-19 Treatment Guidelines Panel empfohlen

Dexamethasone (and other corticosteroids)

In **EU, dexamethasone use** is endorsed by **EMA** following referral procedure: it is **indicated** in **adults and adolescents (from 12 years of age and weighing at least 40 kg) who require supplemental oxygen therapy.** In all cases, the recommended dose in adults and adolescents is **6 milligrams once a day for up to 10 days.**

In current **WHO living guidance** the WHO panel made two recommendations: a **strong recommendation** (based on moderate certainty evidence) **for systemic** (i.e. intravenous or oral) **corticosteroid therapy** (e.g. 6 mg of dexamethasone orally or intravenously daily or 50 mg of hydrocortisone intravenously every 8 hours) for 7 to 10 days in **patients with severe and critical COVID-19**, and a **conditional recommendation** (based on low certainty evidence) **not to use corticosteroid therapy in patients with non-severe COVID-19.**

The **US COVID-19 Treatment Guidelines Panel recommends using dexamethasone** (at a dose of 6 mg per day for up to 10 days) in patients with COVID-19 who are mechanically ventilated **(AI)** and in patients with COVID-19 who require supplemental oxygen but who are not mechanically ventilated **(BI).** The Panel **recommends against** using dexamethasone in patients with COVID-19 who do not require supplemental oxygen **(AI).** If dexamethasone is not available, the Panel **recommends using** alternative glucocorticoids such as **prednisone, methylprednisolone, or hydrocortisone (AIII).**

Daily regimen of dexamethasone 6 mg once daily is equivalent to 160 mg of hydrocortisone, 40 mg of prednisone, and 32 mg of methylprednisolone.

Remdesivir (Veklury)

zugelassen: Remdesivir (Veklury)

von WHO nicht empfohlen

von US COVID-19 Treatment Guidelines Panel nur empfohlen für Patient*innen, die zusätzlich Sauerstoff benötigen, nicht aber für jene, die bereits künstlich beatmet werden

Remdesivir (Veklury) is an antiviral medicine for systemic use which received a **conditional marketing authorisation** in **EU.** It is **indicated** for the treatment of coronavirus disease 2019 (**COVID-19**) in **adults and adolescents** (aged 12 years and older with body weight at least 40 kg) with **pneumonia requiring supplemental oxygen.**

The **U.S. Food and Drug Administration approved** remdesivir for use in **adult and pediatric patients 12 years of age and older** and weighing at least 40 kilograms (about 88 pounds) for the treatment of **COVID-19 requiring hospitalisation.**

Current WHO living guidance on remdesivir for COVID-19 has a **conditional recommendation against the use of remdesivir in hospitalised patients with COVID-19, regardless of disease severity.**

The US COVID-19 Treatment Guidelines Panel issued new recommendations on remdesivir treatment for patients with COVID-19: It is **recommended for use in hospitalised patients who require supplemental oxygen**. However, it is **not routinely recommended for patients who require mechanical ventilation** due to the lack of data showing benefit at this advanced stage of the disease.

Baricitinib in combination with remdesivir

The **FDA** recently issued an **emergency use authorization (EUA)** for the Janus kinase inhibitor **baricitinib** to be used **in combination with remdesivir** in patients with **COVID-19** who **require oxygen or ventilatory support.**

zugelassen nur in USA (EUA): Baricitinib als Kombinationstherapie mit Remdesivir

The **US COVID-19 Treatment Guidelines Panel** stated that there are **insufficient data** to recommend either **for or against** baricitinib in combination with remdesivir therapy in **hospitalised patients** with COVID-19 disease, in cases where corticosteroids can be used instead. In the rare circumstances where corticosteroids cannot be used, the Panel recommends using baricitinib in combination with remdesivir for the treatment of COVID-19 in hospitalised, nonintubated patients who require oxygen supplementation **(BIIa).** The Panel **recommends against** the use of baricitinib in the absence of remdesivir, except in a clinical trial **(AIII)**.

US COVID-19 Treatment Guidelines Panel: insuffiziente Datenlage für Empfehlung

Casirivimab and imdevimab (REGN-COV2)

The **U.S. Food and Drug Administration** issued an **emergency use authorization (EUA)** for casirivimab and imdevimab (REGN-COV2) to be administered together for the **treatment** of **mild to moderate COVID-19** in **adults and pediatric patients** (12 years of age or older weighing at least 40 kilograms [about 88 pounds]) with positive results of direct SARS-CoV-2 viral testing and who are **at high risk for progressing to severe COVID-19.**

zugelassen nur in USA (EUA): Casirivimab and imdevimab (REGN-COV2)

The **US COVID-19 Treatment Guidelines Panel** stated that there are **insufficient data** to recommend either **for or against** the use of **casirivimab plus imdevimab** for the treatment of **outpatients** with **mild to moderate COVID-19**. The casirivimab plus imdevimab combination **should not be considered** the **standard of care** for the treatment of patients with COVID-19. Patients who are **hospitalised** for COVID-19 **should not receive** casirivimab plus imdevimab **outside of a clinical trial.**

US COVID-19 Treatment Guidelines Panel: insuffiziente Datenlage für Empfehlung

There are currently **no comparative data to determine whether there are differences in clinical efficacy or safety between casirivimab plus imdevimab and bamlanivimab.**

Bamlanivimab

The **U.S. Food and Drug Administration issued an Emergency Use Authorization (EUA)** for the investigational monoclonal antibody therapy bamlanivimab (previously LY-CoV555) for the treatment of **mild-to-moderate COVID-19** in adult and pediatric patients. Bamlanivimab is authorized for patients with positive results of direct SARS-CoV-2 viral testing who are **12 years of age and older** weighing at least 40 kilograms (about 88 pounds), and who are **at high risk for progressing to severe COVID-19 and/or hospitalisation.**

zugelassen nur in USA (EUA): Bamlanivimab

The **US COVID-19 Treatment Guidelines Panel** stated that there are **insufficient data** to recommend either **for or against** the use of bamlanivimab for the treatment of **outpatients with mild to moderate COVID-19**. Bamlanivimab **should not be considered** the **standard of care** for the treatment of patients with COVID-19. Patients who are **hospitalised** for COVID-19 **should not receive** bamlanivimab **outside of a clinical trial.**

US COVID-19 Treatment Guidelines Panel: insuffiziente Datenlage für Empfehlung

Lopinavir + ritonavir, chloroquine and hydroxychloroquine

Lopinavir + ritonavir, chloroquine and hydroxychloroquine: Nachweis für keine Wirksamkeit

Lopinavir + ritonavir, chloroquine and hydroxychloroquine are not effective in treating **COVID-19 patients.**

Other pharmaceuticals listed in this document and convalescent plasma

Rekonvaleszentenplasma: unsichere Datenlage

Related to other pharmaceuticals listed in this document and convalescent plasma, the **current evidence** is **uncertain or very uncertain** about their effect on different clinical outcomes in **COVID-19 patients**. Further RCTs are currently ongoing.

EMA scientific advice für viele unterschiedliche Medikamente

EMA is providing guidance to assist developers of potential COVID-19 medicines, to prepare for eventual applications for marketing authorisation. This includes scientific advice, as well as informal consultation with the COVID-19 EMA pandemic Task Force (COVID-ETF). The outcome of any consultation or advice from EMA is not binding on developers. COVID-19 medicines that have received EMA advice can be found in Table 3-1 below, https://www.ema.europa.eu/en/human-regulatory/overview/public-health-threats/coronavirus-disease-covid-19/treatments-vaccines-covid-19.

Table 3-1: COVID-19 medicines that have received EMA advice

Product	Developer	Therapeutic class/drug type	Development stage at time of guidance
VIR-7831, VIR-7832	Vir Biotechnology/GSK	Antiviral (monoclonal antibody)	Clinical phase
UNI911	Union Therapeutics	Antiviral	Clinical phase
Tocilizumab	Roche	Immunomodulator	Clinical phase
SNG-001	Synargein	Immunomodulator	Clinical phase
Siltuximab	EUSApharma	Immunomodulator	Clinical phase
Sarilumab	Sanofi Aventis	Immunomodulator	Clinical phase
Remdesivir	Gilead	Antiviral	Clinical phase
RBT-9	Renibus Therapeutics Inc	Antiviral	Clinical phase
Ravulizumab	Alexion	Other therapeutics	Clinical phase
Otilimab	GSK	Immunomodulator	Clinical phase
Meplazumab	Jiangsu Pacific Meinuoke Biophar.	Antiviral (mAb)	Clinical phase
Mavrilimumab	Kiniksa Pharmaceuticals	Immunomodulator	Clinical phase
Gimsilumab	Roivant	Immunomodulator	Clinical phase
Favipiravir	Glenmark Pharmaceuticals Ltd	Antiviral	Clinical phase
Emapalumab and anakinra	Swedish Orphan Biovitrum AB	Immunomodulator	Clinical phase
Eculizumab	Alexion	Immunomodulator	Clinical phase
Danoprevir	Ascletis Pharmaceuticals Co Ltd	Antiviral	Clinical phase
Copper chloride	ACOM srl	Antiviral	Clinical phase
Chloroquine and hydroxychloroquine cyclops DPI	PureIMS	Other therapeutics	Clinical phase
Chloroquine	Oxford University	Other therapeutics	Clinical phase
CD24Fc	Oncoimmune Inc	Immunomodulator	Clinical phase
Baricitinib	Eli Lilly	Immunomodulator	Clinical phase
Apremilast	Amgen Europe BV	Immunomodulator	Clinical phase
APN01	Apeiron Biologics	Immunomodulator	Clinical phase
Anti-SARS-CoV-2 polyclonal hyperimmune immunoglobulin	Alliance hyperimmune project (Biotest AG, Bio Products Laboratory, LFB, Octapharma, CSL Behring and Takeda)	Antiviral	Clinical phase
Acalabrutinib	Acerta Pharma BV	Immunomodulator	Clinical phase

In this document we present information for some therapies in development.

Table 3 -2: Most advanced therapeutics in the R&D pipeline

Drug	Mechanism of operation	Approval Status Withdrawn, suspended or terminated
Remdesivir (Veklury®)	Antiviral agent	**EMA: Conditional marketing authorisation granted** **FDA: Marketing authorisation granted** 2 RCTs (suspended and terminated)
Favipiravir (Avigan, T-705)	Antiviral agent	No withdrawn, suspended or terminated studies found
Darunavir (Prezista®)	Antiviral agent	No withdrawn, suspended or terminated studies found
Camostat Mesilate (Foipan®)	Antiviral cell-entry inhibitor	1 RCT-withdrawn, no suspended or terminated studies found
APN01 (rhACE2)	Antiviral cell-entry inhibitor	1 RCT – Withdrawn
Tocilizumab (RoActemra®)	Monoclonal antibody	1 RCT withdrawn, 4 RCTs terminated
Sarilumab (Kevzara®)	Monoclonal antibody	1 RCT suspended, 1 RCTs terminated
Interferon beta 1a (SNG001) **and 1b**	Interferon	1 RCT suspended
Convalescent Plasma	Convalescent Plasma	1 RCT terminated, 1 RCT withdrawn
Plasma derived medicinal products: REGN-COV2; LY-CoV555 (bamlanivimab); LY-CoV016 (etesevimab); AZD7442	Neutralizing monoclonal antibodies	**FDA Emergency Use Authorisation (EUA): REGN-COV2 (casirivimab+imdevimab)** **FDA Emergency Use Authorisation (EUA): Bamlanivimab** No withdrawn, suspended or terminated studies found
Solnatide	Synthetic peptide	No withdrawn, suspended or terminated studies found
Umifenovir (Arbidol®)	Antiviral agent	No withdrawn, suspended or terminated studies found
Dexamethasone and other corticosteroids	Glucocorticoid	**EMA: Dexamethasone use endorsed following referral procedure** 2 RCTs terminated, 1 RCT suspended, 1 RCT withdrawn
Anakinra (Kyneret®)	Interleukin 1 receptor antagonist	1 RCT suspended, 2-RCT terminated
Colchicine	An alkaloid, with anti-gout and anti-inflammatory activities	1 RCT withdrawn, no suspended or terminated studies found
Nafamostat (Futhan©)	Trypsin-like serine protease inhibitor	No withdrawn, suspended or terminated studies found
Gimsilumab	Human monoclonal antibody	No withdrawn, suspended or terminated studies found
Canakinumab	Human monoclonal antibody	No withdrawn, suspended or terminated studies found
Lenzilumab	Recombinant monoclonal antibody	No withdrawn, suspended or terminated studies found
Vitamin D	Vitamin	No withdrawn, suspended or terminated studies found
Baricitinib	Inhibitor of Janus kinase (JAK)1 and JAK2	**FDA Emergency Use Authorisation (EUA): Baricitinib in combination with remdesivir**

		No withdrawn, suspended or terminated studies found
Molnupiravir	Pro-drug of the nucleoside analogue *N*4-hydroxycytidine (NHC)	No withdrawn, suspended or terminated studies found
Ivermectin	Antiparasitic	No withdrawn, suspended or terminated studies found
Aspirin (acetylsalicylic acid)	Antitrombotic	1 RCT withdrawn, no suspended or terminated studies found

3.1 Remdesivir (Veklury®)

About the drug under consideration

Remdesivir (Veklury) is an antiviral medicine for systemic use which received a **conditional marketing authorisation** in **EU** in July, 2020 [61-63], https://ec.europa.eu/commission/presscorner/detail/en/mex_20_1266..

erstes zugelassenes antivirales Medikament gegen Coronavirus: conditional marketing authorisation

Remdesivir (Veklury) is **indicated** for the treatment of coronavirus disease 2019 (COVID-19) in adults and adolescents (aged 12 years and older with body weight at least 40 kg) with pneumonia requiring supplemental oxygen. The drug is for administration by intravenous infusion after further dilution. The **recommended dosage** of remdesivir in patients 12 years of age and older and weighing at least 40 kg is: Day 1 – single loading dose of remdesivir 200 mg given by intravenous infusion, Day 2 onwards – 100 mg given once daily by intravenous infusion. The total **duration of treatment** should be at least 5 days and not more than 10 days. **Concomitant use** of remdesivir **with chloroquine phosphate or hydroxychloroquine sulphate** is **not recommended** due to antagonism observed in vitro.

indiziert für Patient*nnen ≥ 12 Jahre mit Lungenentzündung, Sauerstoff-unterstützt Verabreichung iv 5-10 Tage

The **most common adverse reaction** in healthy volunteers is increased transaminases (14%). The most common adverse reaction in patients with COVID-19 is nausea (4%) [64].

Nebenwirkungen

Remdesivir (Veklury) is subject to **additional monitoring for safety**. Due to a conditional marketing authorisation, Marketing Authorisation Holder (MAH) should complete some **measures to confirm the efficacy and safety within different timeframe** [63].

On October 02, 2020 EMA announced that EMA's safety committee (PRAC) has started a review of a safety signal to assess reports of acute kidney injury in some patients with COVID-19 taking Veklury (remdesivir) [65].

Okt 2020: EMA Sicherheitsanalyse

On October 22, 2020 the **U.S. Food and Drug Administration approved** remdesivir for use in adult and pediatric patients 12 years of age and older and weighing at least 40 kilograms (about 88 pounds) for the treatment of **COVID-19 requiring hospitalization**.

FDA Zulassung im Okt 2020

The **FDA** recently issued an emergency use authorization (EUA) for the Janus kinase inhibitor **baricitinib** to be used **in combination with remdesivir** in patients with COVID-19 who require oxygen or ventilatory support [66].

FDA Notzulassung für Kombinationstherapie Remdesvir + Baricitinib

Recently, the new **WHO living guidance** on remdesivir for COVID-19 was published [67]. The WHO panel made a conditional recommendation against the use of remdesivir in hospitalised patients with COVID-19, regardless of disease severity, with new information and recommendations on remdesivir after publication of results from the WHO SOLIDARITY trial [68]. The recommendation on remdesivir was informed by results from a systematic review and network meta-analysis (NMA) that pooled data from four randomized trials with 7333 participants hospitalized for COVID-19. The resulting GRADE evidence summary suggested that remdesivir has possibly no effect on mortality (odds ratio 0.90, 95% confidence interval [CI] 0.70 - 1.12; absolute effect estimate 10 fewer deaths per 1000 patients, 95% CI from 29 fewer - 11 more deaths per 1000 patients; low certainty evidence); and possibly no effect on the other important outcomes identified by the panel, with similar low to very low certainty of evidence. The panel judged the overall credibility of subgroup analyses assessing differences in mortality by severity of illness to be insufficient to make subgroup recommendations.

WHO empfiehlt Remedisivir nicht, unabhängig von Patientenpopulation basierend auf Ergebnisse aus SOLIDARITY

US COVID-19 Treatment Guidelines Panel issued new recommendations on remdesivir treatment for patients with COVID-19 (as of December 3, 2020) [69]:

US COVID-19 Treatment Guidelines

Remdesivir, an antiviral agent, is currently the only drug that is approved by the FDA for the treatment of COVID-19. It is recommended for use in hospitalised patients who require supplemental oxygen. However, it is not routinely recommended for patients who require mechanical ventilation due to the lack of data showing benefit at this advanced stage of the disease.

Empfehlung: nicht routinemäßig

Gilead Sciences Inc. said it plans to start human trials of an inhaled version of its anti-Covid-19 drug remdesivir. An inhaled version, through a nebulizer, could allow Gilead to give the drug to a broader group of patients, including those with milder symptomatic cases who don't need to be hospitalised, https://www.pharmacist.com/article/gilead-begin-human-testing-inhaled-version-covid-19-drug-remdesivir.

Vorhaben von Gilead: Darreichungsform mittels Inhalator

Withdrawn, suspended or terminated studies

The two phase 3 randomised controlled trials (RCT) to evaluate intravenous RVD in patients with 2019-nCoV, initiated in the beginning of February in China, are suspended (NCT04252664) or terminated (NCT04257656) (the epidemic of COVID-19 has been controlled well in China, and no eligible patients can be enrolled further).

in ClinicalTrials.gov & EUdraCT keine weiteren beendeten Studien

Results of publications

Wang Y et al. 2020 [70] published results of the first randomised, double-blind, placebo-controlled, multicentre trial, conducted in China (**NCT04257656**), on intravenous remdesivir in adults admitted to hospital with severe COVID-19. The study was terminated before attaining the prespecified sample size (237 of the intended 453 patients were enrolled) because the outbreak of COVID-19 was brought under control in China. Remdesivir treatment was not associated with a statistically significant difference in time to clinical improvement (hazard ratio 1·23 [95% CI 0·87–1·75]); duration of invasive mechanical ventilation; viral load; adverse events.

Ergebnisse der Studien:

Wang (Hubei/ China): frühzeitig beendet wegen Mangel an Pts.

keine Unterschiede bei klinischer Verbesserung, invasiver Beatmung

Beigel et al. 2020 [71] reported results from double-blind, randomized, placebo-controlled trial of intravenous remdesivir in 1062 adults hospitalized with Covid-19 (541 assigned to remdesivir and 521 to placebo) (NCT04280705). Remdesivir group had a median recovery time of 10 days (95% confidence interval [CI], 9 to 11) vs 15 days (95% CI, 13 to 18) among placebo group (rate ratio for recovery, 1.29; 95% CI, 1.12 to 1.49; P<0.001, by a log-rank test). The rate ratio for recovery was largest among patients with a baseline ordinal score of 5 (rate ratio for recovery, 1.45; 95% CI, 1.18 to 1.79). The Kaplan–Meier estimates of mortality were 6.7% with remdesivir vs 11.9% in placebo group by day 15 (hazard ratio, 0.55; 95% CI, 0.36 to 0.83); 11.4% with remdesivir vs 15.2% with placebo by day 29 (hazard ratio, 0.73; 95% CI, 0.52 to 1.03). The between group differences in mortality varied considerably according to baseline severity, with the statisticaly significant difference seen among patients with a baseline ordinal score of 5 (hazard ratio, 0.30; 95% CI, 0.14 to 0.64). Serious adverse events were reported in 131 of the 532 patients who received remdesivir (24.6%) and in 163 of the 516 patients who received placebo (31.6%). There were 47 serious respiratory failure adverse events in the remdesivir group (8.8% of patients), including acute respiratory failure and the need for endotracheal intubation, and 80 in the placebo group (15.5% of patients). No deaths were considered by the investigators to be related to treatment assignment.

Beigel (USA)
1.062 Pts.
kürzere Dauer zur Erholung

Unterschiede bei Baseline-Schwergrad erschweren die Interpretation der Mortalitätsdaten

Goldman et al. 2020 [72] published the results from the randomized, open-label, phase 3 trial involving 397 hospitalized patients with confirmed SARS-CoV-2 infection, oxygen saturation of 94% or less while they were breathing ambient air, and radiologic evidence of pneumonia (NCT04292899), to receive intravenous remdesivir for either 5 days or 10 days. Trial did not show a significant difference between a 5-day course and a 10-day course of remdesivir. -The most common adverse events were nausea (9% of patients), worsening respiratory failure (8%), elevated alanine aminotransferase level (7%), and constipation (7%). The absence of a control group in this study did not permit an overall assessment of the efficacy of remdesivir.

Goldman (USA, IT, SP…)
RCT, open-label
397 Pts.

Vergleich von 5 vs. 10 Tagen RDV

primärer Endpunkt: klinischer Status am Tag 14

Spinner et al. 2020 [73] published results from a randomised, open-label, phase 3 trial (NCT04292730) performed on 596 hospitalised patients with moderate COVID-19 pneumonia (pulmonary infiltrates and room-air oxygen saturation >94%). Patients were randomized in a 1:1:1 ratio to receive a 10-day course of remdesivir (n = 197), a 5-day course of remdesivir (n = 199), or standard care (n = 200). On day 11, patients in the 5-day remdesivir group had statistically significantly higher odds of a better clinical status distribution vs standard care (odds ratio, 1.65; 95% CI, 1.09-2.48; p=0.02), but the difference was of uncertain clinical importance. The clinical status distribution on day 11 between the 10-day remdesivir and standard care groups was not significantly different (p=0.18 by Wilcoxon rank sum test).

Spinner (USA, Europa, Asien)

5-Tage vs 10-Tage vs. SOC

596 Pts
kein signifikanter Unterschied zwischen 5 vs. 10 Tage vs. SOC

AE signifikanter Unterschied zwischen 10 Tage vs. SOC zu Ungunsten von Remdesivir
SAE häufiger in SOC Gruppe

There were no significant differences between the 5-day or 10-day remdesivir groups and standard care for any of the exploratory end points—time to 2-point or greater improvement in clinical status, time to 1-point or greater improvement in clinical status, time to recovery, time to modified recovery, and time to discontinuation of oxygen support, duration of oxygen therapy or hospitalization and all-cause mortality at day 28. The difference in AEs proportions between the 5-day remdesivir group and standard care was not statistically significant (4.8%; 95% CI, –5.2% to 14.7%; p=0.36), but the difference between the 10-day remdesivir group and standard care was significant (12.0%; 95% CI, 1.6%-21.8%; p=0.02). Nausea (10% vs 3%), hypokalemia (6% vs 2%), and headache (5% vs 3%) were more frequent among remdesivir-treated patients compared with standard care. Serious adverse events were less common in the remdesivir groups, but the difference was not statisticaly significant.

WHO SOLIDARITY

kein Unterschied bei Mortalität
kein Unterschied bei anderen Endpunkten

Interim results from the **WHO SOLIDARITY trial** (**ISRCTN83971151, NCT04315948**), large, international, adaptive, open-label, randomized controlled trial to evaluate remdesivir, lopinavir/ritonavir, interferon beta-1a and hydroxychloroquine treatment for COVID-19, were published, with 2750 patients allocated to remdesivir [68, 74]. Death rate ratio was not statisticaly significant different between remdesivir and standard care; RR=0.95 (0.81-1.11, p=0.50; 301/2743 active vs 303/2708 control). The same was true for the outocmes: initiation of ventilation and hospitalisation duration, and other three investigation treatment.

EUnetHTA Bericht zu 4 RCTs (Dez 2020):

kein Unterschied:
all-cause mortality

Unterschied bei klinischer Verbesserung und bei Nebenwirkungen

Based on the **living synthesis** of currently available scientific evidence from **4 RCTs** (Wang, Beigel, Spinner and SOLIDARITY-Remdesivir), on remdesivir compared with standard care/placebo, presented in recently published EUnetHTA Rapid Collaborative Review document [75], current scientific conclusions were listed: According to the results of four RCTs with moderate certainty of evidence, remdesivir has no effect on mortality in COVID-19 patients compared to standard treatment; According to the results of three RCTs, remdesivir decreases the incidence of WHO progression score level 6 or above (moderate certainty of evidence), as well as the WHO progression score level 7 or above D14-D28 (high certainty of evidence), compared to standard treatment; According to the results of one RCT with very low certainty of evidence, remdesivir has no effect on viral clearance, compared to standard treatment; According to the results of three RCTs with moderate certainty of evidence, remdesivir increases the number of discharged patients within 28 days compared to standard treatment; According to low certainty of evidence, remdesivir has no effect on outcomes mechanical ventilation (4 RCTs); time to clinical improvement (3 RCTs); duration of ventilation (2RCTs); duration of hospitalisation (3 RCTs) and serious adverse events leading to discontinuation (3 RCTs), compared to standard treatment; According to the results of two RCTs with high certainty of evidence, remdesivir does not increase adverse events compared to standard treatment; According to the results of three RCTs with moderate certainty of evidence, remdesivir decreases the number of patients with SAEs compared to standard treatment.

Details can be found in the **Summary of findings Table** 3.1-1.

The Living Systematic Review with Meta-Analysis (MA), related to Remdesivir 5 days vs Remdesivir 10 days (2 RCTs, Spinner and Goldman) and the Summary of findings table (https://covid-nma.com/living_data/index.php) are presented in Table 3.1-2.

*Table 3.1-1: Summary of findings table on **Remdesivir vs Standard care / Placebo** (4 RCTs: Wang, Beigel, Spinner, SOLIDARITY-Remdesivir)*
***Patient or population:** Mild/Moderate/Severe/Critical COVID-19*

Setting: Wordwide
Intervention: Remdesivir
Comparison: Standard Care/Placebo

Outcome	Anticipated absolute effects (95% CI)		Relative effect (95% CI)	Absolute effect difference (95% CI)	Number of participants (studies)	Certainty of evidence[e] (GRADE)	Comments
	Risk with Standard care[a]	Risk with Remdesivir					
All-cause Mortality[b]	112 per 1.000	**101 per 1.000** (82 to 125)	**RR 0.90** (0.73 to 1.11)	**11 fewer per 1.000** (from 30 fewer to 12 more)	7345 (4 RCTs) Spinner, 2020; SOLIDARITY 2020; Beigel, 2020; Wang, 2020[76][68][68]	⊕⊕⊕◯ MODERATE	Imprecision downgraded by 1 level: due to wide confidence interval consistent with the possibility for benefit and the possibility for harm and low number of events
Clinical improvement D14-D28[b]	759 per 1.000	**805 per 1.000** (751 to 858)	**RR 1.06** (0.99 to 1.13)	**46 more per 1.000** (from 8 fewer to 99 more)	832 (2 RCTs) Spinner, 2020; Wang, 2020	⊕⊕⊕◯ MODERATE	Imprecision downgraded by 1 level: due to low number of events and/or participants
WHO progression score (level 6 or above) D14-D28[b]	193 per 1.000	**131 per 1.000** (106 to 164)	**RR 0.68** (0.55 to 0.85)	**62 fewer per 1.000** (from 87 fewer to 29 fewer)	1894 (3 RCTs) Beigel, 2020; Spinner, 2020; Wang, 2020	⊕⊕⊕◯ MODERATE	Risk of bias downgraded by 1 level: some concerns due to deviation from intended intervention and outcome measurement
WHO progression score level 7 or above D14-28[b]	178 per 1.000	**124 per 1.000** (100 to 156)	**RR 0.70** (0.56 to 0.88)	**53 fewer per 1.000** (from 78 fewer to 21 fewer)	1894 (3 RCTs) Beigel, 2020; Spinner, 2020; Wang, 2020	⊕⊕⊕⊕ HIGH	
Viral negative conversion D7[b]	492 per 1.000	**502 per 1.000** (374 to 679)	**RR 1.02** (0.76 to 1.38)	**10 more per 1.000** (from 118 fewer to 187 more)	196 (1 RCT) Wang, 2020	⊕◯◯◯ VERY LOW	Risk of bias downgraded by 1 level: some concerns with missing data

Outcome	Anticipated absolute effects (95% CI)		Relative effect (95% CI)	Absolute effect difference (95% CI)	Number of participants (studies)	Certainty of evidence[e] (GRADE)	Comments
	Risk with Standard care[a]	Risk with Remdesivir					
							Indirectness downgraded by 1 level: despite a multicenter design this is a single study from a single country, therefore results in this population might not be generalizable to other settings Imprecision downgraded by 1 level: due to wide confidence interval consistent with the possibility for benefit and the possibility for harm and low number of events
Adverse events[b]	583 per 1.000	**542 per 1.000** (496 to 589)	**RR 0.93** (0.85 to 1.01)	**41 fewer per 1.000** (from 87 fewer to 6 more)	1894 (2 RCTs) Wang, 2020; Beigel, 2020;	⨁⨁⨁⨁ HIGH	Presume that the adverse event rates, and the corresponding relative risks, are similar across diverse settings; therefore not downgraded for indirectness
Serious adverse events[b]	40 per 1.000	**24 per 1.000** (15 to 38)	**RR 0.60** (0.38 to 0.96)	**16 fewer per 1.000** (from 25 fewer to 2 fewer)	1894 (3 RCTs) Beigel, 2020; Spinner, 2020; Wang, 2020	⨁⨁⨁◯ MODERATE	Presume that the adverse event rates, and the corresponding relative risks, are similar across diverse settings; therefore not downgraded for indirectness Imprecision downgraded by 1 level: few events and a wide confidence interval consistent with the possibility of a benefit and the possibility of no effect.

Outcome	Anticipated absolute effects (95% CI)		Relative effect (95% CI)	Absolute effect difference (95% CI)	Number of participants (studies)	Certainty of evidence[e] (GRADE)	Comments
	Risk with Standard care[a]	Risk with Remdesivir					
Serious adverse events leading to discontinuation [c]	*15* per 1.000	*15* per 1000	**OR 1.00** (0.37 - 3.83)	***0 fewer per 1.000*** (from 9 fewer to 40 more)	1894 (3 RCTs) Beigel, 2020; Spinner, 2020; Wang, 2020	⊕⊕◯◯ **Low**	Very serious imprecision
Mechanical ventilation [c]	*105* per 1000	*95* per 1000	**OR**: **0.89** (0.76 - 1.03)	***10 fewer per 1000*** (from 23 fewer to 3 more)	6549 (4 RCTs) Spinner, 2020; SOLIDARITY, 2020; Beigel, 2020; Wang, 2020	⊕⊕◯◯ Low	Due to serious risk of bias and serious imprecision
Duration of ventilation [c]	*14.7* Days mean	*13.4* Days mean	Measured by: Scale: lower better	Difference: ***MD 1.3 lower*** (from 4.1 lower to 1.5 higher)	440 (2 RCTs) Wang, 2020; Beigel, 2020;	⊕⊕◯◯ Low	Due to very serious imprecision
Time to clinical improvement [c]	*11.0* Days mean	*9.0* Days mean	Measured by: Scale: lower better	Difference: ***MD 2.0 lower*** (from 4.2 lower to 0.9 higher)	1882 (3 RCTs) Beigel, 2020; Spinner, 2020; Wang, 2020	⊕⊕◯◯ *Low*	Due to serious imprecision and serious indirectness
Duration of hospitalization [c]	*12.8* Days mean	*12.3* Days mean	Measured by: Scale: lower better	Difference: ***MD 0.5 lower*** (from 3.3 lower to 2.3 higher)	1882 (3 RCTs) Beigel, 2020; Spinner, 2020; Wang, 2020	⊕⊕◯◯ *Low*	Due to serious imprecision and serious indirectness

Outcome	Anticipated absolute effects (95% CI)		Relative effect (95% CI)	Absolute effect difference (95% CI)	Number of participants (studies)	Certainty of evidence[e] (GRADE)	Comments
	Risk with Standard care[a]	Risk with Remdesivir					
Number of patients discharged within 28 days [d]	478 per 1.000	**540 per 1,000** (488 to 593)	**RR 1.13** (1.02 to 1.24)	**62 more per 1.000** (from 10 more to 115 more)	1894 (3 RCTs) Beigel, 2020; Spinner, 2020; Wang, 2020	⊕⊕⊕◯ MODERATE	Downgraded of one level for high risk of performance bias in two studies and unclear risk of selection, attrition and reporting bias in one study

Source: [75] [73] [68] [71] [70]

a Background risk in the control group is based on the observed risk in the studies; b outcome data and GRADE assessment from Covid-nma.com, https://covid-nma.com/living_data/index.php (The evidence profile and summary of findings table were updated on November 17th, 2020); C Outcome data and GRADE assessment from WHO guideline [67] d Outcome data and GRADE assessment from the department of Epidemiology Lazio Regional Health Service (DEPLazio), Italy, http://deplazio.net/farmacicovid/index.html;e GRADE Working Group grades of evidence: High certainty=we are very confident that the real effect is close to that of the estimated effect; Moderate certainty=we are moderately confident in the effect estimation: the real effect may be close to the estimated effect, but there is a possibility that it is substantially different; Low certainty=our confidence in the effect estimation is limited: the real effect may be substantially different from the estimated effect; Very Low certainty=we have very little confidence in estimating the effect: the actual effect is likely to be substantially different from the estimated one.

Abbreviations: CI= confidence interval; RR=relative risk; OR=odds ratio.

GRADE Working Group grades of evidence: High certainty: We are very confident that the true effect lies close to that of the estimate of the effect; **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different; **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect; **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Table 3.1-2: Summary of findings table on ***Remdesivir 5 days vs Remdesivir 10 days*** *(2 RCTs: Goldman, Spinner) - https://covid-nma.com/living_data/index.php*

Remdesivir 5 days compared to Remdesivir 10 days for Mild/Moderate/Critical/Severe Covid-19

Patient or population: Mild/Moderate/Critical/Severe Covid-19
Setting: Worldwide
Intervention: Remdesivir 5 days
Comparison: Remdesivir 10 days

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with Remdesivir 10 days	Risk with Remdesivir 5 days				
Incidence of viral negative conversion D7 - not reported	-	-	-	-	-	outcome not yet measured or reported
Incidence of clinical improvement D7	368 per 1.000	**438 per 1.000** (371 to 515)	**RR 1.19** (1.01 to 1.40)	798 (2 RCTs) [b]	⨁⨁◯◯ LOW [c,d]	
Incidence of clinical improvement D14-28	708 per 1.000	**750 per 1.000** (616 to 920)	**RR 1.06** (0.87 to 1.30)	798 (2 RCTs) [b]	⨁◯◯◯ VERY LOW [c,e,f]	
Incidence of WHO progression score (level 6 or above) D14-28	174 per 1.000	**109 per 1.000** (78 to 153)	**RR 0.63** (0.45 to 0.88)	798 (2 RCTs) [b]	⨁⨁◯◯ LOW [c,d]	
Incidence of WHO progression score (level 7 or above) D14-28	146 per 1.000	**85 per 1.000** (58 to 124)	**RR 0.58** (0.40 to 0.85)	798 (2 RCTs) [b]	⨁⨁◯◯ LOW [c,g]	
All-cause mortality D14-28	60 per 1.000	**45 per 1.000** (25 to 81)	**RR 0.74** (0.41 to 1.34)	798 (2 RCTs) [b]	⨁⨁◯◯ LOW [f,g]	
Adverse events	650 per 1.000	**604 per 1.000** (546 to 669)	**RR 0.93** (0.84 to 1.03)	798 (2 RCTs) [b]	⨁⨁⨁◯ MODERATE [c]	
Serious adverse events	196 per 1.000	**126 per 1.000** (92 to 171)	**RR 0.64** (0.47 to 0.87)	798 (2 RCTs) [b]	⨁⨁◯◯ LOW [c,d]	

*The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CI: Confidence interval; RR: Risk ratio

GRADE Working Group grades of evidence: High certainty: We are very confident that the true effect lies close to that of the estimate of the effect; **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different; **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect; **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations

a. Last update: September 18, 2020; b. Spinner CD, 2020; Goldman JD, 2020; c. Risk of bias downgraded by 1 level: some concerns due to concerns during the randomization process, deviation from intended intervention and outcome measurement; d. Imprecision downgraded by 1 level: due to low number of events and/or participants; e. Inconsistency downgraded by 1 level: I^2= 79.3%
f. Imprecision downgraded by 1 level: due to wide confidence interval consistent with the possibility for benefit and the possibility for harm; g. Risk of bias downgraded by 1 level: some concerns due to concerns during the randomization process and deviation from intended intervention

3.2 Lopinavir + Ritonavir (Kaletra®)

wegen erwiesenem Mangel an Wirksamkeit wurde Beobachtung beendet

Due to the lack of effectiveness of lopinavir/ritonavir in treating adults hospitalized with COVID-19 patients and the decisions to stop enrolling participants to the lopinavir/ritonavir (Kaletra) arms of the RECOVERY, SOLIDARITY and DISCOVERY studies in adults hospitalized with COVID-19, our reporting related to lopinavir/ritonavir was stopped also.

Last reporting V6/September 2020:
https://eprints.aihta.at/1234/50/Policy_Brief_002_Update_09.2020.pdf

3.3 Favipiravir (Avigan®)

About the drug under consideration

antivirales Medikament

Favipiravir (Avigan®), an antiviral drug, is a new type of RNA-dependent RNA polymerase (RdRp) inhibitor [77, 78].

Favipiravir (Avigan®) has not been approved by the European Medicines Agency (EMA) or the American Food and Drug Administration (FDA) for COVID-19.

Empfehlungen des US COVID-19 Treatment Guidelines Panel GEGEN jegliche HIV Protease Inhibitoren

The US COVID-19 Treatment Guidelines Panel **recommends against** using the **Lopinavir/ritonavir (AI) or other HIV protease inhibitors (AIII),** except in a clinical trial, because of unfavorable pharmacodynamics and because clinical trials have not demonstrated a clinical benefit in patients with COVID-19 [69].

Withdrawn, suspended or terminated studies

No withdrawn, suspended or terminated RCTs were found in two clinical trial registers (ClinicalTrials.gov and EUdraCT).

Results of publications

1 Publikation zu RCT Vergleich mit Umifenovir

Chen C et al. 2020 [79] published results (as preprint) on a RCT (**ChiCTR2000030254**) related to efficacy and safety of favipiravir, **in comparison with umifenovir.** Summary of findings table on favipiravir compared to umifenovir (1 RCT: Chen) is presented in Table 3.3-1.

1 weitere Publikation Vergleich mit Baloxavir marboxil

Lou Y et al. 2020, published as preprint results of exploratory RCT with 3 arms (**ChiCTR2000029544**) [80] related to the efficacy and safety of favipiravir **in comparison with baloxavir marboxil**, and **lopinavir + ritonavir or darunavir/cobicistat + umifenovir + interferon-a** in hospitalized adult patients with COVID-19. The percentage of patients who turned viral negative after 14-day treatment was 70%, 77%, and 100% in the baloxavir, favipiravir, and control group respectively, with the medians of time from randomization to clinical improvement was 14, 14 and 15 days, respectively.

Summary of findings table on favipiravir compared to baloxavir marboxil is presented in Table 3.3-2 and favipiravir compared to lopinavir + ritonavir or darunavir/cobicistat + umifenovir + interferon-a (1 RCT: Lou 2020) [69] is presented in Table 3.3-3.

Interim results from an adaptive, multicenter, open label, randomized, phase 2/3 clinical trial (NCT04434248) of favipiravir (AVIFAVIR) **versus standard of care** (SOC) in 60 hospitalized patients with moderate COVID-19 pneumonia were published (three treatment groups: AVIFAVIR 1600/600 mg, AVIFAVIR 1800/800 mg, or SOC). AVIFAVIR enabled SARS-CoV-2 viral clearance in 62.5% of patients within 4 days, and was safe and well-tolerated. Based on these interim results, the Russian Ministry of Health granted a conditional marketing authorization to AVIFAVIR, which makes it the only approved oral drug for treatment of moderate COVID-19 to date [81].

AVIFAVIR
Phase 2/3 RCT bei moderater Covid-19 Erkrankung

interim Auswertung orale Verabreichung in Russland „conditional" zugelassen

Dabbous et al. 2020 published results, as preprint, from open-label, phase 3 RCT, comparing **favipiravir vs standard care** (hydroxychloroquine plus oseltamivir) in 100 patients with mild to moderate COVID-19 in Egypt (NCT04349241) [82]. No statistically significant difference was found related to time to PCR negativity (p=0.7). Four patients in favipiravir group had increase in liver transaminase, and 20 patients in standard care group (hydroxychloroquine plus oseltamivir) developed heartburn and nausea. One patient died in hydroxychloroquine plus oseltamivir group after acute myocarditis resulted in acute heart failure.

Phase 3 RCT (Ägypten)
kein Unterschied

Balykova et al. 2020 [83] published results from a RCT in 200 hospitalised patients with COVID-19 showed a signifiant advantage of favipiravir therapy compared with standard therapy in terms of the rate of improvement in clinical status (on average by 4 days), the speed and frequency of recovery on the 10 day of therapy (no clinical signs of the disease in the study and control groups were observed in 44 and 10% of patients, respectively), the frequency of achieving the viral clearance on the 10th day of therapy (98 and 78% in the study and control groups, respectively) (p=0.00003). Favipiravir therapy was accompanied by a significant improvement in lung condition according to CT data, improved laboratory parameters and normalization of oxygen saturation levels. Favipiravir therapy was characterized by a favorable safety profie. In the main group, no aggravation of the course of the disease or serious adverse events related to the drug were recorded.

RCT
200 hospitalisierte Patient*innen

raschere klinische Verbesserung (-4 Tage), insb. der Lunge

akzeptables Sicherheitsprofil

Ruzhentsova et al. 2020 [84] published results as preprint from open-labeled, randomized, active-controlled multicenter trial (NCT04501783) of an oral dosage form of favipiravir in out- and hospitalized patients with mild to moderate COVID-19 in 10 clinical centers in Russia. 190 Patients were randomly assigned (in a 2:1 ratio) to receive either favipiravir (1800 mg BID on day 1, followed by 800 mg BID for up to 9 days), or standard of care (SOC) treatment (umifenovir + intranasal interferon alpha-2b, or hydroxychloroquine) for up to 10 days. The median time to clinical improvement was 6.0 (IQR 4·0; 9·3) days in favipiravir group and 10.0 (IQR 5·0; 21·0) days in SOC group; the median difference was 4 days (HR 1·63; 95% CI 1·14-2·34, p=0·007). The statistically significant difference in the median time to viral clearance was observed only in the hospitalized cohort of patients: 3·0 (IQR 3·0; 3·0) vs. 5·0 (IQR 4·5; 5·5), respectively (HR 2·11; 95% CI 1·04-4·31; p = 0·038). However, the rate of viral elimination on Day 5 in the favipiravir group was significantly higher in the whole population: 81·2% vs. 67·9% respectively (RR 1·22; 05% CI 1·00-1·48; p = 0.022). The rate of clinical improvement on Day 7 in the favipiravir group was 1.5-fold higher compared to SOC: 52·7% vs. 35·8% (RR 1·50; 95% CI 1·02-2·22; p = 0·020). Favipiravir was well tolerated: most of the adverse events (AE) were mild. Any AEs were reported in 74·1% of patients in the favipiravir group vs. 60·0% in the SOC group; the most common adverse reactions were asymptomatic hyperuricemia,

RCT
190 Patient*innen
milde oder moderate Erkrankung

ambulante oder hospitalisiert

Vergleich mit SOC (umifenovir + intranasal interferon alpha-2b, or hydroxychloroquine)

raschere Reduktion der Viruslast und klinische Verbesserung mit favipiravir

akzeptables Sicherheitsprofil

transient elevation of ALT & AST, and gastrointestinal disorders (diarrhea, nausea, abdominal pain).

Udwadia et al. 2020 [85] published results from randomized, open-label, parallel-arm, multicenter, phase 3 trial (CTRI/2020/05/025114), in adults with mild to moderate COVID-19 in India. 150 patients were randomized to favipiravir (n=75) or control (n=75). Median time to cessation of viral shedding was 5 days (95% CI: 4 days, 7 days) versus 7 days (95% CI: 5 days, 8 days), p=0.129, and median time to clinical cure was 3 days (95% CI: 3 days, 4 days) versus 5 days (95% CI: 4 days, 6 days), p=0.030, for favipiravir and control respectively. Adverse events were observed in 36% of favipiravir and 8% of control patients. One control patient died due to worsening disease.

RCT
150 Patient*innen
milde oder moderate Erkrankung

raschere Reduktion der Viruslast und klinische Verbesserung mit favipiravir

Data related to **Summary of findings table** on **favipiravir compared to standard care** (6 RCTs: Lou 2020, Ivashchenko 2020, Dabbous 2020, Balykova 2020, Ruzhentsova 2020, Udwadia 2020) could be found in Table 3.3-4 below. Based on currently available evidence, favipiravir may increase the incidence of Clinical improvement D7 (3 RCTs, RR 1.58, 95% CI 1.15 to 2.16, low certainty of evidence). The evidence is very uncertain about the effect of favipiravir on All-cause mortality D14-28 (RR 0.32, 95%CI 0.01 to 7.82, 3 RCTs, very low certainty of evidence); Viral negative conversion D7 (RR 1.09, 95%CI 0.95 to 1.26, 6 RCTs, very low certainty of evidence); Adverse events (RR 1.53, 95%CI 0.87 to 2.69, 3 RCTs, very low certainty of evidence) and Serious adverse events (RR 1.20, 95%CI 0.48 to 2.99, 4 RCTs, very low certainty of evidence).

Zusammenfassung von 6 RCTs
ev. Effekte auf klinische Verbesserung
Mortalität

Doi et al. 2020 published results from RCT (Japan Registry of Clinical Trials **jRCTs041190120**), related to early versus late favipiravir in hospitalised patients with COVID-19 [86]. 88 patients were randomly assigned at a 1:1 ratio to **early or late favipiravir therapy** (the same regimen starting on day 6 instead of day 1). Viral clearance occurred within 6 days in 66.7% and 56.1% of the early and late treatment groups (adjusted hazard ratio [aHR], 1.42; 95% confidence interval [95% CI], 0.76–2.62). Of 30 patients who had a fever (≥37.5°C) on day 1, time to defervescence was 2.1 days and 3.2 days in the early and late treatment groups (aHR, 1.88; 95%CI, 0.81–4.35). During therapy, 84.1% developed transient hyperuricemia. Neither disease progression nor death occurred to any of the patients in either treatment group during the 28-day participation.

Okt 2020:
RCT mit 89 Pts.
Japan
Vergleich von früher und später Favipiravir Therapie bei hospitalisierten Pts.

kein Unterschied

Zhao H et al. 2020, published results from RCT in moderate to critical COVID-19 patients in China, comparing **favipiravir to tocilizumab and favipiravir plus tocilizumab (ChiCTR2000030096, NCT04310228)** [87]. Patients were randomly assigned (3:1:1) to a 14-day combination of favipiravir combined with tocilizumab (combination group), favipiravir, and tocilizumab. The cumulative lung lesion remission rate at day 14 was significantly higher in the combination group as compared with favipiravir group (p = 0.019, HR 2.66 95% CI [1.08 to 6.53]); a significant difference between tocilizumab and favipiravir found also (p = 0.034, HR 3.16, 95% CI 0.62 to 16.10). There was no significant difference between the combination group and the tocilizumab group (p = 0.575, HR 1.28 95%CI 0.39 to 4.23). Combined therapy can also significantly relieve clinical symptoms and help blood routine to return to normal. No serious adverse events were reported.

RCT
19 Patient*innen
favipiravir + tocilizumab vs. favipiravir vs. tocilizumab

Kombinationstherapie von Vorteil

Table 3.3-1: Summary of findings table on ***favipiravir compared to umifenovir*** *(1 RCT: Chen) - https://covid-nma.com/living_data/index.php)*

Summary of findings:						
Favipiravir compared to Umifenovir for COVID-19						
Patient or population: COVID-19 **Setting**: Worldwide **Intervention**: Favipiravir **Comparison**: Umifenovir						
Outcomes	**Anticipated absolute effects*** **(95% CI)**		**Relative effect (95% CI)**	**№ of participants (studies)**	**Certainty of the evidence (GRADE)**	**Comments**
	Risk with Umifenovir	**Risk with Favipiravir**				
Incidence viral negative conversion D7 - not reported	-	-	-	-	-	outcome not yet measured or reported
Clinical improvement - not reported	-	-	-	-	-	outcome not yet measured or reported
Incidence of clinical recovery D7	517 per 1.000	**594 per 1.000** (470 to 744)	**RR 1.15** (0.91 to 1.44)	240 (1 RCT)	⨁◯◯◯ VERY LOW [a,b,c]	
Incidence of WHO progression score (level 6 or above) - not reported	-	-	-	-	-	outcome not yet measured or reported
Incidence of WHO progression score (level 7 or above) - not reported	-	-	-	-	-	outcome not yet measured or reported
All-cause mortality D7				240 (1 RCT)	⨁◯◯◯ VERY LOW [b,d,e]	zero events in both groups
Adverse events D7	275 per 1.000	**358 per 1.000** (245 to 523)	**RR 1.30** (0.89 to 1.90)	240 (1 RCT)	⨁⨁◯◯ LOW [a,c,f]	

Serious adverse events D7		240 (1 RCT)	⊕◯◯◯ VERY LOW [a,d,f]	zero events in both groups

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio

GRADE Working Group grades of evidence

High certainty: We are very confident that the true effect lies close to that of the estimate of the effect

Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different

Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect

Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations

a. Risk of bias downgraded by 1 level: some concerns or high risk regarding adequate randomization, deviations from intended interventions and outcome measurement

b. Indirectness downgraded by 1 level: single study from a single country, therefore results in this population might not be generalizable to other settings

c. Imprecision downgraded by 1 level: due to wide confidence interval consistent with the possibility for benefit and the possibility for harm and low number of participants

d. Imprecision downgraded by 2 levels: no events in both groups and low number of participants

e. Risk of bias downgraded by 1 level: some concerns regarding adequate randomization and deviations from intended interventions

f. We presume that the adverse event rates, and the corresponding relative risks, is similar across diverse settings; therefore not downgraded for indirectness

Table 3.3-2: Summary of findings table on ***favipiravir compared to baloxavir marboxil*** *(1 RCT: Lou 2020) [69] -* https://covid-nma.com/living_data/index.php

Favipiravir compared to Baloxavir marboxil for Mild/COVID-19

Patient or population: Mild/COVID-19
Setting: Worldwide
Intervention: Favipiravir
Comparison: Baloxavir marboxil

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with Baloxavir marboxil	Risk with Favipiravir				
Incidence viral negative conversion D7	600 per 1.000	**402 per 1.000** (162 to 996)	**RR 0.67** (0.27 to 1.66)	20 (1 RCT)	⨁◯◯◯ VERY LOW [a,b,c]	
Incidence clinical Improvement D7	100 per 1.000	**200 per 1.000** (21 to 1.000)	**RR 2.00** (0.21 to 18.69)	20 (1 RCT)	⨁◯◯◯ VERY LOW [b,c,d]	
Incidence clinical Improvement D14-D28	600 per 1.000	**498 per 1.000** (222 to 1.000)	**RR 0.83** (0.37 to 1.85)	20 (1 RCT)	⨁◯◯◯ VERY LOW [b,c,d]	
Incidence of WHO progression score (level 6 or above D14-D28)	100 per 1.000	**33 per 1.000** (2 to 732)	**RR 0.33** (0.02 to 7.32)	20 (1 RCT)	⨁◯◯◯ VERY LOW [b,c,d]	
Incidence of WHO progression score (level 7 or above D14-D28)	100 per 1.000	**33 per 1.000** (2 to 732)	**RR 0.33** (0.02 to 7.32)	20 (1 RCT)	⨁◯◯◯ VERY LOW [a,b,c]	
All-cause mortality D7				20 (1 RCT)	⨁◯◯◯ VERY LOW [a,b,e]	zero events in both groups
All-cause mortality D14-D28				20 (1 RCT)	⨁◯◯◯ VERY LOW [a,b,e]	zero events in both groups
Adverse events - not reported	-	-	-	-	-	outcome not yet measured or reported
Serious adverse events D14-D28	600 per 1.000	**402 per 1.000** (162 to 996)	**RR 0.67** (0.27 to 1.66)	20 (1 RCT)	⨁⨁◯◯ LOW [d,f,g]	

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio

GRADE Working Group grades of evidence: High certainty: We are very confident that the true effect lies close to that of the estimate of the effect; **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different; **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect; **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations: a. Risk of bias downgraded by 1 level: some concerns regarding adequate randomization, deviations from intended interventions and selection of the reported results; b. Indirectness downgraded by 1 level: single study from a single institution, therefore results in this population might not be generalizable to other settings; c. Imprecision downgraded by 2 levels: due to very wide confidence interval consistent with the possibility for benefit and the possibility for harm and very low number of participants; d. Risk of bias downgraded by 1 level: some concerns regarding adequate randomization, deviations from intended interventions, measurement of the outcome and selection of the reported results; e. Imprecision downgraded by 2 levels: no events in both groups and very low number of participants; f. Indirectness not downgraded: we presume that adverse event rate is not specific to a certain setting; g. Imprecision downgraded by 1 level: due to wide confidence interval consistent with the possibility for benefit and the possibility for harm and very low number of participants

Table 3.3-3: Summary of findings table on favipiravir ***compared to lopinavir + ritonavir or darunavir/cobicistat + umifenovir + interferon-a*** *(1 RCT: Lou 2020) [69] - https://covid-nma.com/living_data/index.php*

Favipiravir compared to Lopinavir + Ritonavir or Darunavir/Cobicistat + Umifenovir + Interferon-a for Mild/COVID-19

Patient or population: Mild/COVID-19
Setting: Worldwide
Intervention: Favipiravir
Comparison: Lopinavir + Ritonavir or Darunavir/Cobicistat + Umifenovir + Interferon-a

Outcomes	Anticipated absolute effects* (95% CI) Risk with Lopinavir + Ritonavir or Darunavir/Cobicistat + Umifenovir + Interferon-a	Risk with Favipiravir	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
Incidence viral negative conversion D7	500 per 1.000	**400 per 1.000** (150 to 1.000)	**RR 0.80** (0.30 to 2.13)	20 (1 RCT)	⊕◯◯◯ VERY LOW [a,b,c]	
Incidence clinical Improvement D7	100 per 1.000	**200 per 1.000** (21 to 1.000)	**RR 2.00** (0.21 to 18.69)	20 (1 RCT)	⊕◯◯◯ VERY LOW [b,c,d]	
Incidence clinical Improvement D14-D28	500 per 1.000	**500 per 1.000** (210 to 1.000)	**RR 1.00** (0.42 to 2.40)	20 (1 RCT)	⊕◯◯◯ VERY LOW [b,c,d]	
Incidence of WHO progression score (level 6 or above D14-D28)				20 (1 RCT)	⊕◯◯◯ VERY LOW [b,d,e]	zero events in both groups
Incidence of WHO progression score (level 7 or above D14-D28)				20 (1 RCT)	⊕◯◯◯ VERY LOW [a,b,e]	zero events in both groups
All-cause mortality D7				20 (1 RCT)	⊕◯◯◯ VERY LOW [a,b,e]	zero events in both groups
All-cause mortality D14-D28				20 (1 RCT)	⊕◯◯◯ VERY LOW [a,b,e]	zero events in both groups
Adverse events - not reported	-	-	-	-	-	outcome not yet measured or reported
Serious adverse events D14-D28	400 per 1.000	**400 per 1.000** (136 to 1.000)	**RR 1.00** (0.34 to 2.93)	20 (1 RCT)	⊕⊕◯◯ LOW [d,f,g]	

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio

GRADE Working Group grades of evidence: High certainty: We are very confident that the true effect lies close to that of the estimate of the effect; **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different; **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect; **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations: a. Risk of bias downgraded by 1 level: some concerns regarding adequate randomization, deviations from intended interventions and selection of the reported results; b. Indirectness downgraded by 1 level: single study from a single institution, therefore results in this population might not be generalizable to other settings; c. Imprecision downgraded by 2 levels: due to very wide confidence interval consistent with the possibility for benefit and the possibility for harm and very low number of participants; d. Risk of bias downgraded by 1 level: some concerns regarding adequate randomization, deviations from intended interventions, measurement of the outcome and selection of the reported results; e. Imprecision downgraded by 2 levels: no events in both groups and very low number of participants; f. Indirectness not downgraded: we presume that adverse event rate is not specific to a certain setting; g. Imprecision downgraded by 1 level: due to wide confidence interval consistent with the possibility for benefit and the possibility for harm and very low number of participants

*Table 3.3-4: Summary of findings table on **favipiravir compared to standard care** (6 RCTs: Lou 2020, Ivashchenko 2020, Dabbous 2020, Balykova 2020, Ruzhentsova 2020, Udwadia 2020) - https://covid-nma.com/living_data/index.php*

Favipiravir compared to Standard care for Mild/Moderate/Unclear COVID-19

Patient or population: Mild/Moderate/Unclear COVID-19
Setting: Worldwide
Intervention: Favipiravir
Comparison: Standard care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with Standard care	Risk with Favipiravir				
Viral negative conversion D3	455 per 1,000	**555 per 1,000** (450 to 682)	**RR 1.22** (0.99 to 1.50)	318 (3 RCTs) [b]	⨁⨁◯◯ LOW [c,d]	
Viral negative conversion D7	688 per 1,000	**750 per 1,000** (653 to 867)	**RR 1.09** (0.95 to 1.26)	677 (6 RCTs) [e]	⨁◯◯◯ VERY LOW [c,d,f]	
Clinical improvement D7	221 per 1,000	**349 per 1,000** (254 to 477)	**RR 1.58** (1.15 to 2.16)	379 (3 RCTs) [g]	⨁⨁◯◯ LOW [h,i]	
Clinical improvement D14-28	895 per 1,000	**895 per 1,000** (868 to 931)	**RR 1.00** (0.97 to 1.04)	379 (4 RCTs) [j]	⨁⨁◯◯ LOW [h,i]	
WHO progression score (level 6 or above) D7	100 per 1,000	**300 per 1,000** (37 to 1,000)	**RR 3.00** (0.37 to 24.17)	20 (1 RCT) [k]	⨁◯◯◯ VERY LOW [l,m,n]	
WHO progression score (level 6 or above) D14-28	0 per 1,000	**0 per 1,000** (0 to 0)	not estimable	220 (2 RCTs) [o]	⨁◯◯◯ VERY LOW [l,p]	zero events in both groups
WHO progression score (level 7 or above) D7	0 per 1,000	**0 per 1,000** (0 to 0)	not estimable	20 (1 RCT) [k]	⨁◯◯◯ VERY LOW [m,p,q]	zero events in both groups
WHO progression score (level 7 or above) D14-28	0 per 1,000	**0 per 1,000** (0 to 0)	not estimable	220 (2 RCTs) [o]	⨁◯◯◯ VERY LOW [p,q]	zero events in both groups
All-cause mortality D7	6 per 1,000	**2 per 1,000** (0 to 50)	**RR 0.33** (0.01 to 7.99)	320 (3 RCTs) [r]	⨁◯◯◯ VERY LOW [n,q]	zero events in the intervention group
All-cause mortality D14-28	6 per 1,000	**2 per 1,000** (0 to 44)	**RR 0.32** (0.01 to 7.82)	360 (3 RCTs) [o]	⨁◯◯◯ VERY LOW [n,q]	zero events in the intervention group
Adverse events	298 per 1,000	**455 per 1,000** (259 to 800)	**RR 1.53** (0.87 to 2.69)	559 (3 RCTs) [o]	⨁◯◯◯ VERY LOW [j,s,t]	
Serious adverse events	22 per 1,000	**26 per 1,000** (10 to 64)	**RR 1.20** (0.48 to 2.99)	519 (4 RCTs) [o]	⨁◯◯◯ VERY LOW [l,n]	

*The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CI: Confidence interval; RR: Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

*The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).CI: Confidence interval; RR: Risk ratio

GRADE Working Group grades of evidence: High certainty: We are very confident that the true effect lies close to that of the estimate of the effect. Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different:Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect:Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations: a. Last update: December 4, 2020; b. Lou Y, 2020; Ruzhentsova T, 2020; Udwadia Z, 2020; c. Risk of bias downgraded by 1 level: some concerns regarding adequate randomization, deviation from intended intervention and selection of reported results; d. Imprecision downgraded by 1 level: due to wide confidence interval consistent with the possibility for benefit and the possibility for no effect; e. Balykova L, 2020; Dabbous HM, 2020; Ivashchenko AA, 2020; Lou Y, 2020; Ruzhentsova T, 2020; Udwadia Z, 2020; f. Inconsistency downgraded by 1 level: I^2=50.4%; g. Balykova L, 2020; Lou Y, 2020; Ruzhentsova T, 2020; h. Risk of bias downgraded by 1 level: some concerns regarding adequate randomization, deviation from intended intervention, outcome measurement and selection of reported results; i. Imprecision downgraded by 1 level: due to low number of events and/or participants; j. Ivashchenko AA, 2020; Lou Y, 2020; Ruzhentsova T, 2020; Udwadia Z, 2020; k. Lou Y, 202; l. Risk of bias downgraded by 1 level: some concerns regarding adequate randomization, deviations from intended intervention and outcome measurement; m. Indirectness downgraded by 1 level: single study from a single institution, therefore results in this population might not be generalizable to other settings; n. Imprecision downgraded by 2 levels: due to very wide confidence interval consistent with the possibility for benefit and the possibility for harm and low number of participants; o. Balykova L, 2020; Lou Y, 2020; p. Imprecision downgraded by 2 levels: no events in both groups and low number of participants; q. Risk of bias downgraded by 1 level: some concerns regarding adequate randomization and deviation from intended intervention; r. Balykova L, 2020; Dabbous HM, 2020; Lou Y, 2020; s. Inconsistency downgraded by 1 level: I^2=78.9%; t. Imprecision downgraded by 1 level: due to wide confidence interval consistent with the possibility for no effect and the possibility for harm

3.4 Darunavir

About the drug under consideration

antivirales Medikament

Darunavir is an antiviral agent from the group of human immunodeficiency virus (HIV) protease inhibitors for the treatment of HIV-1 infections. Darunavir is combined with a pharmacokinetic booster such as ritonavir or cobicistat [88].

als HIV Medikament zugelassen EMA 2007

Darunavir (Prezista®) has not been approved by the European Medicines Agency (EMA) or the American Food and Drug Administration (FDA) for COVID-19.

Empfehlungen des US COVID-19 Treatment Guidelines Panel GEGEN jegliche HIV Protease Inhibitoren

The US COVID-19 Treatment Guidelines Panel recommends **against** using the **Lopinavir/ritonavir (AI) or other HIV protease inhibitors (AIII),** except in a clinical trial, because of unfavorable pharmacodynamics and because clinical trials have not demonstrated a clinical benefit in patients with COVID-19 [69].

Withdrawn, suspended or terminated studies

keine weiteren Studien in ClinicalTrials.gov and EudraCT als abgeschlossen oder beendet registriert

The search in two clinical trial registers (ClinicalTrials.gov and EUdraCT) yielded no suspended, withdrawn or terminated RCTs in COVID-19.

Results of publications

Publikation zu RCT

bei milder Covid-19 Erkrankung DRV+IFN vs. IFN kein Unterschied

Chen J et al. 2020 [89] published results from single-center, randomized, open-label trial (**NCT04252274**) which aimed to evaluate the antiviral activity and safety of darunavir/cobicistat (DRV/c) in treating mild COVID-19 patients. Participants were randomized to receive DRV/c for 5 days on the top of interferon alpha 2b inhaling or interferon alpha 2b inhaling alone. DRV/c did not increase the proportion of negative conversion vs standard of care alone: the proportion of negative PCR results at day 7 was 46.7% (7/15) and 60.0% (9/15) in the DRV/c and control groups (p=0.72), respectively. The viral clearance rate at day 3 was 20% (3/15) in both study groups, while the number increased to 26.7% (4/15) in the DRV/c group and remained 20% (3/15) in the control group at day 5. Fourteen days after randomization, 1 participant in the DRV/c group progressed to critical illness and discontinued DRV/c, while all the patients in the control group were stable (p=1.0). The frequencies of adverse events in the two groups were comparable. The findings are presented in Table 3.4-1.

*Table 3.4-1: Summary of findings table on **darunavir/cobicistat compared to standard care** (1 RCT: Chen J) - https://covid-nma.com/living_data/index.php [89]*

Darunavir/cobistat compared to Standard Care for Moderate COVID-19

Patient or population: Moderate COVID-19
Setting: Worldwide
Intervention: Darunavir/cobistat
Comparison: Standard Care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with Standard Care	Risk with Darunavir/cobicistat				
Incidence of viral negative conversion D7	600 per 1.000	**468 per 1.000** (234 to 924)	**RR 0.78** (0.39 to 1.54)	30 (1 RCT)	⊕◯◯◯ VERY LOW [a,b,c]	
Clinical improvement - not reported	-	-	-	-	-	outcome not yet measured or reported
Clinical recovery - not reported	-	-	-	-	-	outcome not yet measured or reported
WHO progression score (level 6 or above) - not reported	-	-	-	-	-	outcome not yet measured or reported
WHO progression score (level 7 or above D7)	0 per 1.000	**0 per 1.000** (0 to 0)	**RR 3.00** (0.13 to 68.26)	30 (1 RCT)	⊕◯◯◯ VERY LOW [a,b,d]	zero events in control group
All-cause mortality D14-D28				30 (1 RCT)	⊕◯◯◯ VERY LOW [a,b,e]	zero events in both groups
Adverse events - not reported	-	-	-	-	-	outcome not yet measured or reported
Serious adverse events D14-D28				30 (1 RCT)	⊕◯◯◯ VERY LOW [e,f,g]	zero events in both groups

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio

GRADE Working Group grades of evidence: High certainty: We are very confident that the true effect lies close to that of the estimate of the effect; **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different; **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect; **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations: a. Risk of bias downgraded by 1 level: some concerns or high risk due to concerns during the randomization process, deviations from intended interventions and selection of the reported results; b. Indirectness downgraded by 1 level: single study from a single institution, therefore results in this population might not be generalizable to other settings; c. Imprecision downgraded by 2 levels: due to very wide confidence interval consistent with the possibility for benefit and the possibility for harm and very low number of participants; d. Imprecision downgraded by 2 levels: due to very wide confidence interval consistent with the possibility for benefit and the possibility for harm and very low number of participants e. Imprecision downgraded by 2 levels: no events in both groups and very low number of participants; f. Risk of bias downgraded by 2 levels: some concerns or high risk due to concerns during the randomization process, deviation from intended intervention, missing data and selection of reported results; g. We presume that the adverse event rates, and the corresponding relative risks, is similar across diverse settings, therefore not downgraded for indirectness

3.5 Chloroquine (Resochin®) and

3.6 Hydroxychloroquine (Plaquenil®)

wegen erwiesenem Mangel an Wirksamkeit wurde Beobachtung beendet

Due to the lack of effectiveness of chloroquine and hydroxychloroquine in treating COVID-19 patients; in the light of serious adverse effects as well as the decisions to stop enrolling participants to the hydroxychloroquine arm of the RECOVERY and SOLIDARITY trials, the reporting related to these two pharmaceuticals was stopped also.

Last reporting V4/ July:
https://eprints.aihta.at/1234/10/Policy_Brief_002_Update_07.2020.pdf

3.7 Camostat Mesilate (Foipan®)

About the drug under consideration

Protease-Inhibitor bei Entzündung der Bauchspeicheldrüse Zulassung: Japan, Süd-Korea

Camostat Mesilate (Foipan®) is classified as a so-called serine protease inhibitor, blocking several pancreatic and plasmatic enzymes like trypsin, thrombin and plasmin [90]. Studies showed effects on the cell-entry mechanism of coronaviruses (e.g. SARS-CoV and SARS-CoV-2) in in-vitro human cells [91, 92] as well as in pathogenic mice-models [93] by inhibiting the enzyme Transmembrane protease, serine 2 (TMPRSS2).

nicht EMA, FDA
FDA: Orphan Drug Designation seit 2011

Camostat Mesilate (Foipan®) ist not approved for any anti-viral use (FDA, EMA).

vom dt. BMG für schwere Erkrankungen zentral eingekauft

It is one of the drugs for which the German Federal Ministry of Health initiated centralized procurement in April 2020 for the treatment of infected and seriously ill COVID-19 patients in Germany (https://www.abda.de). Up to August 1, 2020, 35 to 60 Covid-19 patients have been treated with the centrally procured medicinal product Foipan (Camostat) as part of an individual medical treatment. There was no obligation for the treating physicians to collect data in a registry [94].

Withdrawn, suspended or terminated studies

in ClinicalTrials.gov and EUdraCT keine abgeschlossenen klinischen Studien registriert

One withdrawn RCT was found (NCT04338906) related to combination therapy camostat + hydroxychloroquine because hydroxychloroquine not being standard of care anymore); no suspended or terminated studies were found in ClinicalTrials.gov and EUdraCT registers.

Results of publications

Until now no scientific publication on a RCT of Camostat Mesilate (Foipan®) in Covid-19 patients could be identified.

3.8 APN01/ Recombinant Human Angiotensin-converting Enzyme 2 (rhACE2)

Drug under consideration

APN01 is a recombinant human Angiotensin Converting Enzyme 2 (rhACE2) developed by Apeiron Biologics under Phase 2 clinical development in ALI (Acute Lung Injury) and PAH (Pulmonal arterial hypertension) [95], [96], [97].

aus SARS-Forschung hervorgegangen

The therapy with APN01 is currently not approved by the European Medicine Agency (EMA) and Food and Drug Administraion (FDA) for COVID-19.

keine Zulassung
1 Studie (Phase 2 RCT), vor Rekrutierung

Withdrawn, suspended or terminated studies

One RCT number NCT04287686 is visible as withdrawn (without CDE Approval).

in ClinicalTrials.gov and EUdraCT keine abgeschlossene, aber eine zurückgezogene Studie registriert

Results of publications

No relevant finished publications or finished trials assessing the efficacy and safety could be identified. First results, related to a phase 2/3 study of hrsACE2 in 200 hospitalised patients with COVID-19, with primary composite outcome – All-cause mortality or invasive mechanical ventilation can be expected on the 10th of November 2020 (NCT04335136) [98].

keine Publikationen zu klinischen Studien

3.9 Tocilizumab (Roactemra®)

Drug under consideration

Tocilizumab (*RoActemra*) is a human monoclonal antibody that specifically binds to soluble and membrane-bound interleukin (IL)-6 receptors (IL-6Rα), and inhibits IL-6-mediated signalling [99].

Interleukin-6-Rezeptor für rheumatoide Arthritis zugelassen (EMA)

Tocilizumab is being investigated as a possible treatment for patients with moderate to severe or critical COVID-19. The therapy is currently not approved by the European Medicine Agency (EMA) and Food and Drug Administraion (FDA) for COVID-19.

The US COVID-19 Treatment Guidelines Panel **recommend against** anti-IL-6 receptor monoclonal antibodies (e.g., sarilumab, tocilizumab) or anti-IL-6 monoclonal antibody (siltuximab) (BI) for the treatment of COVID-19 [69], except in a clinical trial.

Empfehlungen des US COVID-19 Treatment Guidelines Panel: insuffiziente Datenlage, nur in klinischen Studien

Withdrawn, suspended or terminated studies

One withdrawn RCT (NCT04361552, in US, abandoned due to drug billing issues) and four terminated RCTs were found in ClinicalTrials.gov and EudraCT registers: NCT04346355, in Italy, based on interim analysis for futility and given an enrolment rate almost nil; RCT on 129 patients in Brazil compared tocilizumab vs best supportive care NCT04403685 (TOCIBRAS) due to safety issue; RCT NCT04322773, TOCIVID trial, due to changed clinical conditions and too few patients available; RCT NCT04335071 (CORON-ACT) in Switzerland because dexamethasone was included in the

1 beendeter RCT,
1 zurückgezogener (admin Gründe),
1 abgebrochener (Mangel an Rekrutierung)

standard care and planned number of patients was not possible to recruit in the planned study period).

Results of publications

COVACTA
4RCT, 52 Pts
schwere Erkrankung

kein Unterschied bei Mortalität, aber kürzer Zeit zur Erholung

Rosas et al. 2020 [100] reported results from the phase 3, RCT - **COVACTA** (**NCT04320615, EUdraCT 2020-001154-22**) as preprint: 452 patients with **severe COVID-19 pneumonia** were randomized; the modified-intention-to-treat population included 294 tocilizumab-treated and 144 placebo-treated patients. Clinical status at day 28 was not statistically significantly improved for tocilizumab versus placebo (p=0.36). Median (95% CI) ordinal scale values at day 28: 1.0 (1.0 to 1.0) for tocilizumab and 2.0 (1.0 to 4.0) for placebo (odds ratio, 1.19 [0.81 to 1.76]). There was no difference in mortality at day 28 between tocilizumab (19.7%) and placebo (19.4%) (difference, 0.3% [95% CI, –7.6 to 8.2]; nominal p=0.94). Median time to hospital discharge was 8 days shorter with tocilizumab than placebo (20.0 and 28.0, respectively; nominal p=0.037; hazard ratio 1.35 [95% CI 1.02 to 1.79]). Median duration of ICU stay was 5.8 days shorter with tocilizumab than placebo (9.8 and 15.5, respectively; nominal p=0.045). In the safety population, serious adverse events occurred in 34.9% of 295 patients in the tocilizumab arm and 38.5% of 143 in the placebo arm.

Wang (China)
65 Pts
schwere Erkrankung

Wang et al. 2020 [101] reported, as preprint, results from a small randomized, controlled, open-label, multicenter trial at 6 hospitals in Anhui and Hubei (**ChiCTR2000029765**). 65 **moderate to severe COVID-19 patients** were enrolled and randomly assigned to a treatment group (33 to tocilizumab and 32 to the controls). The cure rate in tocilizumab group was higher than that in the controls but not significant (94.12% vs 87.10%, p=0.4133). Adverse events were recorded in 20 (58.82%) of 34 tocilizumab recipients versus 4 (12.90%) of 31 in the controls. No serious adverse events were reported in tocilizumab group.

EMPACTA
389 Pts
RCT (US, SA,Kenya, Brasilien, Mexiko, Peru)
schwere Erkrankung

Vorteil bei Verhinderung im Fortschreiten der Erkrankung

bei weiteren Endpunkten: kein Unterschied

Salama et al. 2020 [102], reported as preprint, results from the phase III **EMPACTA** study (**NCT04372186**) (389 patients in the United States, South Africa, Kenya, Brazil, Mexico and Peru), showing that patients with **COVID-19 associated pneumonia** who received tocilizumab plus standard of care were 44% less likely to progress to mechanical ventilation or death compared to patients who received placebo plus standard of care (log-rank p-value = 0.0348; HR [95% CI] = 0.56 [0.32, 0.97]). The cumulative proportion of patients who progressed to mechanical ventilation or death by day 28 was 12.2% in tocilizumab arm versus 19.3% in the placebo arm. Key secondary outcomes (difference in time to hospital discharge or "ready for discharge" to day 28; difference in time to improvement in ordinal clinical status to day 28; time to clinical failure to day 28 and mortality by day 28) were not statisticaly significant different between groups. At day 28, incidence of infections was 10% and 11% in the tocilizumab and placebo arms, respectively, and the incidence of serious infections was 5.0% and 6.3% in tocilizumab and placebo arms, respectively. The most common adverse events in patients who received tocilizumab were constipation (5.6%), anxiety (5.2%), and headache (3.2%).

Hermine et al. 2020 [103] published the results from multicentre **CORIMUNO-TOCI-1** RCT (**NCT04331808**), which included 131 **moderate to severe COVID-19** patients (63 treated with tocilizumab, others in usual care group) in France, with follow-up through 28 days. In the TCZ group, 12 patients had a WHO-CPS score greater than 5 at day 4 vs 19 in the UC group (median posterior absolute risk difference [ARD] -9.0%; 90% credible interval [CrI], -21.0 to 3.1), with a posterior probability of negative ARD of 89.0% not achieving the 95% predefined efficacy threshold. At day 14, 12% (95% CI -28% to 4%) fewer patients needed noninvasive ventilation (NIV) or mechanical ventilation (MV) or died in the TCZ group than in the UC group (24% vs 36%, median posterior hazard ratio [HR] 0.58; 90% CrI, 0.33-1.00), with a posterior probability of HR less than 1 of 95.0%, achieving the predefined efficacy threshold. The HR for MV or death was 0.58 (90% CrI, 0.30 to 1.09). At day 28, 7 patients had died in the TCZ group and 8 in the UC group (adjusted HR, 0.92; 95% CI 0.33-2.53). Serious adverse events occurred in 20 (32%) patients in the TCZ group and 29 (43%) in the UC group (p=0.21).

CORIMUNO-TOCI-1
131 Pts.
moderate bis schwere Erkrankung

Vorteil bei Bedarf nach Beatmung
kein Unterschied bei Mortalität

Salvarani et al. 2020 [104] published results from multicentre RCT **(RCT-TCZ-COVID-19) (NCT04346355)** conducted on 126 **severe COVID-19 patients** in Italy (60 received tocilizumab). Seventeen patients of 60 (28.3%) in the tocilizumab arm and 17 of 63 (27.0%) in the standard care group showed clinical worsening within 14 days since randomization (rate ratio, 1.05; 95% CI, 0.59-1.86). Two patients in the experimental group and 1 in the control group died before 30 days from randomization, and 6 and 5 patients were intubated in the 2 groups, respectively. The trial was prematurely interrupted after an interim analysis for futility.

RCT-TCZ-COVID-19
126 Pts
schwere Erkrankung

kein Unterscheid, frühzeitiger Studienabbruch

Stone et al. 2020 [105] published results from multicentre RCT **(NCT04356937)** conducted on 243 **moderate to severe COVID-19 patients** in US (161 received tocilizumab). The hazard ratio for intubation or death in the tocilizumab group vs placebo group was 0.83 (95% confidence interval [CI], 0.38 to 1.81; p=0.64), and the hazard ratio for disease worsening was 1.11 (95% CI, 0.59 to 2.10; p=0.73). At 14 days, 18.0% of the patients in the tocilizumab group and 14.9% of the patients in the placebo group had worsening of disease. The median time to discontinuation of supplemental oxygen was 5.0 days (95% CI, 3.8 to 7.6) in the tocilizumab group vs 4.9 days (95% CI, 3.8 to 7.8) in the placebo group (p=0.69). At 14 days, 24.6% of the patients in the tocilizumab group and 21.2% of the patients in the placebo group were still receiving supplemental oxygen. Patients who received tocilizumab had fewer serious infections than patients who received placebo.

RCT 243
moderate bis schwere Erkrankung

keine oder klaum Unterschiede in einigen Endpunkten

Gordon et al. 2021 [106] published preliminary report as preprint, with positive results related to IL-6 receptor antagonist, tocilizumab and sarilumab, to improve outcome, including survival, in **criticall COVID-19 patients**. This is ongoing international, multifactorial, adaptive platform trial **(REMAP-CAP, NCT02735707)**, in which adult patients with criticall Covid-19, within 24 hours of commencing organ support in an intensive care unit, were randomized to receive either tocilizumab (8mg/kg) or sarilumab (400mg) or standard care (control). At the time of full analysis 353 patients had been assigned to tocilizumab, 48 to sarilumab and 402 to control. Median organ support-free days were 10 (interquartile range [IQR] -1, 16), 11 (IQR 0, 16) and 0 (IQR -1, 15) for tocilizumab, sarilumab and control, respectively. Relative to control, median adjusted odds ratios were 1.64 (95% credible intervals [CrI] 1.25, 2.14) for tocilizumab and 1.76 (95%CrI 1.17, 2.91) for sarilumab, yielding >99.9% and 99.5% posterior probabilities of superiority

REMAP-CAP Studienarm
353 Pts

Vorteile bei 90-Tages Überleben,
Zeit bis zur Intensivmedizin
Spitalsentlassung
klinische Verbesserung

compared with control. Hospital mortality was 28.0% (98/350) for tocilizumab, 22.2% (10/45) for sarilumab and 35.8% (142/397) for control. Tocilizumab and sarilumab were effective across all secondary outcomes, including 90-day survival, time to ICU and hospital discharge, and improvement in the World Health Organization (WHO) ordinal scale at day 14. There were nine serious adverse events reported in the tocilizumab group including one secondary bacterial infection, five bleeds, two cardiac events and one deterioration in vision. There were 11 serious adverse events in the control group, four bleeds and seven thromboses; and no serious adverse events in the sarilumab group.

Tocilizumab auch in RECOVERY 850 Pts

Tocilizumab continues to be evaluated in the **RECOVERY trial**. Because over 850 patients randomised to tocilizumab versus standard of care (almost twice the size of the COVACTA trial) will provide critical data to confirm or refute the COVACTA results [107].

Metaanalyse von 6 RCTs: sehr unsichere Evidenz: kein Vorteil bei Gesamtübeleben und SAE, ev. Vorteil bei klinischen Verbesserungen

Meta-analysis with Summary of findings table on tocilizumab compared to standard of care (related to **6 RCTs**) is presented in Table 3.9-1. According to currently available scientific evidence, tocilizumab compared to standard care/placebo probably does not reduce All-cause mortality D14-28 (RR 1.09, 95% CI 0.80 to 1.50, 5 RCTs, moderate certainty of evidence) and probably does not reduce incidence of Serious adverse events (RR 0.87, 95% CI 0.72 to 1.04, 6 RCTs, moderate certainty of evidence). Tocilizumab may not reduce WHO progression score level 6 or above D14-D28 (RR 0.80, 95% CI 0.59 to 1.09, 2 RCTs, low certainty of evidence) The evidence is very uncertain about the effect of tocilizumab on outcomes: Clinical improvement D14-28 (RR 1.03, 95% CI 0.96 to 1.10, 3 RCTs, very low certainty of evidence); WHO progression score level 7 or above D14-D28 (RR 0.82, 95% CI 0.50 to 1.35, 2 RCTs, very low certainty of evidence) and Adverse events (RR 1.26, 95% CI 0.81 to 1.96, 6 RCTs, very low certainty of evidence).

*Table 3.9-1: Summary of findings table on **tocilizumab compared standard care/placebo** (6 RCTs: Rosas, Wang, Hermine, Salvarani, Stone, Salama)*

Tocilizumab compared to Standard care/Placebo for Mild/Moderate/Severe/Critical COVID-19
Patient or population: Mild/Moderate/Severe/Critical COVID-19
Setting: Worldwide
Intervention: Tocilizumab
Comparison: Standard care/Placebo

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with Standard care/Placebo	Risk with Tocilizumab				
Viral negative conversion D3 - not reported	-	-	-	-	-	outcome not yet measured or reported
Viral negative conversion D7 - not reported	-	-	-	-	-	outcome not yet measured or reported
Clinical improvement D7	134 per 1,000	**191 per 1,000** (86 to 420)	**RR 1.42** (0.64 to 3.13)	130 (1 RCT) [b]	⨁◯◯◯ VERY LOW [c,d,e]	
Clinical improvement D14-28	844 per 1,000	**870 per 1,000** (811 to 929)	**RR 1.03** (0.96 to 1.10)	486 (3 RCTs) [f]	⨁◯◯◯ VERY LOW [c,g,h]	
WHO progression score (level 6 or above) D7	518 per 1,000	**467 per 1,000** (404 to 544)	**RR 0.90** (0.78 to 1.05)	582 (2 RCTs) [i]	⨁⨁◯◯ LOW [g,h]	
WHO progression score (level 6 or above) D14-D28	335 per 1,000	**268 per 1,000** (198 to 365)	**RR 0.80** (0.59 to 1.09)	582 (2 RCTs) [i]	⨁⨁◯◯ LOW [g,j]	
WHO progression score (level 7 or above) D7	399 per 1,000	**347 per 1,000** (247 to 487)	**RR 0.87** (0.62 to 1.22)	582 (2 RCTs) [i]	⨁⨁◯◯ LOW [g,j]	
WHO progression score (level 7 or above) D14-D28	294 per 1,000	**241 per 1,000** (147 to 396)	**RR 0.82** (0.50 to 1.35)	582 (2 RCTs) [i]	⨁◯◯◯ VERY LOW [e,g]	
All-cause mortality D7	73 per 1,000	**79 per 1,000** (43 to 143)	**RR 1.07** (0.59 to 1.95)	582 (2 RCTs) [i]	⨁◯◯◯ VERY LOW [e,g]	
All-cause mortality D14-D28	104 per 1,000	**113 per 1,000** (83 to 155)	**RR 1.09** (0.80 to 1.50)	1336 (5 RCTs) [k]	⨁⨁⨁◯ MODERATE [l]	
All-cause mortality D60	133 per 1,000	**114 per 1,000** (70 to 187)	**RR 0.86** (0.53 to 1.41)	518 (2 RCTs) [m]	⨁⨁◯◯ LOW [e]	
All-cause mortality D90	164 per 1,000	**112 per 1,000** (46 to 269)	**RR 0.68** (0.28 to 1.64)	130 (1 RCT) [b]	⨁◯◯◯ VERY LOW [d,e]	
Adverse events	475 per 1,000	**599 per 1,000** (385 to 931)	**RR 1.26** (0.81 to 1.96)	1401 (6 RCTs) [n]	⨁◯◯◯ VERY LOW [i,o,p]	
Serious adverse events	250 per 1,000	**218 per 1,000** (180 to 260)	**RR 0.87** (0.72 to 1.04)	1401 (6 RCTs) [n]	⨁⨁⨁◯ MODERATE [j]	

*The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CI: Confidence interval; **RR**: Risk ratio

GRADE Working Group grades of evidence: High certainty: We are very confident that the true effect lies close to that of the estimate of the effect; **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different; **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect; **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations: a. Last update: November 23, 2020; b. Hermine O, 2020; c. Risk of bias downgraded by 1 level: some concerns regarding deviation from intended interventions and outcome measurement; d. Indirectness downgraded by 1 level: despite a multicentre design this is a single study from a single country, therefore results in this population might not be generalizable to other settings; e. Imprecision downgraded by 2 levels: due to low number of events and a wide confidence interval consistent with the possibility for benefit and the possibility for harm; f. Stone JH, 2020; Hermine O, 2020; Salvarani C, 2020; g. Indirectness downgraded by 1 level: small studies only from high-income countries, therefore results in this population might not be generalizable to other settings; h. Imprecision downgraded by 1 level: due to low number of events and participants; i. Hermine O, 2020; Rosas I, 2020; j. Imprecision downgraded by 1 level: due to low number of events and a wide confidence interval consistent with the possibility for benefit and the possibility for no effect; k. Stone JH, 2020; Hermine O, 2020; Rosas I, 2020; Salama C, 2020; Salvarani C, 2020; l. Imprecision downgraded by 1 level: due to a wide confidence interval consistent with the possibility for no effect and the possibility for harm; m. Hermine O, 2020; Salama C, 2020; n. Stone JH,

2020; Hermine O, 2020; Wang D, 2020; Rosas I, 2020; Salama C, 2020; Salvarani C, 2020; o. Risk of bias downgraded by 1 level: some concerns regarding randomization, deviations from intended interventions, outcome measurement and selection of reported result; p. Inconsistency downgraded by 1 level: I^2=91.5%

3.10 Sarilumab (Kevzara®)

Drug under consideration

Sarilumab (*Kevzara*) is a human monoclonal antibody that specifically binds to soluble and membrane-bound interleukin (IL)-6 receptors (IL-6Rα), and inhibits IL-6-mediated signalling [108]. It is being investigated as a possible treatment for patients with moderate to severe or critical COVID-19. The therapy is currently not approved by the European Medicine Agency (EMA) and Food and Drug Administraion (FDA) for COVID-19.

Interleukin-6-Rezeptor für rheumatoide Arthritis zugelassen (EMA)

Covid-10: bei erhöhten IL-6-Spiegeln

The US COVID-19 Treatment Guidelines Panel **recommend against** anti-IL-6 receptor monoclonal antibodies (e.g., sarilumab, tocilizumab) or anti-IL-6 monoclonal antibody (siltuximab) (BI) for the treatment of COVID-19 [69], except in a clinical trial.

Empfehlung des US COVID-19 Treatment Guidelines Panel: insuffiziente Datenlage, nur in klinischen Studien

Withdrawn, suspended or terminated studies

One RCT found as suspended, NCT04341870 - CORIMUNO-VIRO Trial (DSMB recommendation (futility)). One RCT found as terminated, NCT04322773 (TOCIVID) in Denmark, due to changed clinical conditions and too few patients available).

Results of publications

On July 03, 2020 in press release related to sarilumab RCT conducted in US, https://www.clinicaltrialsarena.com/news/kevzara-us-covid19-trial-data/, Sanofi and Regeneron Pharmaceuticals have reported that this phase III clinical trial of sarilumab, compared 400mg dose of the drug plus best supportive care to best supportive care alone, failed to meet its primary and key secondary endpoints in 194 **critically ill Covid-19 patients** who required mechanical ventilation in the US. In the primary analysis arm, adverse events were reported in 80% of patients treated with sarilumab and 77% of those on placebo. Serious adverse events in at least 3% of patients, more frequent among sarilumab patients, were multi-organ dysfunction syndrome and hypotension. Based on the data, the companies have halted this US-based trial, including a second cohort of patients who were on a higher 800mg dose of the drug. The trial being conducted outside of the US is continuing, in hospitalised patients with severe and critical Covid-19 using a different dosing regimen.

Juli 2020: Pressemeldung zu RCT mit 194 Pts

kein Unterschied mehr SAE in Sarilumab Gruppe

As already described in Tocilizumab Section above, **Gordon et al. 2021 [106](REMAP-CAP, NCT02735707)** published preliminary report as preprint, with positive results related to IL-6 receptor antagonist, tocilizumab and sarilumab, to improve outcome, including survival, in **criticall COVID-19 patients** who were randomised to receive either tocilizumab (8mg/kg) or sarilumab (400mg) or standard care (control). At the time of full analysis 353 patients had been assigned to tocilizumab, 48 to sarilumab and 402 to control. Median organ support-free days were 11 (IQR 0, 16) sarilumab and and 0 (IQR -1, 15) for control. Relative to control, median adjusted odds ratio was 1.76 (95%CrI 1.17, 2.91) for sarilumab, compared with control. Hospital mortality was 22.2% (10/45) for sarilumab and 35.8% (142/397) for control. All secondary outcomes and analyses supported efficacy of these IL-6 receptor antagonists. There were no serious adverse events in the sarilumab group.

REMAP-CAP Studienarm 48 Pts.

Vorteile bei Soitalsmortalität, 90-Tages Überleben, Zeit bis zur Intensivmedizin Spitalsentlassung klinische Verbesserung

3.11 Interferon beta 1a (SNG001) (Rebif®, Avonex®) and Interferon beta 1b (Betaferon®, Extavia®)

About the drug under consideration

Interferon beta-1a (INFb) is a cytokine in the interferon family used to treat relapsing multiple sclerosis (MS). Finding of studies in patients with MERS-CoV have led to exploration of treatment with INFb in COVID-19 [109].

INFb Präparate bei Multipler Sklerose zugelassen (EMA)

Two pharmaceuticals which the active substance Interferon beta-1a are commercially available: Rebif® and Avonex®. They are used to slow the progression of disability and reduce the number of relapses in MS. Rebif is approved by the European Medicines Agency (EMA) since 1998 and by the American Food and Drug Administration (FDA) since 2002. Avonex is approved by EMA since 1997 and by the FDA since 1996. Both drugs are approved for the treatment of relapsing forms of multiple sclerosis (MS), in cases of clinically isolated syndromes, as well as relapsing remitting disease, and active secondary progressive disease in adults.

Interferon beta-1a: Rebif® Avonex® seit 1997/1998 zugelassen

nicht für Covid-19

Two pharmaceuticals, with the active substance Interferon beta-1b, are commercially available in EU: Betaferon® and Extavia® to treat adults with multiple sclerosis (MS) [110, 111]. Betaferon® is approved by the European Medicines Agency (EMA) since 1995. Extavia® is approved by EMA since 2008. Interferon beta-1a and beta-1b are not approved for COVID-19 patients treatment.

Interferon beta-1b: Betaferon® and Extavia® seit 1995/2008 zugelassen nicht für Covid-19

The US COVID-19 Treatment Guidelines Panel [69] **recommends against** use of the **interferons (alfa or beta)** for the treatment of **severely or critically ill** patients with COVID-19, except in the context of a clinical trial (AIII).

Empfehlung des US COVID-19 Treatment Guidelines Panel: nur in klinischen Studien

There are **insufficient data** for the Panel to recommend **either for or against** the use of the **Interferon-beta** for the treatment of early (i.e., <7 days from symptom onset) **mild and moderate** COVID-19.

Withdrawn, suspended or terminated studies

One RCT was found as suspended, NCT04469491 (COV-NI), on interferon beta 1b by nebulization in France (in anticipation for Data and Safety Monitoring Board).

Results of publications

The results from the first randomised controlled trial on triple combination of interferon beta-1b, lopinavir–ritonavir and ribavirin, in comparison with lopinavir–ritonavir (**NCT04276688**) are presented in Section 3.14 of this report [112].

Kombinationstherapie: Ergebnisse in 3.14

Results from **Huang et al. 2020** (**ChiCTR2000029387**) [113] related to Ribavirin Plus Interferon-Alpha, Lopinavir/Ritonavir Plus Interferon-Alpha, and Ribavirin Plus Lopinavir/Ritonavir Plus Interferon-Alpha in Patients With Mild to Moderate COVID-19 were presented in Section 3.14 of this report.

August 2020: 2 RCTs publiziert 1 RCT zu Kombinations-therapie in 3.14

Esquivel-Moynelo et al. 2020 [114] presented the results from a RCT for efficacy and safety evaluation of subcutaneous IFN -α2b and IFNγ administration in 79 patients positive to SARS-CoV-2. Patients were randomly assigned in a 1:1 ratio to receive either, subcutaneous treatment with a combination of 3.0 MIU IFN-α2b and 0.5 MIU IFN-γ, twice a week for two weeks, or thrice a week intramuscular injection of 3.0 MIU IFN-α2b. Additionally, all patients received lopinavir-ritonavir 200/50 mg every 12 h and chloroquine 250 mg every 12 h (standard of care). None of the patients developed severe COVID-19 during the study or the epidemiological follow-up for 21 more days.

1 RCT
79 Pts.
Kombinationstherapie IFN (unterscheidliche Dosierungen) + Kaletra

79 symptomatische/ asymptomatische Pts.

Monk et al. 2020 published results from randomised, double-blind, placebo-controlled, phase 2 pilot trial at nine UK sites (NCT04385095) [115]. 101 COVId-19 hospitalized adult patients were randomly assigned (1:1) to receive **inhaled nebulised interferon beta-1a** (SNG001) (6 MIU) or placebo by inhalation via a mouthpiece daily for 14 days. 66 (67%) patients required oxygen supplementation at baseline: 29 in the placebo group and 37 in the SNG001 group. Patients receiving SNG001 had greater odds of improvement on the OSCI scale (odds ratio 2·32 [95% CI 1·07–5·04]; p=0·033) on day 15 or 16 and were more likely than those receiving placebo to recover to an OSCI score of 1 (no limitation of activities) during treatment (hazard ratio 2·19 [95% CI 1·03–4·69]; p=0·043). No significant difference was found between treatment groups in the odds of hospital discharge by day 28: 39 (81%) of 48 patients had been discharged in the nebulised interferon beta-1a group compared with 36 (75%) of 48 in the placebo group (OR 1·84 [95% CI 0·64–5·29]; p=0·26). There was no significant difference between treatment groups in the odds of intubation or the time to intubation or death. SNG001 was well tolerated: the most frequently reported treatment-emergent adverse event was headache (seven [15%] patients in the SNG001 group and five [10%] in the placebo group). There were three deaths in the placebo group and none in the SNG001 group.

1 RCT
101 Pts
inhaltiertes INF

Vorteil bei klinischen Verbesserungen, nicht aber bei Dauer des Spitalsaufenthalts

Davoudi-Monfared et al. 2020 published results related to the RCT on Interferon beta-1a treatment (n=46) **vs** the **standard of care** (n=46), in 92 patients with severe COVID-19 in Iran **(IRCT20100228003449N28)** [116]. Finally 81 patients (42 in the IFN and 39 in the control group) completed the study. Time to the clinical response was not significantly different between the IFN and the control groups (9.7 +/- 5.8 vs. 8.3 +/- 4.9 days respectively, P=0.95). On day 14, 66.7% vs. 43.6% of patients in the IFN group and the control group were discharged, respectively (OR= 2.5; 95% CI: 1.05- 6.37). The 28-day overall mortality was significantly lower in the IFN then the control group (19% vs. 43.6% respectively, p= 0.015). Early administration significantly reduced mortality (OR=13.5; 95% CI: 1.5-118).

RCT (Iran)
92 Pts

Reduktion der 28-Tages Mortalität insb. bei früher Verabreichung von IFN

Rahmani et al. 2020 [117] published the results of RCT evaluated efficacy and safety of interferon (IFN) β-1b in the treatment of 80 patients with severe COVID-19 (**IRCT20100228003449N27**). Patients in the IFN group received IFN β-1b (250 mcg subcutaneously every other day for two consecutive weeks) along with the national protocol medications while in the control group, patients received only the national protocol medications (lopinavir/ritonavir or atazanavir/ritonavir plus hydroxychloroquine for 7–10 days). 33 patients in each group completed the study. Time to clinical improvment in the IFN group was significantly shorter than the control group ([9(6–10) vs. 11(9–15) days respectively, p = 0.002, HR = 2.30; 95% CI: 1.33–3.39]). At day 14, the percentage of discharged patients was 78.79% and 54.55% in the IFN and control groups respectively (OR = 3.09; 95% CI: 1.05–9.11, p = 0.03). ICU

RCT (Iran)
80 Pts
Zeit zur klinischen Verbesserung signifikant kürzer mit IFN, weniger ICU Einweisungen

nicht aber Dauer der Hospitalisierung und in ICU

admission rate in the control group was significantly higher than the IFN group (66.66% vs. 42.42%, p = 0.04). The duration of hospitalization and ICU stay were not significantly different between the groups. All-cause 28-day mortality was 6.06% and 18.18% in the IFN and control groups respectively (p = 0.12).

SOLIDARITY
651 Pts INF + lopinavir, 1.412 Pts. nur INF

keine Unterscheide bei den Endpunkten

In **SOLIDARITY (INF)** RCT (**ISRCTN83971151**) results on comparisons of subcutaneous interferon beta-1a vs standard care in patients with mild to critical COVID-19 admitted to 405 centers in 30 countries were published as preprint [68, 74]. In 11,266 adults were randomized, with 2750 allocated remdesivir, 954 hydroxychloroquine, 1411 lopinavir, 651 interferon plus lopinavir, 1412 only interferon, and 4088 no study drug. Death rate ratio for interferon was not statistically significant different in comparision with control group: RR=1.16 (0.96-1.39, p=0.11; 243/2050 vs 216/2050) (or 1.12, 0.83-1.51, without lopinavir co-administration). The same is true for outcomes Initiation of ventilation or Hospitalisation duration.

sehr niedrige Evidenz: Vorteile bei Gesamtmortalität

Summary of Findings table related to **meta-analysis** on results of **3 RCTs** (Davoudi-Monfared, Rahmani, SOLIDARITY-INF), on comparisons of **interferon beta-1a vs standard of care** in patients with moderate/severe/critical COVID-19 patients, is presented in Table 3.11-1. In summary, according to currently available very low certainty of evidence, the evidence is very uncertain about the effect of interferon beta-1a on outcomes: WHO progression score level 6 or above D14-D28 (RR 0.46, 95% CI 0.24 to 0.90, 2 RCTs): WHO progression score level 7 or above D14-D28 (RR 0.46, 95% CI 0.24 to 0.90, 2 RCTs); All-cause mortality D7 (RR 0.11, 95% CI 0.01 to 0.91, 2 RCTs) and All-cause mortality D14-28 (RR 0.68, 95% CI 0.32 to 1.45, 3 RCTs).

Table 3.11-1: Summary of findings table on ***Interferon β-1a compared to Standard Care for Moderate/Severe/Critical COVID-19*** *(3 RCTs: Davoudi-Monfared, Rahmani, SOLIDARITY-INF) – https://covid-nma.com/living_data/index.php*

Interferon β compared to Standard Care for Moderate/Severe/Critical COVID-19

Patient or population: Moderate/Severe/Critical COVID-19
Setting: Worldwide
Intervention: Interferon β
Comparison: Standard Care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with Standard Care	Risk with Interferon β				
Viral negative conversion - not reported	-	-	-	-	-	outcome not yet measured or reported
Clinical improvement - not reported	-	-	-	-	-	outcome not yet measured or reported
WHO progression score level 6 or above D7	293 per 1,000	**149 per 1,000** (59 to 375)	**RR 0.51** (0.20 to 1.28)	165 (2 RCTs) [b]	⨁◯◯◯ VERY LOW [c,d,e]	
WHO progression score level 6 or above D14-D28	268 per 1,000	**123 per 1,000** (64 to 241)	**RR 0.46** (0.24 to 0.90)	165 (2 RCTs) [b]	⨁◯◯◯ VERY LOW [c,d,f]	
WHO progression score level 7 or above D7	256 per 1,000	**149 per 1,000** (79 to 277)	**RR 0.58** (0.31 to 1.08)	165 (2 RCTs) [b]	⨁◯◯◯ VERY LOW [c,g,h]	
WHO progression score level 7 or above D14-D28	268 per 1,000	**123 per 1,000** (64 to 241)	**RR 0.46** (0.24 to 0.90)	165 (2 RCTs) [b]	⨁◯◯◯ VERY LOW [c,f,g]	
All-cause mortality D7	134 per 1,000	**15 per 1,000** (1 to 122)	**RR 0.11** (0.01 to 0.91)	165 (2 RCTs) [b]	⨁◯◯◯ VERY LOW [c,f,g]	
All-cause mortality D14-D28	112 per 1,000	**76 per 1,000** (36 to 163)	**RR 0.68** (0.32 to 1.45)	4265 (3 RCTs) [i]	⨁◯◯◯ VERY LOW [g,j,k]	
Adverse events - not reported	-	-	-	-	-	outcome not yet measured or reported
Serious adverse events - not reported	-	-	-	-	-	outcome not yet measured or reported

*The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CI: Confidence interval; RR: Risk ratio

GRADE Working Group grades of evidence: High certainty: We are very confident that the true effect lies close to that of the estimate of the effect; **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different; **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect; **Very low certainty**: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations: a. Last update: November 10, 2020; b. Davoudi-Monfared E, 2020; Rahmani H, 2020; c. Risk of bias downgraded by 2 levels: some concerns regarding adequate randomization, outcome measurement and selection of reported results, and high risk regarding deviations from intended interventions and missing data; d. Indirectness downgraded by 1 level: studies from a single country, therefore results in this population might not be generalizable to other settings; e. Imprecision downgraded by 2 levels: due to wide confidence interval consistent with the possibility for benefit and the possibility for harm and low number of participants and events; f. Imprecision downgraded by 1 level: due to low number of events and/or participants; g. Risk of bias downgraded by 2 levels: some concerns regarding adequate randomization and selection of reported results, and high risk regarding deviations from intended interventions and missing data; h. Imprecision downgraded by 1 level: due to wide confidence interval consistent with the possibility for benefit and the possibility for no effect and low number of participants and events; i. Davoudi-Monfared E, 2020; Rahmani H, 2020; SOLIDARITY, 2020; j. Inconsistency downgraded by 1 level: I^2=71.2%; k. Imprecision downgraded by 2 levels: due to wide confidence interval consistent with the possibility for benefit and the possibility for harm

3.12 Convalescent plasma transfusion

About the treatment under consideration

Convalescent plasma is plasma collected from patients that have recovered from an infectious disease and can be transfused to patients fighting an infection or can be used to manufacture immune globulin concentrates (plasma derived medicinal products). Possible explanations for the efficacy are that the antibodies from convalescent plasma might suppress viraemia and activate the complement system, thus promoting viral elimination. Antibody is most effective when administered shortly after the onset of symptoms, and a sufficient amount of antibody must be administered. Plasma transfusions may be associated with transfusion reactions such as allergic reactions, antibody-mediated enhancement of infection, transfusion-related acute lung injury (TRALI) and circulatory overload [118-120]. Rare complications include the transmission of infectious pathogens and red cell alloimmunization.

(Re-) Konvaleszenzplasma von covid-19 Patient*innen, die sich von der Erkrankung bereits erholt haben

auch zur Herstellung von Immunglobulin-konzentraten verwendet

The European Commission (EC) and US Food and Drug Administration (FDA) published guidance on convalescent plasma collected from individuals who have recovered from COVID-19 [121, 122]. The EC guidance aims to facilitate a common approach across EU Member States to the donation, collection, testing, processing, storage, distribution and monitoring of convalescent plasma for the treatment of Covid-19 [121]. The FDA guidance provides recommendations on the pathways for use of investigational COVID-19 convalescent plasma; patient eligibility; collection of COVID-19 convalescent plasma, including donor eligibility and donor qualifications; labeling and record keeping. As COVID-19 convalescent plasma is regulated as an investigational product, three patways for use are available in US: 1. Clinical Trials; 2. Expanded Access; 3. Single Patient Emergency IND [122, 123].

EMA & FDA Guidance zu CVP

On August 23, 2020 the FDA issued an **emergency use authorization (EUA)** for investigational convalescent plasma for the treatment of COVID-19 in hospitalized patients [124].

FDA im August 2020: Emergency Authorization

Current US **NIH COVID-19 Treatment Guidelines** stated that there are insufficient clinical data to recommend either for or against the use of convalescent plasma for the treatment of COVID-19 (last update October 9, 2020) [125].

US NIH COVID-19 Treatment Guidelines: insuffiziente Datenlage weder für noch gegen CVP

Withdrawn, suspended or terminated studies

1 RCT was found as withdrawn in US, NCT04467151 (did not obtain funding to proceed) and 1 RCT found as terminated in Italy, NCT04393727, the Promoter was changed and a new study promoted by AIFA started).

Results of publications

Li et al. 2020 published results from RCT (**ChiCTR200029757**) [126] conducted in 103 patients with COVID-19 (severe to critical) admitted to 7 centers in China. Convalescent plasma therapy added to standard treatment, compared with standard treatment alone, did not result in a statistically significant improvement in time to clinical improvement within 28 days (51.9% (27/52) of the convalescent plasma group vs 43.1% (22/51) in the control group (difference, 8.8% [95% CI, −10.4% to 28.0%]; hazard ratio

Li (China) RCT, 103 Pts (statt 200, wegen Mangel an Pts)

keine Unterschiede bei Endpunkten

[HR], 1.40 [95% CI, 0.79-2.49]; p =0.26). Among those with severe disease, the primary outcome was statistically significant in favour of convalescent plasma (91.3% (21/23) vs 68.2% (15/22) of the control group (HR, 2.15 [95% CI, 1.07-4.32]; p = 0.03); among those with life-threatening disease the primary outcome occurred in 20.7% (6/29) of the convalescent plasma group vs 24.1% (7/29) of the control group (HR, 0.88 [95% CI, 0.30-2.63]; p = 0.83) (P for interaction = 0.17). There was no significant difference in 28-day mortality (15.7% vs 24.0%; OR, 0.65 [95% CI, 0.29-1.46]; p =0.30) or time from randomization to discharge (51.0% vs 36.0% discharged by day 28; HR, 1.61 [95% CI, 0.88-2.93]; p = 0.12). Two patients in the convalescent plasma group experienced adverse events within hours after transfusion that improved with supportive care. Interpretation of results is limited by early termination of the trial, which may have been underpowered to detect a clinically important difference.

RCT (Niederlande): 86 Pts.,

Gharbharan et al. 2020 [127], published results as **preprint,** from prematurely **halted RCT** (**NCT04342182**), performed on 86 patients with COVID-19 (moderate-critical) admitted to 14 centers in the Netherlands [127].

Sept 2020: Publikation zu RCT CVP vs. SOC

frühzeitiger Abbruch wegen Mangel an Rekrutierung: Interim Analyse von 81 Pts

Avendano-Sola et al. 2020 published as **preprint,** results of multi-center RCT (**NCT04345523**) [128]: All patients received standard of care treatment, including off-label use of marketed medicines, and were randomized 1:1 to receive one dose (250-300 mL) of CP from donors with IgG anti-SARS-CoV-2. The trial was stopped after first interim analysis due to the fall in recruitment related to pandemic control. With 81 patients randomized, there were no patients progressing to mechanical ventilation or death among the 38 patients assigned to receive plasma (0%) versus 6 out of 43 patients (14%) progressing in control arm. Mortality rates were 0% vs 9.3% at days 15 and 29 for the active and control groups, respectively. No significant differences were found in secondary endpoints.

Okt 2020
preprint RCT (open-label)
Indien
464 Pts

kein Unterschied bei Mortalität oder Fortschreiten der Krankheit

Agarwal et al. 2020 [129] [130] reported results from open-label, parallel-arm, phase 2, multicentre, randomized controlled trial in India (**CTRI/2020/04/024775**) conducted on hospitalized, moderately ill confirmed COVID-19 patients (PaO2/FiO2: 200-300 or respiratory rate > 24/min and SpO2 ≤ 93% on room air). 464 participants were enrolled; 235 and 229 in intervention and control arm, respectively. Composite primary outcome (progression to severe disease or all cause mortality at 28 days) was achieved in 44 (19%) participants in the intervention arm and 41 (18%) in the control arm (risk difference 0.008 (95% confidence interval -0.062 to 0.078); risk ratio 1.04, 95% confidence interval 0.71 to 1.54

preprint RCT (open-label)
Chile
58 Pts

kein Unterschied bei Mortalität, Dauer des Krankenhausaufenthalts und künstlicher Beatmung

Balcells et al. 2020 [131] reported, as preprint, results from open-label, single-center, randomized clinical trial performed in an academic center in Santiago, Chile, including 58 patients (**NCT04375098**). No benefit was found in the primary outcome (32.1% vs 33.3%, OR 0.95, 95% CI 0.32-2.84, p>0.99) in the early versus deferred CP group. In-hospital mortality rate was 17.9% vs 6.7% (OR 3.04, 95% CI 0.54-17.2, p=0.25), mechanical ventilation 17.9% vs 6.7% (OR 3.04, 95% CI 0.54-17.2, p=0.25), and prolonged hospitalization 21.4% vs 30% (OR 0.64, 95%CI, 0.19-2.1, p=0.55) in early versus deferred CP group, respectively. Viral clearance rate on day 3 (26% vs 8%, p=0.20) and day 7(38% vs 19%, p=0.37) did not differ between groups. Two patients experienced serious adverse events within 6 or less hours after plasma transfusion.

Simonovich et al 2020 [132] published results from RCT (NCT04383535) in hospitalised adult patients with severe Covid-19 pneumonia. A total of 228 patients were assigned to receive convalescent plasma and 105 to receive placebo. The median time from the onset of symptoms to enrollment in the trial was 8 days (interquartile range, 5 to 10), and hypoxemia was the most frequent severity criterion for enrollment. The infused convalescent plasma had a median titer of 1:3200 of total SARS-CoV-2 antibodies (interquartile range, 1:800 to 1:3200]. At day 30 day, no significant difference was noted between the convalescent plasma group and the placebo group in the distribution of clinical outcomes according to the ordinal scale (odds ratio, 0.83 (95% confidence interval [CI], 0.52 to 1.35; p=0.46). Overall mortality was 10.96% in the convalescent plasma group and 11.43% in the placebo group, for a risk difference of -0.46 percentage points (95% CI, -7.8 to 6.8). Adverse events and serious adverse events were similar in the two groups.

RCT
228 Patient*innen
kein Unterschied

Libster et al. 2021 [133] published results from randomised, double-blind, placebo-controlled trial of convalescent plasma with high IgG titers against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in older adult patients within 72 hours after the onset of **mild Covid-19** symptoms (NCT04479163; PAEPCC19; Plataforma PRIISA (1421)). The trial was stopped early at 76% of its projected sample size because cases of Covid-19 in the trial region decreased considerably and steady enrollment of trial patients became virtually impossible. A total of 160 patients underwent randomisation. In the intention-to-treat population, severe respiratory disease developed in 13 of 80 patients (16%) who received convalescent plasma and 25 of 80 patients (31%) who received placebo (relative risk, 0.52; 95% confidence interval [CI], 0.29 to 0.94; p=0.03), with a relative risk reduction of 48%. A modified intention-to-treat analysis that excluded 6 patients who had a primary end-point event before infusion of convalescent plasma or placebo showed a larger effect size (relative risk, 0.40; 95% CI, 0.20 to 0.81). No solicited adverse events were observed.

RCT 160 Pts
milde Erkrankung

Vorteile bei Fortschreiten zu schwerer Atemwegserkrankung

keine Nebenwirkungen

Two more RCTs was found as preprint publications: AlQahtani et al. 2020 (NCT04356534); and Ray et al. 2020 (CTRI/2020/05/025209); results will be presented after peer-review publication. The **Living Systematic Review with meta-analysis**, related to **seven RCTs:** Li et al. 2020 [126], Gharbharan et al. 2020 [127], Avendano-Sola et al. 2020 [141], Agarwal et al. 2020 [129], Simonovich [132], AlQahtani et al. 2020 and Libster et al. 2020 with **Summary of findings** table is provided in Table 3.12-1.

2 weitere RCTs in preprint

in SoF Tabelle präsentiert

In summary, according to currently available evidence, convalescent plasma may not reduce All-cause mortality D14-D28 (RR 0.86, 95% CI 0.63 to 1.18, 6 RCTs, low certainty of evidence); may not increase incidence of Clinical improvement D14-D28 (RR 1.06, 95% CI 0.92 to 1.23, 3 RCTs, low certainty of evidence); may not decrease WHO progression score level 7 or above D14-28 (RR 0.90, 95% CI 0.58 to 1.42, 2 RCTs, low certainty of evidence); and may not increase incidence of Serious adverse events (RR 1.26, 95% CI 0.83 to 1.92, 5 RCTs, low certainty of evidence). The evidence is very uncertain about the effect of convalescent plasma on further outcomes: Viral negative conversion D7 (RR 1.23, 95% CI 1.04 to 1.46, 1 RCT, very low certainty of evidence) and WHO progression score level 6 or above D14-28 (RR 0.16, 95% CI 0.01 to 3.02, 1 RCT, very low certainty of evidence).

Zusammenfassung von 6 RCTs (unsichere Evidenz)

kein Unterschied bei Gesamtmortalität, bei klinischer Verbesserung

Table 3.12-1: Summary of findings table on ***Convalescent plasma compared to Standard Care for Mild/Moderate/Severe/Critical COVID-19***
–(7 RCTs: Li, Gharbharan, Avendano-Sola, Agarwal, AlQahtani, Simonovich, Libster)

Convalescent plasma compared to Standard Care for Mild/Moderate/Severe/Critical COVID-19

Patient or population: Mild/Moderate/Severe/Critical COVID-19
Setting: Worldwide
Intervention: Convalescent plasma
Comparison: Standard Care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with Standard Care	Risk with Convalescent plasma				
Viral negative conversion D3	350 per 1,000	**610 per 1,000** (270 to 1,000)	**RR 1.74** (0.77 to 3.90)	470 (2 RCTs) [b]	⨁◯◯◯ VERY LOW [c,d,e]	
Viral negative conversion D7	550 per 1,000	**677 per 1,000** (572 to 803)	**RR 1.23** (1.04 to 1.46)	342 (1 RCT) [f]	⨁◯◯◯ VERY LOW [g,h,i]	
Clinical improvement D7	98 per 1,000	**96 per 1,000** (29 to 313)	**RR 0.98** (0.30 to 3.19)	103 (1 RCT) [j]	⨁◯◯◯ VERY LOW [h,k,l]	
Clinical improvement D14-D28	570 per 1,000	**604 per 1,000** (525 to 701)	**RR 1.06** (0.92 to 1.23)	229 (3 RCTs) [m]	⨁⨁◯◯ LOW [e,k]	
WHO progression score (level 6 or above) D7	47 per 1,000	**27 per 1,000** (2 to 279)	**RR 0.57** (0.05 to 5.99)	81 (1 RCT) [n]	⨁◯◯◯ VERY LOW [n,i,o]	
WHO progression score (level 6 or above) D14-28	70 per 1,000	**11 per 1,000** (1 to 211)	**RR 0.16** (0.01 to 3.02)	81 (1 RCT) [n]	⨁◯◯◯ VERY LOW [n,i,o]	zero events in the intervention arm
WHO progression score (level 7 or above) D7	182 per 1,000	**184 per 1,000** (124 to 277)	**RR 1.01** (0.68 to 1.52)	414 (2 RCTs) [p]	⨁⨁◯◯ LOW [i]	
WHO progression score (level 7 or above) D14-28	155 per 1,000	**140 per 1,000** (90 to 221)	**RR 0.90** (0.58 to 1.42)	414 (2 RCTs) [p]	⨁⨁◯◯ LOW [i]	
All-cause mortality D7	47 per 1,000	**14 per 1,000** (4 to 53)	**RR 0.30** (0.08 to 1.11)	414 (2 RCTs) [p]	⨁⨁⨁◯ MODERATE [e]	
All-cause mortality D14-D28	148 per 1,000	**127 per 1,000** (93 to 174)	**RR 0.86** (0.63 to 1.18)	1098 (6 RCTs) [q]	⨁⨁◯◯ LOW [e,r]	
Adverse events	280 per 1,000	**299 per 1,000** (252 to 355)	**RR 1.07** (0.90 to 1.27)	596 (3 RCTs) [s]	⨁⨁⨁◯ MODERATE [t]	
Serious adverse events	81 per 1,000	**102 per 1,000** (67 to 155)	**RR 1.26** (0.83 to 1.92)	763 (5 RCTs) [u]	⨁⨁◯◯ LOW [t,v]	

*The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

GRADE Working Group grades of evidence: High certainty: We are very confident that the true effect lies close to that of the estimate of the effect; **Moderate certainty**: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different; **Low certainty**: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect; **Very low certainty**: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations

a. Last update: December 10, 2020; b. Agarwal A, 2020; Li L, 2020; c. Risk of bias downgraded by 1 level: some concerns or high risk regarding adequate randomization, deviations from intended interventions, missing outcome data and selection of reported results; d. Inconsistency downgraded by 1 level: I2=89.9%; e. Imprecision downgraded by 1 level: due to wide confidence interval consistent with the possibility for benefit and the possibility for no effect and low number of participants; f. Agarwal A, 2020; g. Risk of bias downgraded by 1 level: some concerns or high risk regarding adequate randomization, missing outcome data and selection of reported results; h. Indirectness downgraded by 1 level: despite a multicentre design this is a single study from a single country, therefore results in this population might not be generalizable to other settings; i. Imprecision downgraded by 1 level: due to low number of participants; j. Li L, 2020; k. Risk of bias downgraded by 1 level: some concerns regarding adequate randomization, deviation from intended intervention and outcome measurement; l. Imprecision downgraded by 2 levels: due to very wide confidence interval consistent with the possibility for benefit and the possibility for harm and low number of participants; m. AlQahtani M, 2020; Gharbharan A, 2020; Li L, 2020; n. Avendaño-Solà C, 2020; o. Risk of bias downgraded by 1 level: some concerns regarding adequate randomization and outcome measurement; p. Avendaño-Solà C, 2020; Simonovich VA, 2020; q. AlQahtani M, 2020; Avendaño-Solà C; Agarwal A, 2020; Gharbharan A, 2020; Li L, 2020; Simonovich VA, 2020; r. Risk of bias downgraded by 1 level: some concerns or high risk regarding adequate randomization, deviation from intended intervention and missing data; s. Li L, 2020; Libster R, 2020; Simonovich VA, 2020; t. Imprecision downgraded by 1 level: due to wide confidence interval consistent with the possibility for no effect and the possibility for harm and low number of participants; u. Avendaño-Solà C, 2020; Gharbharan A, 2020; Li L, 2020; Libster R, 2020; Simonovich VA, 2020; v. Risk of bias downgraded by 1 level: some concerns or high risk regarding adequate randomization, deviation from intended intervention, missing data and outcome measurement

3.13 Plasma derived medicinal products

Neutralizing monoclonal antibodies

neutralisierende monoklonale Antikörper: Prävention und Behandlung

Halbwertszeit bis 3 Wochen von Vorteil

Nachteil: unbekannte Bioverfügbarkeit der infundierten Antikörper

As Marovich et al. 2020 [134] stated, **neutralizing monoclonal antibodies** to SARS-CoV-2 have the potential to be used for both prevention and treatment of infection. They can help to guide vaccine design and development as well. The main target of SARS-CoV-2 neutralizing monoclonal antibodies is the surface spike glycoprotein that mediates viral entry into host cells. Some products will include of a combination of 2 monoclonal antibodies targeting different sites on the spike protein. Due to long half-life of most monoclonal antibodies (approximately 3 weeks for IgG1), a single infusion should be sufficient. A potential limitation of monoclonal antibodies for treatment of COVID-19 is the unknown bioavailability of passively infused IgG in tissues affected by the disease, especially the lungs, which serve as a key target of SARS-CoV-2 infection. Due to the effect of viral diversity it will be important to monitor for the emergence of resistant viral mutations under selective pressure of monoclonal antibody treatment.

Possible disease enhancement include antibody-mediated enhancement of viral entry and replication in target cells (Fc-bearing monocytes or macrophages) and virus-antibody immune complexes and the associated cytokine release [134].

3.13.1 REGN-COV2 - combination of two monoclonal antibodies (REGN10933 and REGN10987)

Kombination aus 2 monoklonalen Antikörpern: Casirivimab + Imdevimab

REGN-COV2 is combination of two monoclonal antibodies (REGN10933 and REGN10987) which bind non-competitively to the critical receptor binding domain of the virus's spike protein, which diminishes the ability of mutant viruses to escape treatment and protects against spike variants that have arisen in the human population.

Phase 3 REGNCOV2 Studie NIAID (NIH) Studie mit 2.000 Teilnehmer*innen

A **phase 3 prevention trial** evaluates REGNCOV2's ability to prevent infection among uninfected people who have had close exposure to a COVID-19 patient (such as the patient's housemate) at approximately 100 sites and is expected to enroll 2,000 patients in the U.S.; the trial will assess SARS-CoV-2 infection status.

Behandlung von hospitalisierten und ambulanten Patiente*innen 1.050 Pts. In Planung

REGN-COV2 has also moved into the **phase 2/3** portion of **two adaptive phase 1/2/3 trials** testing the cocktail's ability **to treat hospitalised and non-hospitalised (or "ambulatory") patients with COVID-19**. The two phase 2/3 treatment trials in hospitalized (estimated enrollment =1,850) and non-hospitalized (estimated enrollment =1,050) patients are planned to be conducted at approximately 150 sites in the U.S., Brazil, Mexico and Chile, and will evaluate virologic and clinical endpoints, with preliminary data expected later this summer.

Sept 2020: RECOVERY nimmt REGNCOV2 als Studienmedikament auf

On September 14, 2020 the University of Oxford and Regeneron Pharmaceuticals, Inc. announced that **RECOVERY** (Randomised Evaluation of COVid-19 thERapY will evaluate Regeneron's investigational anti-viral antibody cocktail, REGNCOV2, https://www.recoverytrial.net/news/recovery-covid-19-phase-3-trial-to-evaluate-regeneron2019s-regn-cov2-investigational-antibody-cocktail-in-the-uk. The phase 3 open-label trial in patients hospitalised with COVID-19 will

compare the effects of adding REGN-COV2 to the usual standard-of-care versus standard-of-care on its own.

Results of publication

Phase 2/3 RCT
799 ambulante Pts.

Firmenankündigung zu positive Efekten

Endpunkte:
Reduktion der Viruslast
Artzt-/ Notfall-/ Spitalsbesuche

On Oct 28, 2020 Regeneron Pharmaceuticals, Inc. announced **positive results** from an **ongoing phase 2/3 RCT** in the COVID-19 **outpatient setting** (ambulatory patients, n=799) on their website; the trial met the primary and key secondary endpoints. REGN-COV2 significantly reduced viral load and patient medical visits (hospitalizations, emergency room, urgent care visits and/or physician office/telemedicine visits), by 57% through day 29 (2.8% combined dose groups; 6.5% placebo; p=0.024) and by 72% in patients with one or more risk factor (including being over 50 years of age; body mass index greater than 30; cardiovascular, metabolic, lung, liver or kidney disease; or immunocompromised status) (combined dose groups; nominal p = 0.0065). Manufacturer will submit detailed results from this trial for publication, https://www.prnewswire.com/news-releases/regenerons-covid-19-outpatient-trial-prospectively-demonstrates-that-regn-cov2-antibody-cocktail-significantly-reduced-virus-levels-and-need-for-further-medical-attention-301162255.html.

Teilergebnisse von Phase 1–3 RCT

275 Pts.

Vorteile bei Viruslastreduktion
Reduktion von Arztbesuchen

On December 17 2020, Weinreich et al. [135] published **preliminary results of phase 1-2 portion** of ongoing double-blind, **phase 1–3 trial (NCT04425629)** involving **nonhospitalised** patients with Covid-19, randomly assigned (1:1:1) to receive placebo, 2.4 g of REGN-COV2, or 8.0 g of REGN-COV2 and were prospectively characterized at baseline for endogenous immune response against SARS-CoV-2 (serum antibody–positive or serum antibody–negative). In this interim analysis, data from 275 patients are reported: the REGN-COV2 antibody cocktail reduced viral load, with a greater effect in patients whose immune response had not yet been initiated or who had a high viral load at baseline: The least-squares mean difference (combined REGN-COV2 dose groups vs. placebo group) in the time-weighted average change in viral load from day 1 through day 7 was −0.56 log10 copies per milliliter (95% confidence interval [CI], −1.02 to −0.11) among patients who were serum antibody–negative at baseline and −0.41 log10 copies per milliliter (95% CI, −0.71 to −0.10) in the overall trial population. In the overall trial population, 6% of the patients in the placebo group and 3% of the patients in the combined REGN-COV2 dose groups reported at least one medically attended visit; among patients who were serum antibody–negative at baseline, the corresponding percentages were 15% and 6% (difference, −9 percentage points; 95% CI, −29 to 11). The percentages of patients with hypersensitivity reactions, infusion-related reactions, and other adverse events were similar in the combined REGN-COV2 dose groups and the placebo group.

Safety issue

Sicherheitswarnung für Kohorte hospitalisierte und künstlich beatmete Pts.

On 30 October 2020, Regeneron Pharmaceuticals, Inc. received a recommendation from the independent data monitoring committee (IDMC) for the REGN-COV2 antibody cocktail treatment trials for COVID-19 that the current **hospitalised patient** trial be modified. Specifically, based on a potential safety signal and an unfavorable risk/benefit profile at this time, the IDMC recommends further enrollment of patients requiring high-flow oxygen or mechanical ventilation be placed on hold pending collection and analysis of further data on patients already enrolled. The IDMC also recommends continuing enrollment of hospitalised patients requiring either no or low-flow oxygen as the risk/benefit remains acceptable in these cohorts. Finally, the IDMC recommends continuation of the outpatient trial without

modification, https://investor.regeneron.com/news-releases/news-release-details/regn-cov2-independent-data-monitoring-committee-recommends.

FDA: Notzulassung von von REGN-COV2

für milde bis moderate Erkrankung

Regulatory update: On November 21, 2020, the U.S. Food and Drug Administration issued an **emergency use authorization (EUA)** for casirivimab and imdevimab to be administered together for the **treatment** of **mild to moderate COVID-19** in adults and pediatric patients (12 years of age or older weighing at least 40 kilograms [about 88 pounds]) with positive results of direct SARS-CoV-2 viral testing and who are **at high risk for progressing to severe COVID-19**. This includes those who are 65 years of age or older or who have certain chronic medical conditions. [136]

Empfehlung des US COVID-19 Treatment Guidelines Panel

wenn, dann in sehr frühem Stadium aber insuffiziente Datenlage

The **US COVID-19 Treatment Guidelines Panel** issued new recommendations on pharmacological treatment for patients with COVID-19 (as of December 3, 2020) [125]. In summary, related to the anti-SARS-CoV-2 monoclonal antibodies bamlanivimab and casirivimab plus imdevimab, in the earliest stages of infection, before the host has mounted an effective immune response, anti-SARS-CoV-2 antibody-based therapies may have their greatest likelihood of having an effect. In this regard, although there are insufficient data from clinical trials to recommend either for or against the use of any specific therapy in this setting, preliminary data suggests that outpatients may benefit from receiving anti-SARS-CoV-2 monoclonal antibodies early in the course of infection. The anti-SARS-CoV-2 monoclonal antibodies bamlanivimab and casirivimab plus imdevimab are available through Emergency Use Authorizations for outpatients who are at high risk for disease progression.

At this time, there are **insufficient** data to recommend either **for or against** the use of **casirivimab plus imdevimab** for the treatment of **outpatients** with **mild to moderate COVID-19.** The casirivimab plus imdevimab combination **should not be considered** the **standard of care** for the treatment of patients with COVID-19. Patients who are **hospitalised** for COVID-19 **should not receive** casirivimab plus imdevimab **outside of a clinical trial.**

There are currently **no comparative data to determine whether there are differences in clinical efficacy or safety between casirivimab plus imdevimab and bamlanivimab** [125].

3.13.2 LY-CoV555 - neutralizing IgG1 monoclonal antibody (bamlanivimab) and LY-CoV016 - recombinant fully human monoclonal neutralizing antibody (etesevimab)

2 weitere mAb: LY-CoV555 (Bamlanivimab)

LY-CoV555 is a neutralizing IgG1 monoclonal antibody (mAb) directed against the spike protein of SARS-CoV-2. It is designed to block viral attachment and entry into human cells, thus neutralizing the virus, potentially preventing and treating COVID-19.

LY-CoV016 (Etesevimab)

LY-CoV016 (also known as JS016) is a recombinant fully human monoclonal neutralizing antibody, which specifically binds to the SARS-CoV-2 surface spike protein receptor binding domain with high affinity and can effectively block the binding of the virus to the ACE2 host cell surface receptor.

LY-CoV555: Phase 1

Lilly has successfully completed enrollment and primary safety assessments of LY-CoV555 in a **phase 1** study of hospitalised patients with COVID-19 (NCT04411628) and long-term follow-up is ongoing.

BLAZE-1 (NCT04427501) is ongoing randomized, double-blind, placebo-controlled **phase 2** study designed to assess the efficacy and safety of LY-CoV555 and LY-CoV016 for the treatment of symptomatic COVID-19 in the **outpatient setting**. Across all treatment arms, the trial will enroll an estimated 800 participants.

BLAZE-1: RCT, Phase 2
800 Pts.
LY-CoV555 &
LY-CoV016

A **phase 3** study for the **prevention** of COVID-19 in residents and staff at long-term care facilities (NCT04497987, **BLAZE-2**) is recently initiated.

BLAZE-2: RCT, Phase 3
initiiert

In addition, LY-CoV555 is being tested in the National Institutes of Health-led **ACTIV-2** and **ACTIV-3** studies of **ambulatory** and **hospitalised** COVID-19 patients.

NIH-Studien: ACTIV-2 and ACTIV-3

To generate additional efficacy and safety data, a pragmatic, open-label study enrolling patients treated with either monotherapy or combination therapy, with a focus on collecting data regarding hospitalizations, deaths and safety, planned to be initiated in October 2020.

pragmatic trial in Planung

US COVID-19 Treatment Guidelines (see also above in casirivimab plus imdevimab section).

Empfehlung wie 3.13.1

At this time, there are **insufficient data** to recommend either **for or against** the use of bamlanivimab for the treatment of **outpatients with mild to moderate COVID-19.** Bamlanivimab **should not be considered** the **standard of care** for the treatment of patients with COVID-19. Patients who are **hospitalised** for COVID-19 **should not receive** bamlanivimab **outside of a clinical trial** [125].

insuffiziente Datenlage für Empfehlung für/ gegen

Results of publications

Chen et al. 2020 [137] published **interim analysis results** of **BLAZE-1**, phase 2 **RCT (NCT04427501),** in 452 **mild or moderate Covid-19 patients in outpatient setting**. One of three doses of neutralizing antibody LY-CoV555 appeared to accelerate the natural decline in viral load over time, whereas the other doses had not by day 11: 2800-mg dose of LYCoV555, the difference from placebo in the decrease from baseline was -0.53 (95% confidence interval [CI], -0.98 to -0.08; p=0.02. On days 2 to 6, the patients who received LY-CoV555 had a slightly lower severity of symptoms than those who received placebo. The percentage of patients who had a Covid-19–related hospitalisation or visit to an emergency department was 1.6% in the LY-CoV555 group and 6.3% in the placebo group. In a post hoc analysis that was focused on high-risk subgroups (an age of ≥65 years or a BMI of ≥35), the percentage of hospitalisation was 4.2% in the LY-CoV555 group and 14.6% in the placebo group. The safety outcomes were similar in intervention and placebo groups.

Phase 2 RCT
452 Pts.
milde/moderate Erkrankung

Vorteil bei Endpunkten: Reduktion der Viruslast Artzt-/ Notfall-/ Spitalsbesuche

On October 7, 2020 Eli Lilly and Company **announced** data from an interim analysis of the BLAZE-1 clinical trial showed that combination therapy with two of Lilly's SARS-CoV-2 neutralizing antibodies reduced viral load, symptoms and COVID-related hospitalization and ER visits. The combination cohort enrolled recently diagnosed patients with mild-to-moderate COVID-19, who were assigned to 2800 mg of each antibody (n=112) or placebo (n=156). The combination therapy significantly reduced viral load at day 11 (p=0.011), meeting the primary endpoint of the study.

BLAZE-1
268 Pts,
Zwischenauswertung

Vorteil bei Endpunkten: Reduktion der Viruslast Artzt-/ Notfall-/ Spitalsbesuche

The combination therapy also met prespecified clinical endpoints, including the time-weighted average change from baseline in total symptom score from day 1 to 11 (p=0.009). The rate of COVID-related hospitalization and ER visits was lower for patients treated with combination therapy (0.9 percent) versus placebo (5.8 percent), a relative risk reduction of 84.5 percent

Ergebnisse in Kombinationstherapie gleich wie in Monotherapie LY-CoV555

(p=0.049). Combination therapy has been generally well tolerated with no drug-related serious adverse events.

Lundgren et al. 2020 (**ACTIV-3/TICO** LY-CoV555 Study group) published **preliminary** negative results from RCT (**NCT04501978**) compared LY-CoV555 with placebo in **hospitalised patients** who had Covid-19 without end-organ failure [138] . In addition, all the patients received high-quality supportive care as background therapy, including the antiviral drug remdesivir (95% of patients) and, when indicated, supplemental oxygen and glucocorticoids. The data and safety monitoring board recommended stopping enrollment for futility after 314 patients (163 in the LY-CoV555 group and 151 in the placebo group) had undergone randomization and infusion. Monoclonal antibody LY-CoV555, when co-administered with remdesivir, did not demonstrate efficacy among hospitalised patients who had Covid-19 without end-organ failure. Across the seven categories, the odds ratio of being in a more favorable category in the LY-CoV555 group than in the placebo group was 0.85 (95% confidence interval [CI], 0.56 to 1.29; p=0.45). The percentage of patients with the primary safety outcome (a composite of death, serious adverse events, or clinical grade 3 or 4 adverse events through day 5) was similar in the LY-CoV555 group and the placebo group (19% and 14%, respectively; odds ratio, 1.56; 95% CI, 0.78 to 3.10; p=0.20). The rate ratio for a sustained recovery was 1.06 (95% CI, 0.77 to 1.47).

RCT mit hospitalisierten Pts. mit Organversagen

Kombinationstherapie Bamlanivimab + Remdesivir

kein Unterschied/ keine Wirksamkeit

Regulatory update:

On November 9, 2020, the **U.S. Food and Drug Administration** issued an **Emergency Use Authorization (EUA)** for the investigational monoclonal antibody therapy **bamlanivimab (previously LY-CoV555)** for the treatment of **mild-to-moderate COVID-19** in adult and pediatric patients. Bamlanivimab is authorized for patients with positive results of direct SARS-CoV-2 viral testing who are **12 years of age and older** weighing at least 40 kilograms (about 88 pounds), and who are **at high risk for progressing to severe COVID-19 and/or hospitalisation**. This includes those who are 65 years of age or older, or who have certain chronic medical conditions, https://www.fda.gov/news-events/press-announcements/coronavirus-covid-19-update-fda-authorizes-monoclonal-antibody-treatment-covid-19. Bamlanivimab is not authorized for patients who are hospitalised due to COVID-19 or require oxygen therapy due to COVID-19. A benefit of bamlanivimab treatment has not been shown in patients hospitalised due to COVID-19. Monoclonal antibodies, such as bamlanivimab, may be associated with worse clinical outcomes when administered to hospitalised patients with COVID-19 requiring high flow oxygen or mechanical ventilation.

November: FDA EUA für bamlanivimab

für ambulante Pts mit Risiko auf Verschlechterung

nicht für bereits hospitalisierte Pts.

3.13.3 AZD7442 - combination of two monoclonal antibodies (AZD8895 + AZD1061)

AZD7442 is a combination of two mAbs (AZD8895 + AZD1061) derived from convalescent patients with SARS-CoV-2 infection. Discovered by Vanderbilt University Medical Center and licensed to AstraZeneca in June 2020, the mAbs were optimised by AstraZeneca with half-life extension and reduced Fc receptor binding. The half-life extended mAbs should afford at least six months of protection from COVID-19.

AZD7442 Kombination aus 2 monoklonalen Antikörpern Vanderbilt University/ AstraZeneca

NCT04507256 is a **phase 1**, first time in human, randomised, double-blind, placebo-controlled, and dose escalation study that aims to evaluate the safety,

Phase 1
Ende Sept 2021

tolerability and pharmacokinetics of AZD7442 in healthy participants. Estimated study completion date is September 2021.

Should AZD7442 prove to be tolerated and have a favourable safety profile in the trial, AstraZeneca will progress it into larger late-stage **phase 2** and **phase 3** trials to evaluate ist efficacy as a potential preventative and treatment approach against COVID-19, https://www.astrazeneca.com/media-centre/press-releases/2020/phase-1-clinical-trial-initiated-for-monoclonal-antibody-combination-for-the-prevention-and-treatment-of-covid-19.html.

Phase 2 & 3 in Vorbereitung

3.14 Combination therapy – triple combination of interferon beta-1b, lopinavir–ritonavir and ribavirin vs. lopinavir–ritonavir or other triple combination of interferons

Hung et al. 2020 [112] present the results of the first randomised controlled trial (**NCT04276688**) on the triple combination of interferon beta-1b, lopinavir–ritonavir, and ribavirin, compared with lopinavir–ritonavir alone, in the treatment of patients admitted to hospital with mild to moderate COVID-19 in Hong-Kong. In this multicentre, prospective, open-label, randomised, phase 2 trial, 127 patients were randomly assigned (2:1) to a 14-day combination of lopinavir 400 mg and ritonavir 100 mg every 12 h, ribavirin 400 mg every 12 h, and three doses of 8 million international units of interferon beta-1b on alternate days (combination group) or to 14 days of lopinavir 400 mg and ritonavir 100 mg every 12 h (control group). Triple therapy was associated with a significant reduction in the duration of viral shedding (time to negative nasopharyngeal swab 7 days [IQR 5–11] in the combination group vs 12 days [8–15] in the control group; hazard ratio [HR] 4·37 [95% CI 1·86–10·24], p=0.0010), symptom alleviation (time to NEWS2 0 of 4 days [IQR 3–8] vs 8 days [7–9]; HR 3·92 [1·66–9·23], p<0.0001), and duration of hospital stay (9·0 days [7·0–13·0] vs 14·5 days [9·3–16·0]; HR 2·72 [1·2–6·13], p=0.016). There was no mortality in either group. The triple combination also suppressed IL-6 levels. Adverse events included self-limited nausea and diarrhoea with no difference between the two groups. No serious adverse events were reported in the combination group. One patient in the control group had a serious adverse event of impaired hepatic enzymes requiring discontinuation of treatment.

Reduktion der Dauer der Virusausscheidung, Symtomverbesserung, Dauer des Krankenhausaufenthalts

kein Unterschied bei AE keine Todesfälle in beiden Gruppen

The **Living Systematic Review**, related to this RCT mentioned above, with **Summary of finding table** (https://covid-nma.com/living_data/index.php) is provided in Table 3.14-1.

keine weiteren RCTs publiziert

Huang et al. 2020 [113] reported the results from a single-center, randomized, open-labeled, prospective clinical trial (**ChiCTR2000029387**). 101 eligible patients with mild to moderate COVID-19 were randomized into three groups: ribavirin (RBV) plus interferon-a (IFN-a), lopinavir/ritonavir (LPV/r) plus IFN-a, and RBV plus LPV/r plus IFN-a at a 1:1:1 ratio, with a 28-d follow-up. The median interval from baseline to SARS-CoV-2 nucleic acid negativity was 12 d in the LPV/r+IFN-a-treated group, as compared with 13 and 15 d in the RBV+IFN-a-treated group and in the RBV+LPV/r+ IFN-a-treated group, respectively (p=0.23). The proportion of patients with SARS-CoV-2 nucleic acid negativity in the LPV/ r+IFN-a-treated group (61.1%) was higher than the RBV+ IFN-a-treated group (51.5%) and the RBV+LPV/r+IFN-a-treated group (46.9%) at day 14; however, the difference

RCT: 101 Pts

3 Gruppen:
RBV+IFN
LPV/r+IFN
RBV+LPV/r

kein Unterschied

between these groups was calculated to be statistically insignificant. The RBV+LPV/ r+IFN-a-treated group developed a significantly higher incidence of gastrointestinal adverse events than the LPV/r+ IFN-a-treated group and the RBV+ IFN-a-treated group.

RCT (China)
89 Pts.

3 Gruppen
Novaferon (IFN-I)
LPV/r
Novaferon + LPV/r

bessere Ergebnisse in IFN Gruppen

Chinese RCT published by **Zheng et al. 2020** [139, 140] with three arms including 89 patients has evaluated the effect of Novaferon (the pharmaceutical which has similar properties of IFN-I but its antiviral activities has been greatly improved being at least 10 times more potent than human interferon α -2b) (n=30), Lopinavir/Ritonavir (n=29) and Novaferon + Lopinavir/Ritonavir (n=30) in COVID-19 patients. The groups treated with Novaferon alone or in combination with Lopinavir/Ritonavir showed significantly higher clearance rates on day 6 than the group treated with Lopinavir/Ritonavir alone, but the certainty on the evidence is very low. No serious adverse events were reported.

The **Living Systematic Review**, related to this RCT mentioned above, with **Summary of findings table** is provided in Table 3.14-1 continued.

Okt 2020:
preprint RCT
China
94 Pts.

rSIFN vs. IFN-a
beide in Kombination mit
Lopinavir oder
Ritonavir oder
Umifenovir

signifikanter Unterschied zugunsten von rSIFN-co bei klinischer Verbesserung und bei Nebenwirkungen

Li C et al. 2020 [141] reported, as preprint, results from a multicenter, randomized controlled trial (**ChiCTR2000029638**) with aim to evaluate the efficacy and safety of recombinant super-compound interferon versus traditional interferon alpha added to baseline antiviral agents (lopinavir rSIFN-co –ritonavir or umifenovir) for the treatment of moderate-to-severe COVID-19. Recombinant super-compound interferon (rSIFN-co) is a new genetically engineered interferon. Participants received rSIFN-co (12 million international units [IU], twice daily) or interferon alpha (5 million IU, twice daily) nebulization added to baseline antiviral agents for no more than 28 days.

94 patients hospitalized with moderate-to-severe COVID-19 were included in the safety set (46 patients assigned to rSIFN-co group, 48 to interferon alpha group). Individuals in the rSIFN-co group showed shorter time to clinical improvement (11.5 days vs 14.0 days; p = 0.019) as compared to those in the interferon alpha group. The overall rate of clinical improvement on day 28 was much higher in the rSIFN-co group than that in the interferon alpha group (93.5% vs 77.1%; difference, 16.4%; 95% condence interval 3% to 30%). The time to radiological improvement and the time to virus nucleic acid negative conversion were also much shorter in the rSIFN-co group (8.0 days vs 10.0 days, p = 0.002; 7.0 days vs 10.0 days, p = 0.018, respectively). Adverse events were reported in 13 (28.3%) patients in the rSIFN-co group and 18 (37.5%) patients in the interferon alpha group. No patients died during the study.

Table 3.14-1: Summary of findings table on ***triple combination of interferon beta-1b, lopinavir–ritonavir and ribavirin*** *(1 RCT: Hung) - https://covid-nma.com/living_data/index.php*

Summary of findings:						
Lopinavir + Ritonavir + Ribavirin + Interferon-b-1b compared to Lopinavir + Ritonavir for Mild/Moderate COVID-19						
Patient or population: Mild/Moderate COVID-19 **Setting**: Worldwide **Intervention**: Lopinavir + Ritonavir + Ribavirin + Interferon-b-1b **Comparison**: Lopinavir + Ritonavir						
Outcomes	**Anticipated absolute effects* (95% CI)**		**Relative effect (95% CI)**	**№ of participants (studies)**	**Certainty of the evidence (GRADE)**	**Comments**
	Risk with Lopinavir + Ritonavir	**Risk with Lopinavir + Ritonavir + Ribavirin + Interferon-b-1b**				
Incidence of viral negative conversion D7	902 per 1.000	**875 per 1.000** (767 to 993)	**RR 0.97** (0.85 to 1.10)	127 (1 RCT)	⨁⨁◯◯ LOW [a,b]	
WHO Clinical Progression Score (decrease in 1 point) (i.e., improvement) - not reported	-	-	-	-	-	outcome not yet measured or reported
Admission in ICU or death - not reported	-	-	-	-	-	outcome not yet measured or reported
Incidence of WHO progression score (level 6 or above) - not reported	-	-	-	-	-	outcome not yet measured or reported
Incidence of WHO progression score (level 7 or above) - not reported	-	-	-	-	-	outcome not yet measured or reported
All-cause mortality D7				127 (1 RCT)	⨁◯◯◯ VERY LOW [a,c]	zero events in both groups

All-cause mortality D14-D28				127 (1 RCT)	⊕◯◯◯ VERY LOW [a,c]	zero events in both groups
Adverse events D14-D28	488 per 1.000	**478 per 1.000** (327 to 698)	**RR 0.98** (0.67 to 1.43)	127 (1 RCT)	⊕⊕⊕◯ MODERATE [d,e]	
Serious adverse events D14-D28	24 per 1.000	**4 per 1.000** (0 to 94)	**RR 0.16** (0.01 to 3.87)	127 (1 RCT)	⊕⊕◯◯ LOW [d,f]	

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio

GRADE Working Group grades of evidence

High certainty: We are very confident that the true effect lies close to that of the estimate of the effect

Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different

Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect

Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations

a. Indirectness downgraded by 1 level: single study from a single country, therefore results in this population might not be generalizable to other settings

b. Imprecision downgraded by 1 level: low number of participants

c. Imprecision downgraded by 2 levels: no events in both groups and low number of participants

d. Indirectness not downgraded: we presume that adverse event rate is not specific to a certain setting

e. Imprecision downgraded by 1 level: due to wide confidence interval consistent with the possibility for benefit and the possibility for harm and low number of participants

f. Imprecision downgraded by 2 levels: due to very wide confidence interval consistent with the possibility for benefit and the possibility for harm and low number of participants

Table 3.14-1 continued: Summary of findings tables on ***Novaferon , Lopinavir/Ritonavir and Novaferon + Lopinavir/Ritonavir*** *(1 RCT: Zheng 2020)*

Novaferon versus Lopinavir/Ritonavir

Outcome	Anticipated absolute effects (95% CI)		Relative effect (95% CI)	Absolute effect (95% CI)	Number of participants (studies)	Certainty of evidence
	Risk with Lopinavir/ Ritonavir	Risk with Novaferon				
SARS-CoV-2 clearance	517 per 1000	567 per 1000	RR 1.10 (0.68 to 1.75)	**52 more per 1000 (from 166 fewer to 388 more)**	59	Very low
Progression of COVID-19 severity	143 per 1000	0 per 1000	RR 0.11 (0.01 to 1.97)	**127 fewer per 1000 (from 141 fewer to 139 more)**	56	Very low
Number with adverse events	138 per 1000	0 per 1000	RR 0.11 (0.01 to 1.91)	**123 fewer per 1000 (from 137 fewer to 126 more)**	59	Very low

Explanations of GRADE: Level of certainty was downgraded of one level for high risk of performance bias and unclear risk of selection bias, and further downgraded of two levels for very few events and small sample size

Novaferon versus Novaferon + Lopinavir/Ritonavir

Outcome	Anticipated absolute effects (95% CI)		Relative effect (95% CI)	Absolute effect (95% CI)	Number of participants (studies)	Certainty of evidence
	Risk with Novaferon + Lopinavir/ Ritonavir	Risk with Novaferon				
SARS-CoV-2 clearance	700 per 1000	567 per 1000	RR 1.24 (0.84 to 1.83)	**136 more per 1000 (from 91 fewer to 470 more)**	60	Very low
Number with adverse events	100 per 1000	0 per 1000	RR 7.00 (0.38 to 129.93)	**0 fewer per 1000 (from 0 fewer to 0 fewer)**	60	Very low
Number with severe adverse events	Serious adverse events were not reported in either group.					Low
Progression of COVID-19 severity	None of the patients, with a moderate disease severity, had worsened disease.					Low

Explanations of GRADE: For the outcomes "SARS-CoV-2 clearance" and "Number with adverse events", the level of certainty was downgraded of two levels for very few events and small sample size, and further downgraded of one level for small sample size. For the outcomes "Number with severe adverse events" and "Progression of COVID-19 severity", the level of certainty was downgraded of one level for high risk of performance bias and unclear risk of selection bias, and further downgraded of one level for small sample size

Novaferon + Lopinavir/Ritonavir versus Lopinavir/Ritonavir

Outcome	Anticipated absolute effects (95% CI)		Relative effect (95% CI)	Absolute effect (95% CI)	Number of participants (studies)	Certainty of evidence
	Risk with Lopinavir/ Ritonavir	Risk with Novaferon + Lopinavir/ Ritonavir				
SARS-CoV-2 clearance	517 per 1000	700 per 1000	RR 1.35 (0.89 to 2.06)	**181 more per 1000 (from 57 fewer to 548 more)**	59	Very low
Progression of COVID-19 severity	143 per 1000	0 per 1000	RR 0.11 (0.18 to 2.96)	**127 fewer per 1000 (from 141 fewer to 139 more)**	56	Very low
Number with severe adverse events	138 per 1000	100 per 1000	RR 0.72 (0.18 to 2.96)	**39 fewer per 1000 (from 113 fewer to 270 more)**	59	Low

Explanations of GRADE: For the outcomes "SARS-CoV-2 clearance" and "Number with adverse events", the level of certainty was downgraded of two levels for very few events and small sample size, and further downgraded of one level for small sample size. For the outcomes "Number with severe adverse events" and "Progression of COVID-19 severity", the level of certainty was downgraded of one level for high risk of performance bias and unclear risk of selection bias, and further downgraded of one level for small sample size

Novaferon + Lopinavir/Ritonavir versus Lopinavir/Ritonavir

Outcome	Anticipated absolute effects (95% CI)		Relative effect (95% CI)	Absolute effect (95% CI)	Number of participants (studies)	Certainty of evidence
	Risk with Lopinavir/ Ritonavir	Risk with Novaferon + Lopinavir/ Ritonavir				
SARS-CoV-2 clearance	517 per 1000	700 per 1000	RR 1.35 (0.89 to 2.06)	**181 more per 1000 (from 57 fewer to 548 more)**	59	Very low
Progression of COVID-19 severity	143 per 1000	0 per 1000	RR 0.11 (0.18 to 2.96)	**127 fewer per 1000 (from 141 fewer to 139 more)**	56	Very low
Number with severe adverse events	138 per 1000	100 per 1000	RR 0.72 (0.18 to 2.96)	**39 fewer per 1000 (from 113 fewer to 270 more)**	59	Low

Explanations of GRADE: For the outcomes "SARS-CoV-2 clearance" and "Progression of COVID-19 severity", the level of certainty was downgraded of two levels for very few events and small sample size, and further downgraded of one level for small sample size. For the outcome "Number with severe adverse events" the level of certainty was downgraded of one level for high risk of performance bias and unclear risk of selection bias, and further downgraded of one level for small sample size.

3.15 Solnatide

About the treatment under consideration

Medikament gegen akutes Atemnotsyndrom

Verabreichung: Inhalation

The therapeutic molecule solnatide (INN) has been designed by APEPTICO (a privately-held biotechnology company from Vienna/Austria) for the therapeutic treatment of patients with Acute Respiratory Distress Syndrome (ARDS) and various forms of life-threatening Pulmonary Oedema (PPO). Solnatide is a synthetic peptide of less than 20 amino acids applied directly in the lower airways in the form of a liquid aerosol, aims to accelerate the dissolution of alveolar oedema and reduce barrier damage caused by Covid-19 in the lungs.

April: BASG, AIFA lassen Solnatide für "Compassionate Use" zu

In April 2020, solnatide has been approved for Compassionate Use by the Austrian Federal Office for Safety in Health Care (BASG) for the treatment of patients infected by the novel coronavirus SARS-CoV-2 and subsequently developing severe pulmonary dysfunction (severe COVID-19), as well as by the Italian Medicines Agency and the Ethics Committee of the National Institute for Infectious Diseases (Lazzaro Spallanzani-Rome), within the compassionate use program of drugs undergoing clinical trials for the treatment of COVID-19 patients suffering from pulmonary oedema and acute respiratory distress syndrome.

EC-Grant seit April für covid-19

bis Dezember 2021

APEPTICO Forschung und Entwicklung GmbH has signed, together with the "solnatide consortium", the Grant Agreement ID: 101003595 with the European Commission to accelerate the process of making APEPTICO's proprietary investigational medicinal product (IMP) solnatide available for medical treatment of patients severely affected by the novel coronavirus 2019 (SARS-CoV-2) disease, COVID-19; the Grant Agreement was made available via the Horizon2020 programme "Advancing knowledge for the clinical and public health response to the 2019-nCoV epidemic" (https://ec.europa.eu/commission/presscorner/detail/en/ip_20_386). Project started on 1 April 2020 and will end on 31 December 2021.

1 laufender RCT mit 40 moderat bis schwer Covid-19 Erkrankten

One ongoing randomised, double-blind, placebo controlled, parallel assignment trial with aim to assess efficacy and safety of 7 days orally inhaled 100 mg solnatide to treat pulmonary permeability oedema of 40 SARS-Cov-2 positive patients with moderate-to-severe ARDS is registered in EUdraCT register (EudraCT number 2020-001244-26), https://www.clinicaltrialsregister.eu/ctr-search/trial/2020-001244- 26/AT [142].

Withdrawn, suspended or terminated studies

ClinicalTrials.gov & EUdraCT: keine klinischen Studien registriert,

keine Publikation von RCT

No withdrawn, suspended or terminated studies related to solnatide in COVID-19 patients were found in ClinicalTrials.gov and EUdraCT registers [142].

Results of publications

No publications related to the RCTs of solnatide in COVID-19 patients were found [142].

3.16 Umifenovir (Arbidol®)

About the treatment under consideration

Umifenovir (Arbidol), an indole-derivative is a broad-spectrum drug against a wide range of enveloped and non-enveloped viruses: it interacts preferentially with aromatic amino acids, and it affects multiple stages of the virus life cycle, either by direct targeting viral proteins or virus-associated host factors. Umifenovir is currently being investigated as a potential treatment and prophylactic agent for COVID-19 caused by SARS-CoV2 infections in combination with both currently available and investigational HIV therapies (https://pubchem.ncbi.nlm.nih.gov/compound/Arbidol). Its use is only in China and Russia, since not approved by neither the FDA nor the EMA.

antivirales Medikament zugelassen in China, Russland, aber nicht EMA/ FDA

As Wang et al. 2020 recently published, arbidol efficiently inhibited SARS-CoV-2 infection in vitro (it appears to block virus entry by impeding viral attachment and release from the Els) [143].

1 in vitro Publikation

Withdrawn, suspended or terminated studies

No withdrawn, suspended or terminated studies related to umifenovir were found in ClinicalTrials.gov and EUdraCT registers.

ClinicalTrials.gov & EudraCT: keine Studien registriert

Results of publications

RCT published by **Yueping et al. 2020** (**NCT04252885**) [144] was an exploratory randomised (2:2:1) controlled trial, conducted in China, with the aim to assess the efficacy and safety of lopinavir/ritonavir or arbidol monotherapy in 86 patients with mild/moderate COVID-19. 34 of them assigned to lopinavir/ritonavir; 35 to arbidol and 17 with no antiviral medication as control, with follow-up of 21 days. The rate of positive-to-negative conversion of SARS-CoV-2 nucleic acid, as the primary endpoint, was similar between groups (all $p>0.05$) and there were no differences between groups in the secondary endpoints, the rates of antipyresis, cough alleviation, or improvement of chest CT at days 7 or 14 (all $p>0.05$). At day 7, eight (23.5%) patients in the LPV/r group, 3 (8.6%) in the arbidol group and 2 (11.8%) in the control group showed a deterioration in clinical status from moderate to severe/critical ($p=0.206$). Related to adverse events, 12 (35.3%) patients in the lopinavir/ritonavir group and 5 (14.3%) in the arbidol group experienced adverse events during the follow-up period, and no AE occured in the control group [144].

Yueping (China) RCT, 86 Pts. leichte/ moderate Erkrankung

kein Unterschied zwischen den Gruppen in einigen Surrogatendpunkten

mehr AE

One publication [79] on the completed RCT (**ChiCTR2000030254**) about the efficacy and safety of favipiravir, in comparison with umifenovir, to treat Covid-19 patients was identified; Summary of findings table can be found in Section related to favipiravir.

1 RCT nur im preprint (nicht peer-reviewed)

RCT (**IRCT20180725040596N2**) published by **Nojomi et al. 2020**, as preliminary report in the format of preprints [145], is an open label randomized controlled trial, on effectiveness of umifenovir on 100 patients with COVID-19, assigned randomly to two groups of either hydroxychloroquine just on the 1st day followed by Kaletra (lopinavir-ritonavir) or hydroxychloroquine just on the 1st day followed by umifenovir 7-14 days based on severity of disease. The duration of hospitalization in umifenovir group was less than lopinavir-ritonavir arm significantly (7.2 versus 9.6 days; $p=0.02$). Time to relief fever was similar across two groups (2.7 versus 3.1 days in umifenovir and lopinavir-ritonavir arms respectively). Peripheral oxygen saturation rate was different

Okt 2020: RCT (Iran) 100 Pts.

in Kombinationstherapie kleine Vorteile

after seven days of admission across two groups significantly (94% versus 92% in umifenovir and lopinavir-ritonavir groups respectively) (p=0.02).

November 2020
RCT, 30 Pts. Kirgistan

Yethindra et al. 2020 [146] published results from exploratory randomized controlled study recruited 30 mild and moderate COVID-19 patients in Kyrgyzstan. No patient progressed toward severe and critical illness in either category. Pneumonia was ameliorated in 76.6% (23/30) of the patients, with moderate and potential amelioration in 36.6% and 40% of the patients, respectively. Many patients were observed to have significantly ameliorated pneumonia in the umifenovir category (86.6%, 13 of 15) compared to the control category (66.6%, 10 of 15). In addition, 66.6% of patients in the umifenovir category had potential pneumonia absorption. Only one patient presented with mild side effects in the umifenovir category, while one patient had cephalalgia; notably, no patient experienced severe side effects.

Zusammenfassung von 2 RCTs: unsichere Evidenz zu den Effekten von Umifenovir

The **Living Systematic Review**, related to these two RCTs mentioned above, with Summary of findings table (https://covid-nma.com/living_data/index.php) is presented in Table 3.16-1. According to currently available very low quality of evidence, the evidence is very uncertain about the effect of umifenovir on further outcomes: All-cause mortality D14-D28; WHO progression score level 6 or above D14-28; WHO progression score level 7 or above D14-28; Serious adverse events and Viral negative conversion D7 (RR 0.90, 95% CI 0.44 to 1.84, 1 RCT, very low certainty of evidence).

*Table 3.16-1. Summary of findings table, on **umifenovir vs standard care** (2 RCTs:Yueping, Yethindra)*

Umifenovir compared to Standard Care for Mild/Moderate COVID-19

Patient or population: Mild/Moderate COVID-19
Setting: Worldwide
Intervention: Umifenovir
Comparison: Standard Care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with Standard Care	Risk with Umifenovir				
Viral negative conversion D3 - not reported	-	-	-	-	-	outcome not yet measured or reported
Viral negative conversion D7	412 per 1,000	**371 per 1,000** (181 to 758)	**RR 0.90** (0.44 to 1.84)	52 (1 RCT) [b]	⨁◯◯◯ VERY LOW [c,d]	
Clinical improvement D7 - not reported	-	-	-	-	-	outcome not yet measured or reported
Clinical improvement D14-D28 - not reported	-	-	-	-	-	outcome not yet measured or reported
WHO progression score (level 6 or above) D7	63 per 1,000	**46 per 1,000** (8 to 248)	**RR 0.73** (0.13 to 3.96)	82 (2 RCTs) [e]	⨁◯◯◯ VERY LOW [d,f,g]	
WHO progression score (level 6 or above) D14-D28	0 per 1,000	**0 per 1,000** (0 to 0)	not estimable	30 (1 RCT) [h]	⨁◯◯◯ VERY LOW [c,i,j]	zero events in both groups
WHO progression score (level 7 or above) D7	0 per 1,000	**0 per 1,000** (0 to 0)	not estimable	82 (2 RCTs) [e]	⨁◯◯◯ VERY LOW [g,i,k]	zero events in both groups
WHO progression score (level 7 or above) D14-D28	0 per 1,000	**0 per 1,000** (0 to 0)	not estimable	30 (1 RCT) [h]	⨁◯◯◯ VERY LOW [c,i,j]	zero events in both groups
All-cause mortality D7	0 per 1,000	**0 per 1,000** (0 to 0)	not estimable	82 (2 RCTs) [e]	⨁◯◯◯ VERY LOW [j,k,m]	zero events in both groups
All-cause mortality D14-D28	0 per 1,000	**0 per 1,000** (0 to 0)	not estimable	82 (2 RCTs) [e]	⨁◯◯◯ VERY LOW [j,k,m]	zero events in both groups
Adverse events	0 per 1,000	**0 per 1,000** (0 to 0)	**RR 5.50** (0.32 to 94.06)	52 (1 RCT) [b]	⨁⨁◯◯ LOW [d,n]	zero events in control group
Serious adverse events	0 per 1,000	**0 per 1,000** (0 to 0)	not estimable	82 (2 RCTs) [e]	⨁◯◯◯ VERY LOW [j,k,n]	zero events in both groups

*The **risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR**: Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

GRADE Working Group grades of evidence: High certainty: We are very confident that the true effect lies close to that of the estimate of the effect; **Moderate certainty**: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different; **Low certainty**: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect; **Very low certainty**: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations: a. Last update: November 13, 2020; b. Yueping L, 2020; c. Indirectness downgraded by 1 level: single study from a single institution, therefore results in this population might not be generalizable to other settings; d. Imprecision downgraded by 2 level: due to wide confidence interval consistent with the possibility for benefit and the possibility for harm and very low number of participants; e. Yethindra V, 2020; Yueping L, 2020; f. Risk of bias downgraded by 1 level: some concerns around deviation from intended intervention in both studies, some concerns in one study regarding randomization, outcome measurement, and selection of reported result; g. Indirectness downgraded by 1 level: results are mainly from a single study from a single institution, therefore results in this population might not be generalizable to other settings.; h. Yethindra, 2020; i. Risk of bias downgraded by 1 level: some concerns regarding randomization, deviations from intended intervention, outcome measurement, and selection of the reported results; j. Imprecision downgraded by 2 levels: no events in both groups and very low number of participants; k. Risk of bias downgraded by 1 level: some concerns regarding deviations from intended intervention in both studies, some concerns regarding randomization and selection of reported result in one study; l. Risk of bias downgraded by 1 level: some concerns regarding randomization, deviations from intended intervention, and selection of the reported results; m. Indirectness downgraded by 1 level: results from two single-institution studies, therefore results in the population might not be generalizable to other settings.; n. We presume that the adverse event rates, and the corresponding relative risks, is similar across diverse settings; therefore not downgraded for indirectness

3.17 Dexamethasone and other corticosteroids

About the drug under consideration

Glukokortikoide: entzündungshemmend

Dexamethasone is a long-acting glucocorticoid which is used principally as an anti-inflammatory or immunosuppressant agent. Daily regimen of dexamethasone 6 mg once daily is equivalent to 160 mg of hydrocortisone, 40 mg of prednisone, and 32 mg of methylprednisolone. The proposed mechanism of glucocorticoids in severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) involves the mitigation of an excessive immune response that can lead to acute respiratory distress syndrome (ARDS) and multi-organ failure. ARDS develops in approximately 20% of COVID-19 patients and is linked to multi-organ failure through cytokine release syndrome [147, 148].

nationale, nicht EMA Zulassung, UK: Zulassung im Juni für Covid-19

Dexamethasone is authorised at national level in the EU and is used in a wide range of conditions, including rheumatic problems, skin diseases, severe allergies, asthma and chronic obstructive lung disease. The UK has approved dexamethasone for the treatment of Covid-19 on June 16, 2020 [149].

EMA- CHMP: Zulassungsantrag von Taw Pharma (Sept 2020)

CHMP is currently evaluating Dexamethasone Taw for a marketing authorisation for the treatment of hospitalised adult patients with COVID-19 [150].

Sept 2020: basierend auf Ergebnissen aus RECOVERY EMA (Rasch-)Zulassung für Pts mit (künstlicher) Beatmung oder Sauerstoff Supplementierung

On September 18, 2020 EMA announced that CHMP has completed its review of results from the RECOVERY dexamethasone study arm. **EMA is endorsing the use of dexamethasone in adults and adolescents (from 12 years of age and weighing at least 40 kg) who require supplemental oxygen therapy.** In all cases, the recommended dose in adults and adolescents is 6 milligrams once a day for up to 10 days. Companies that market dexamethasone medicines can request this new use to be added to their product's license by submitting an application to national medicines agencies or to EMA [151].

Empfehlungen des US COVID-19 Treatment Guidelines Panel: bei künstlich beatmeten Patient*innen , nicht jedoch bei nicht beatmeten Pts.

Based on results of the RECOVERY Trial described below, the **US COVID-19 Treatment Guidelines Panel recommends using dexamethasone** (at a dose of 6 mg per day for up to 10 days) in patients with COVID-19 who are mechanically ventilated **(AI)** and in patients with COVID-19 who require supplemental oxygen but who are not mechanically ventilated **(BI)**. The Panel **recommends against** using dexamethasone in patients with COVID-19 who do not require supplemental oxygen **(AI)** [69]. If dexamethasone is not available, the Panel **recommends using** alternative glucocorticoids such as **prednisone**, **methylprednisolone**, or **hydrocortisone (AIII)** [61]. For more details, see also section on remdesivir.

WHO-Empfehlung für Pts. mit schwerer oder kritischer Erkrankung

The **WHO panel** made two recommendations: a **strong recommendation** (based on moderate certainty evidence) **for systemic** (i.e. intravenous or oral) **corticosteroid therapy** (e.g. 6 mg of dexamethasone orally or intravenously daily or 50 mg of hydrocortisone intravenously every 8 hours) for 7 to 10 days in **patients with severe and critical COVID-19**, and a **conditional recommendation** (based on low certainty evidence) **not to use corticosteroid therapy** in **patients with non-severe COVID-19** [152, 153].

Withdrawn, suspended or terminated studies

Two RCTs were found as terminated: RCT - NCT04327401 (CoDEX), related to dexamethasone, in 299 COVID-19 patients with moderate and severe ARDS in Brazil, the Data Monitoring Committee recommended to stop the trial based on the Recovery Trial results, which was accepted by the CoDEX Steering Committee. NCT04344288 (CORTI-Covid) on prednisone in France, terminated due Competent Authority decision. DEXA-COVID trial (NCT04325061, EudraCT 2020-001278-31) on dexamethasone, is written as suspended (lack of enrollment) in ClinicalTrials.gov, but as ongoing in EUdraCT register. The results of this RCT are not yet published [37]. 1 RCT in US (NCT04360876) is withdrawn because funding not received.

2 abgeschlossene RCTs
1 abgebrochener RCT wegen (besseren Ergebnissen in) Rovery Trial in Brazilien

1 eingestellter RCT – wegen Magel an Rekrutierung

Results of publications

The RCT with the largest number of included COVID-19 patients is RCTs of dexamethasone arm of the **RECOVERY trail** in Covid-19 patients (**NCT04381936, EudraCT 2020-001113-21**) [154]. The primary outcome was all-cause mortality within 28 days after randomization; further analyses were specified at 6 months.

größter RCT: RECOVERY

2.104 Pts

Results from preliminary report of the RECOVERY trial are related to the comparison of oral or intravenous dexamethasone 6 mg given once daily for up to ten days (2104 patients) plus the usual standard of care vs. usual care alone (4321 patients). Authors showed that overall, 482 (22.9%) patients allocated dexamethasone and 1110 (25.7%) patients allocated usual care died within 28 days (age adjusted rate ratio [RR] 0.83; 95% confidence interval [CI] 0.75 to 0.93; P<0.001). The proportional and absolute mortality rate reductions varied significantly depending on level of respiratory support at randomization (test for trend p<0.001): dexamethasone reduced deaths by one-third in patients receiving invasive mechanical ventilation (29.3% vs. 41.4%, RR 0.64 [95% CI 0.51 to 0.81]), by one-fifth in patients receiving oxygen without invasive mechanical ventilation (23.3% vs. 26.2%, RR 0.82 [95% CI 0.72 to 0.94], but did not reduce mortality in patients not receiving respiratory support at randomization (17.8% vs. 14.0%, RR 1.19 [95% CI 0.91 to 1.55]. Allocation to dexamethasone was associated with a shorter duration of hospitalization than usual care (median 12 days vs. 13 days) and a greater probability of discharge within 28 days (rate ratio 1.10 [95% CI 1.03 to 1.17]) with the greatest effect seen among those receiving invasive mechanical ventilation at baseline (11.5 by chi-square test for trend). The risk of progression to invasive mechanical ventilation was lower among those allocated dexamethasone vs. usual care (risk ratio 0.92 [95% CI 0.84 to 1.01). Analyses are ongoing regarding cause-specific mortality, the need for renal dialysis or hemofiltration, and the duration of ventilation [154, 155].

Reduktion der Mortalität RR -30% bei Pts. mit künstlicher Beatmung

RR -20% bei Pts. mit Sauerstoff ohne invasive Beatmung

ohne Effekt auf Mortalität bei Pts ohne Untestützun bei Beatmung

zusätzlich: kürzere Hospitalisierung

The **CoDEX trial** (**NCT04327401**) randomized 299 patients in 41 ICUs in Brazil with moderate or severe ARDS and COVID-19 to open-label high-dose dexamethasone (20 mg/d for 5 days, then 10 mg/d for 5 days) vs usual care alone, with the primary outcome ventilator-free days through day 28, which were greater in patients randomized to dexamethasone (6.6 vs 4.0, p=0.04). 28-day mortality was not significantly different between patients randomized to corticosteroids vs usual care (56.3% vs 61.5%, p=0.83); stopping the study early when RECOVERY results were announced resulted in a sample size that was underpowered to adequately evaluate the effect of corticosteroids on mortality and other secondary outcomes [156, 157].

CoDEX
299 Pt (Brasilien)

kein signifikanter Unterschied, aber wegen Abbruch "underpowered" für valide Ergebnisse

CAPE COVID
149 Pts (Frankreich)
bessere Ergebnisse mit hydrocortisone

The **CAPE COVID trial** (**NCT02517489**) was blinded, placebo-controlled trial randomized 149 patients in 9 ICUs in France with severe respiratory disease from COVID-19 to low-dose hydrocortisone (200 mg/d infusion, tapered per protocol) vs placebo. The primary outcome of 21-day treatment failure, defined as death or ongoing respiratory support with mechanical ventilation or high-flow oxygen, occurred in 42.1% of patients randomized to hydrocortisone vs 50.7% of those randomized to placebo (p=0.29) [157, 158].

REMAP-CAP
403 Pts (UK, CA, USA)
bessere Ergebnisse mit hydrocortisone

The **REMAP-CAP trial** (**NCT02735707**), an existing multicenter, multinational adaptive platform trial for pneumonia, randomized 403 patients with severe COVID-19 (in the intensive care unit and receiving respiratory or cardiovascular organ support) to 1 of 3 open-label groups: fixed low-dose hydrocortisone, shock-dependent hydrocortisone, or no hydrocortisone. The primary study outcome was days patients remained alive and free of organ support to day 21. The Bayesian model found that fixed-dose hydrocortisone (93% probability), as well as shock-dependent hydrocortisone (80% probability), were both likely superior to no hydrocortisone, but data were insufficient to confirm a single optimal regimen. In addition, the probabilities did not meet the prespecified probabilities to define success [157, 159].

MetCOVID
418 Pts (Brasilien)
methylprednisolone
kein Unterschied zwischen Gruppen bei Mortalität
methylprednisolone
Subgruppenanalyse: >60 Jahre bessere Ergebnisse

MetCOVID trial (**NCT04343729**) was parallel, double-blind, placebo-controlled, randomized, phase IIb clinical trial, performed with hospitalized patients aged ≥ 18 years with clinical, epidemiological and/or radiological suspected COVID-19, at a tertiary care facility in Brazil. 416 patients were randomly allocated (1:1 ratio) to receive either intravenous methylprednisolone (0.5 mg/kg) or placebo (saline solution), twice daily, for 5 days. Mortality at day 28 was not different between groups. A subgroup analysis showed that patients over 60 years in the methylprednisolone group had a lower mortality rate at day 28. Patients in the methylprednisolone arm tended to need more insulin therapy, and no difference was seen in virus clearance in respiratory secretion until day 7 [160].

GLUCOCOVID
85 Pts (Spanien)
Methylprednisolone

bessere Ergebnisse bei „composite"Endpunkten

Ergebnisse sind ebenfalls alters-abhängig

GLUCOCOVID trial (**EudraCT 2020-001934-37**) was multicentric, partially randomized, preference, open-label trial, including adults with COVID-19 pneumonia, impaired gas exchange and biochemical evidence of hyper-inflammation, aimed to determine whether a 6-day course of intravenous methylprednisolone improves outcome in patients with SARS CoV-2 infection at risk of developing Acute Respiratory Distress Syndrome (ARDS). Patients were assigned to standard of care (SOC), or SOC plus intravenous methylprednisolone (40mg/12h 3 days, then 20mg/12h 3 days). The use of methylprednisolone was associated with a reduced risk of the composite endpoint in the intention-to-treat, age-stratified analysis (combined risk ratio -RR- 0.55 [95% CI 0.33-0.91]; p=0.024). In the per-protocol analysis, RR was 0.11 (0.01-0.83) in patients aged 72 yr or less, 0.61 (0.32-1.17) in those over 72 yr, and 0.37 (0.19-0.74, p=0.0037) in the whole group after age-adjustment by stratification. The decrease in C-reactive protein levels was more pronounced in the methylprednisolone group (p=0.0003). Hyperglycaemia was more frequent in the methylprednisolone group [160].

Okt 2020:
RCT (Iran)
68 Pts.

schwere Erkrankung

signifikante Ergebnisse bei klinischer Verbesserung und bei Mortalität

Edalatifard et al. 2020 [161] published results of a single-blind, randomized, controlled, clinical trial involving severe hospitalized patients with confirmed COVID-19 at the early pulmonary phase of the illness in Iran (**IRCT20200404046947N1**). Sixty-eight eligible patients underwent randomization (34 patients in each group) The percentage of improved patients was significantly higher in the methylprednisolone group than in the standard care group (32 (94.1%) vs 16 (57.1%); P =0.001) and the mortality rate was significantly lower in the methylprednisolone group (2 (5.9%) vs 12 (42.9%); P <0.001). Patients in the methylprednisolone intervention group had a significantly increased survival time compared with the patients in the standard care group [Log rank test: P<0.001; Hazard ratio: 0.293; 95% CI: 0.154-0.555]. A total of two patients in each group (5.8% and 7.1% respectively) showed severe adverse events between initiation of treatment and the end of the study. There were one infection and one edema adverse event in the methylprednisolone group and two shock adverse events in the standard care group. Following the use of high dose of corticosteroids, most of the patients required insulin due to their known or hidden diabetes, and the insulin requirement was increased in the intervention group especially in diabetic and overweight patients.

Phase 2 RCT
(Iran)
29 Pts.

signifikante Vorteile bei Mortalität

Farahani et al. 2020 [162] reported, as preprint, results from phase 2, double-blind, randomized, clinical trial in 29 adults with intermediate or severe COVID-19 with PaO2/FiO2 less than 300 and progressive disease unresponsive to standard treatments admitted to the intensive care unit (ICU) (**IRCT20200406046963N1**): The investigation group received the recommended regimen plus methylprednisolone (1000mg/day for three days) and oral prednisolone 1mg/kg with tapering of dose within ten days. There was no mortality among the patients receiving the methylprednisolone treatment, but the mortality was high in patients without methylprednisolone therapy. In addition to improvement of respiratory outcome, Glasgow Coma Scale (GCS) of methylprednisolone group significantly (p < 0.001) improved also.

3 weitere kleine Studien

Results from three unpublished studies were found related to hydrocortisone (NCT04348305), methylprednisolone (NCT04244591) and dexamethasone (NCT04325061), which included small number of COVID-19 patients (from 19 to 47), in comparisons to placebo or standard care. RCTs results, the meta-analysis results and SoF table will be updated after results are published in peer-review journals.

Metaanalyse von 7 RCTs

Reduktion von Gesamtmortalität
Verbesserung der klinischen Symptomatik

unsichere Evidenz bei anderen Endpunkten

Meta-analysis data on high, low and very low certainty of evidence, related to effectiveness and safety of dexamethasone and other corticosteroids reported in 7 RCTs, can be found in the **Summary of Findings** Table 3.17-1. In summary, according to the results of six RCTs with high certainty of evidence, corticosteroids reduce the risk of all-cause mortality D14-28 in COVID-19 patients (RR 0.90, 95% CI 0.83 to 0.97; absolute effect estimate 25 fewer per 1000 (95% CI from 23 fewer to 27 fewer). The same is true for outcome. WHO progression score level 7 or above D14-28 (RR 0.88, 95% CI 0.79 to 0.98, high certainty of evidence, 4 RCTs). Corticosteroids may reduce the WHO progression score level 6 or above D14-28 (RR 0.87, 95% CI 0.78 to 0.97, low certainty of evidence, 3 RCTs). The evidence is very uncertain about the effect of corticosteroids on outcomes: Clinical improvement D14-28 (RR 1.25, 95% CI 0.82 to 1.90, very low certainty of evidence, 2 RCTs), Adverse events (RR 1.49, 95% CI 0.11 to 20.63, very low certainty of evidence, 2 RCTs) and Serious adverse events (RR 0.88, 95% CI 0.48 to 1.60, very low certainty of evidence, 5 RCTs).

*Table 3.17-1: Summary of findings table, on **dexamethasone and other corticosteroids** (7 RCTs: Horbey, Tomazini, Dequin, REMAP-CAP Investigators, Jeronimo, Corral, Edalatifard)*

Corticosteroids compared to Standard Care/Placebo for Mild/Moderate/Severe/Critical COVID-19

Patient or population: Mild/Moderate/Severe/Critical COVID-19
Setting: Worldwide
Intervention: Corticosteroids
Comparison: Standard Care/Placebo

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with Standard Care/Placebo	Risk with Corticosteroids				
Viral negative conversion D3 - not reported	-	-	-	-	-	Outcome not yet measured or reported
Viral negative conversion D7	474 per 1,000	**478 per 1,000** (360 to 635)	**RR 1.01** (0.76 to 1.34)	212 (1 RCT) [b]	⨁◯◯◯ VERY LOW [c,d,e]	
Clinical improvement D7 - not reported	-	-	-	-	-	Outcome not yet measured or reported
Clinical improvement D14-28	620 per 1,000	**775 per 1,000** (508 to 1,000)	**RR 1.25** (0.82 to 1.90)	6724 (2 RCTs) [f]	⨁◯◯◯ VERY LOW [g,h,i]	
WHO progression score level 6 or above D7 - not reported	-	-	-	-	-	Outcome not yet measured or reported
WHO progression score level 6 or above D14-28	720 per 1,000	**626 per 1,000** (562 to 698)	**RR 0.87** (0.78 to 0.97)	512 (3 RCTs) [j]	⨁⨁◯◯ LOW [k,l]	
WHO progression score level 7 or above D7 - not reported	-	-	-	-	-	Outcome not yet measured or reported
WHO progression score level 7 or above D14-28	254 per 1,000	**224 per 1,000** (201 to 249)	**RR 0.88** (0.79 to 0.98)	6937 (4 RCTs) [m]	⨁⨁⨁⨁ HIGH	
All-cause mortality D7	246 per 1,000	**187 per 1,000** (128 to 271)	**RR 0.76** (0.52 to 1.10)	416 (1 RCT) [b]	⨁⨁◯◯ LOW [d,e]	
All-cause mortality D14-28	27 per 100	**25 per 100** (23 to 27)	**RR 0.90** (0.83 to 0.97)	7591 (6 RCTs) [n]	⨁⨁⨁⨁ HIGH	
Adverse events	68 per 1,000	**101 per 1,000** (7 to 1,000)	**RR 1.49** (0.11 to 20.63)	363 (2 RCTs) [o]	⨁◯◯◯ VERY LOW [k,p,q]	
Serious adverse events	86 per 1,000	**75 per 1,000** (41 to 137)	**RR 0.88** (0.48 to 1.60)	817 (5 RCTs) [r]	⨁◯◯◯ VERY LOW [q,s]	

*The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CI: Confidence interval; **RR**: Risk ratio

GRADE Working Group grades of evidence: High certainty: We are very confident that the true effect lies close to that of the estimate of the effect; **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different; **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect; **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations: a. Last update: November 10, 2020; b. Prado Jeronimo CM, 2020; c. Risk of bias downgraded by 1 level: high risk due to missing data; d. Indirectness downgraded by 1 level: single study from a single institution, therefore results in this population might not be generalizable to other settings; e. Imprecision downgraded by 1 level: due to wide confidence interval consistent with the possibility for benefit and the possibility for no effect and low number of participants; f. Horby P (RECOVERY Trial), 2020; Tomazini BM, 2020; g. Risk of bias downgraded by 1 level: some concerns regarding deviations from intended intervention and outcome measurement; h. Inconsistency downgraded by 1 level: I^2=74.1%; i. Imprecision downgraded by 1 level: due to wide confidence interval consistent with the possibility for benefit and the possibility for no effect; j. Corral-Gudino L, 2020; Dequin P-F, 2020; Tomazini BM, 2020; k. Risk of bias downgraded by 1 level: some concerns or high risk regarding adequate randomization, deviations from intended interventions and outcome measurement; l. Imprecision downgraded by 1 level: due to low number of events and/or participants; m. Corral-Gudino L, 2020; Dequin P-F, 2020; Horby P (RECOVERY Trial), 2020; Tomazini BM, 2020; n. Angus DC, 2020; Corral-Gudino L, 2020; Dequin P-F, 2020; Horby P (RECOVERY Trial), 2020; Prado Jeronimo CM, 2020; Tomazini BM, 2020; o. Corral-Gudino L, 2020; Tomazini BM, 2020; p. Inconsistency downgraded by 1 level: I^2=81.6%; q. Imprecision downgraded by 2 levels: due to very wide confidence interval consistent with the possibility for benefit and the possibility for harm and low number of participants; r. Angus DC, 2020; Corral-

Gudino L, 2020; Edalatifard M, 2020; Dequin P-F, 2020; Tomazini BM, 2020; s. Risk of bias downgraded by 1 level: some concerns or high risk regarding adequate randomization, deviations from intended interventions, missing data and outcome measurement

3.18 Anakinra (Kineret®)

About the drug under consideration

Anakinra (Kineret®) is an immunosuppressive medicine, a copy of a natural human protein - 'human interleukin 1 receptor antagonist' (r-metHuIL-1ra, produced in Escherichia coli cells by recombinant DNA technology). Anakinra neutralises the biologic activity of interleukin-1α (IL-1α) and interleukin-1β (IL-1β) by competitively inhibiting their binding to interleukin-1 type I receptor (IL-1RI). Interleukin-1 (IL-1) is a pivotal pro-inflammatory cytokine mediating many cellular responses including those important in synovial inflammation. Anakinra is not authorised in Covid-19 patients (EMA, FDA).

Immunsuppressivum, humaner Interleukin-1 Rezeptorantagonist

EMA-Zulassung für Rheumatoide Arthritis seit 2002

The **US COVID-19 Treatment Guidelines Panel** stated that there are insufficient data to recommend either for or against Interleukin-1 inhibitors (e.g., anakinra) therapy in patients with COVID-19 disease [69].

mehrere laufende Studien, Empfehlung des US COVID-19 Treatment Guidelines Panel: insuffiziente Datenlage

Withdrawn, suspended or terminated studies

One RCT was found as suspended – ANACONDA (NCT04364009) –due to efficiency and safety reasons, after enrolment of 71 hospitalized COVID-19 patients in France. The intermediate review of data from this clinical trial showed early excess mortality in the group of patients treated with anakinra combined with standard optimized care, compared to the group of patients treated with standard optimized care alone. On October 29, 2020, the French National Agency for Medicines and Health Products Safety (ANSM) announced that inclusions in clinical trials evaluating anakinra in the treatment of COVID-19 are suspended due to safety information regarding the ANACONDA-COVID-19 clinical trial, https://ansm.sante.fr/S-informer/Actualite/Suspension-des-inclusions-en-France-dans-les-essais-clinique-evaluant-l-anakinra-dans-la-prise-en-charge-de-la-COVID-19-Point-d-information.

ANACONDA (Frankreich) 71 hospitaliserte Pts

wegen Sicherheit abgebrochen

Two RCTs were found as terminated: NCT04366232 (JAKINCOV), due investigator decision in France, on anakinra alone and in combination with ruxolitinib, and NCT04324021 in Italy and US because of recruitment issues.

2 RCTs abgebrochen

Results of publications

Until now no scientific publication on RCTs of anakinra (Kineret®) in Covid-19 patients could be identified.

keine Publikation eines RCTs

3.19 Colchicine

About the drug under consideration

Colchicine is an alkaloid isolated from the autumn crocus, Colchicinum autumnale, with anti-gout and anti-inflammatory activities. Colchicine is available throughout the world in a generic form [163].

toxisches Alkaloid wirkt als Zellgift (Mitosehemmung)

Colchicine is not authorised in Covid-19 patients (EMA, FDA).

generisch

Withdrawn, suspended or terminated studies

One RCT was found as withdrawn because no funding is available (NCT04603690; no suspended or terminated interventional studies were found on colchicine in ClinicalTrials.gov and EUdraCT registers.

1 RCT zurückgezogen

Results of publications

Deftereos et al. 2020 [164] reported results from open-label, randomized controled trial (**NCT04326790**) on 105 patients hospitalized with COVID-19 in 16 tertiary hospitals in Greece (randomization in a 1:1 allocation to either standard medical treatment or colchicine with standard medical treatment). Patient recruitment was terminated on April 27, 2020, because of slow enrollment as a result of the rapid flattening of the curve of COVID-19 cases in Greece. The clinical primary end point rate was 14.0% in the control group (7 of 50 patients) and 1.8% in the colchicine group (1 of 55 patients) (odds ratio, 0.11; 95% CI, 0.01-0.96; p=0.02). Mean (SD) event-free survival time was 18.6 (0.83) days the in the control group vs 20.7 (0.31) in the colchicine group (log rank p=0.03). Adverse events were similar in the 2 groups, except for diarrhea, which was more frequent with colchicine group than the control group (25 patients [45.5%] vs 9 patients [18.0%]; p=0.003).

1 publizierter RCT (Griechenland): 105 Pts.

klinisch gering-relevanter Unterschied bei Verbesserung der Erkrankung

viele Surrogatendpunkte niedrige Evidenz

Salehzadeh et al. 2020 [165] reported results (as preprint) from prospective, open-label, randomized and double blind clinical trial, in 100 patients hospitalized with COVID-19 in Iran (**IRCT20200418047126N1**). Patients were randomized in a 1:1 allocation, to either standard medical treatment (hydroxychloroquine) or colchicine with standard medical treatment. Colchicine group were received 1 mg tablet of colchicine daily alongside the hydroxychloroquine for 6 days. Duration of hospitalisation and duration of fever were significantly different between patients groups, in favour of colchicine (p<0.05). Although in colchicine group dyspnea was improved more rapid than the placebo group, difference was not statistically significant. None of the patients died or were readmitted.

RCT preprint (Iran) 100 Pts.

kein Unterschied

Lopes et al. 2020 [166], reported (as preprint) interim results of a single-center, randomized, double-blinded, placebo controlled clinical trial of colchicine for the treatment of 38 moderate to severe COVID-19 patients in Brazil. Thirty-five patients (18 for placebo and 17 for colchicine) completed the study. Median (and interquartile range) time of need for supplemental oxygen was 3.0 (1.5- 6.5) days for the colchicine group and 7.0 (3.0-8.5) days for placebo group (p=0.02). Median (IQR) time of hospitalization was 6.0 (4.0-8.5) days for the colchicine group and 8.5 (5.5-11.0) days for placebo group (p=0.03). At day 2, 53% vs 83% of patients maintained the need for supplemental oxygen, while at day 7 the values were 6% vs 39%, in the colchicine and placebo groups, respectively (log rank; p=0.01). Hospitalization was maintained for 53% vs 78% of patients at day 5 and 6% vs 17% at day 10, for the colchicine and placebo groups, respectively (log rank; p=0.01). One patient per group needed admission to ICU. No recruited patient died. At day 4, patients of colchicine group presented significant reduction of serum C-reactive protein compared to baseline (p<0.001). The majority of adverse events were mild and did not lead to patient withdrawal. Diarrhea was more frequent in the colchicine group (p=0.17). Cardiac adverse events were absent.

RCT preprint (Brasilien) 38 Pt.

Reduktion von Sauerstoff Supplementierung und von Hospitalisierung

Summary of Finding table related to colchicine compared to standard care for moderate/severe COVID-19 patients, related to 3 RCTs mentioned above, is presented in Table 3.19-1 below. According to currently available evidence, the evidence is very uncertain about the effect of colchicine on outcomes: All-cause mortality D14-D28 (RR 0.24, 95% CI 0.03 to 2.09, 3 RCTs, very low certainty of evidence); Clinical improvement D7 (RR 1.336, 95% CI 0.90 to 1.98, 1 RCTs, very low certainty of evidence); WHO progression score level 6 or above D14-28 (RR 0.14, 95% CI 0.02 to 1.08, 2 RCTs, very low certainty of evidence); WHO progression score level 7 or above D14-28 (RR 0.16, 95% CI 0.02 to 1.29, 2 RCTs, very low certainty of evidence); Adverse events (RR 1.25, 95% CI 0.63 to 2.46, 1 RCT, very low certainty of evidence) and Serious adverse events (RR 1.00, 95% CI 0.16 to 6.38, 2 RCTs, very low certainty of evidence).

Zusammenfassung von 3 RCTs
sehr unsichere Evidenz
Vorteil bei Gesamtmortalität
klnische Verbesserung

*Table 3.19-1: Summary of findings table on **colchicine compared to standard care** (3 RCT: Deftereos, Lopes, Salehzadeh) - https://covid-nma.com/living_data/index.php)*

Colchicine compared to Standard care or Placebo for Moderate/Severe/Critical COVID-19

Patient or population: Moderate/Severe/Critical COVID-19
Setting: Worldwide
Intervention: Colchicine
Comparison: Standard care or Placebo

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with Standard care or Placebo	Risk with Colchicine				
Incidence viral negative conversion D7 - not measured	-	-	-	-	-	outcome not yet measured or reported
Clinical improvement D7	632 per 1.000	**840 per 1.000** (568 to 1.000)	**RR 1.33** (0.90 to 1.98)	38 (1 RCT) [b]	⨁◯◯◯ VERY LOW [c,d,e]	
Clinical improvement D24-D28	1.000 per 1.000	**0 per 1.000** (0 to 0)	not estimable	38 (1 RCT) [b]	⨁◯◯◯ VERY LOW [c,d,f]	
WHO progression score (level 6 or above) D7	158 per 1.000	**106 per 1.000** (21 to 561)	**RR 0.67** (0.13 to 3.55)	38 (1 RCT) [b]	⨁◯◯◯ VERY LOW [c,d,g]	
WHO progression score (level 6 or above) D14-D28	96 per 1.000	**13 per 1.000** (2 to 104)	**RR 0.14** (0.02 to 1.08)	148 (2 RCTs) [h]	⨁◯◯◯ VERY LOW [g,j]	
WHO progression score (level 7 or above) D7	53 per 1.000	**105 per 1.000** (11 to 1.000)	**RR 2.00** (0.20 to 20.24)	38 (1 RCT) [b]	⨁◯◯◯ VERY LOW [d,g]	
WHO progression score (level 7 or above) D14-D28	82 per 1.000	**13 per 1.000** (2 to 106)	**RR 0.16** (0.02 to 1.29)	148 (2 RCTs) [h]	⨁◯◯◯ VERY LOW [g,j]	
All-cause mortality D7	0 per 1.000	**0 per 1.000** (0 to 0)	not estimable	38 (1 RCT) [b]	⨁◯◯◯ VERY LOW [d,k]	
All-cause mortality D14-D28	33 per 1.000	**8 per 1.000** (1 to 68)	**RR 0.24** (0.03 to 2.09)	258 (3 RCTs) [l]	⨁◯◯◯ VERY LOW [g,j]	
Adverse events	421 per 1.000	**526 per 1.000** (265 to 1.000)	**RR 1.25** (0.63 to 2.46)	38 (1 RCT) [b]	⨁◯◯◯ VERY LOW [c,g,m]	
Serious adverse events	27 per 1.000	**27 per 1.000** (4 to 175)	**RR 1.00** (0.16 to 6.38)	148 (2 RCTs) [h]	⨁◯◯◯ VERY LOW [g,i,m]	

*The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CI: Confidence interval; **RR**: Risk ratio

GRADE Working Group grades of evidence: High certainty: We are very confident that the true effect lies close to that of the estimate of the effect; **Moderate certainty**: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different; **Low certainty**: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect; **Very low certainty**: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations: a. Last update: November 10, 2020; b. Lopes MIF, 2020; c. Risk of bias downgraded by 1 level: some concerns regarding outcome measurement and selection of the reported result; d. Indirectness downgraded by 1 level: single study from a single country, therefore results in this population might not be generalizable to other settings; e. Imprecision downgraded by 1 level: due to few events; f. Imprecision downgraded by 2 levels: all participants had the event, no relative effect calculated; g. Imprecision downgraded by 2 levels: due to very wide confidence interval consistent with the possibility for benefit and the possibility for harm and low number of participants; h. Deftereos S, 2020; Lopes MIF, 2020; i. Risk of bias downgraded by 1 level: some concerns regarding deviation from intended intervention and outcome measurement; j. Risk of bias downgraded by 1 level: some concerns with deviation from intended interventions and selection of reported result; k. Imprecision downgraded by 2 levels: no events in both groups; l. Deftereos S, 2020; Lopes MIF, 2020; Salehzadeh F, 2020; m. We presume that the adverse event rates, and the corresponding relative risks, is similar across diverse settings; therefore not downgraded for indirectness

3.20 Nafamostat (Futhan©)

About the drug under consideration

Nafamostat mesilate (FUT-175, Futhan®, Nichi-Iko Pharmaceutical) is (with implications on coagulation, fibrinolysis, complement system, inflammatory cytokine release) and is quickly hydrolysed, the reason why it is typically administered as an intravenous drip. Nafamostat is not approved for any use by EMA or FDA.

Futhan®

Withdrawn, suspended or terminated studies

No withdrawn, suspended or terminated interventional studies were found on nafamostat in ClinicalTrials.gov and EUdraCT registers.

keine abgeschlossenen, abgebrochenen Studien

Results of publications

Until now, no scientific publication on randomized clinical trials of nafamostat in Covid-19 patients could be identified.

keine veröffentlichten Studien

3.21 Gimsilumab

About the drug under consideration

Gimsilumab is a fully human monoclonal antibody that acts on granulocyte-macrophage colony-stimulating factor (GM-CSF) [1]; it is manufactured by Roivant Sciences Ltd. /Altasciences. Gimsilumab – ATC-code not assigned yet. Gimsilumab belongs to anti-inflammatories, antirheumatics, monoclonal antibodies drug class and has no approvement for any indication by EMA or FDA yet.

monoklonaler Antkörper in Entwicklung

EMA/ FDA: keine Zulassung

Withdrawn, suspended or terminated studies

No withdrawn, suspended or terminated interventional studies were found on gimsilumab in ClinicalTrials.gov and EUdraCT registers.

keine abgeschlossenen, abgebrochenen Studien

Results of publications

There are no published results from RCTs related to effectiveness and safety of gimsilumab for Covid-19 treatment; one Phase II study of gimsilumab is ongoing, estimated study completion date is March 2021 [167, 168].

keine veröffentlichten Studien

1 Phase 2 Studie läuft

3.22 Canakinumab

About the drug under consideration

Canakinumab is a human monoclonal anti-human interleukin-1 beta (IL-1 beta) antibody of the IgG1/κ isotype manufactured by Novartis Pharma AG. Canakinumab binds with high affinity specifically to human IL-1 beta and neutralises the biological activity of human IL-1 beta by blocking its interaction with IL-1 receptors, thereby preventing IL-1 beta-induced gene activation and the production of inflammatory mediators [169].

monoklonaler Antkörper

EMA Orphan Drug Zulassung für diverse Indikationen

Canakinumab is not authorised in Covid-19 patients (EMA, FDA).

Withdrawn, suspended or terminated studies

No withdrawn, suspended or terminated interventional studies were found on canakinumab in ClinicalTrials.gov and EUdraCT registers.

keine abgeschlossenen, abgebrochenen Studien

Results of publications

There are no published RCTs related to effectiveness and safety of canakinumab for Covid-19. Two studies of canakinumab are still ongoing: one Phase III study, estimated study completion date on December 2020 and one Phase II study, estimated completion date on December 2020 [170-172].

keine veröffentlichten Studien
1 Phase 3 Studie läuft

Manufacturer recently **announced preliminary interim results** from the CAN-COVID trial: the CAN-COVID trial failed to meet its primary endpoint showing that treatment with canakinumab plus standard of care (SoC) did not demonstrate a significantly greater chance of survival for patients without the need for invasive mechanical ventilation, compared with placebo plus SoC up to Day 29. The trial did not meet its key secondary endpoint of reducing the COVID-19-related death rate during the 4-week period after treatment. The safety profiles of canakinumab plus SoC and placebo plus SoC were comparable (https://www.novartis.com/coronavirus/can-covid-clinical-trial).

CAN-COVID
negative Ergebnisse
kein Unterschied

3.23 Lenzilumab

About the drug under consideration

Lenzilumab is a first-in-class Humaneered® recombinant monoclonal antibody targeting human GM-CSF, with potential immunomodulatory activity, high binding affinity in the picomolar range, 94% homology to human germline, and has low immunogenicity. Following intravenous administration, lenzilumab binds to and neutralizes GM-CSF, preventing GM-CSF binding to its receptor, thereby preventing GM-CSF-mediated signaling to myeloid progenitor cells. The inhibition of GM-CSF signaling may be beneficial in improving the hyperinflammation-related lung damage in the most severe cases of COVID-19. This blockade can be achieved through antagonism of the GM-CSF receptor or the direct binding of circulating GM-CSF [173, 174].

monoklonaler Antikörper

für keine Indikation bislang zugelassen

FDA: für Einzelanwendungen im Notfall – compassionate use zur Verhinderung von akutem Lungenversagen

Lenzilumab is not authorised in Covid-19 patients (EMA, FDA). FDA has approved the administration of lenzilumab for COVID-19 patients under individual patient emergency IND applications to patients under the company's compassionate use program.

Withdrawn, suspended or terminated studies

No withdrawn, suspended or terminated interventional studies were found on lenzilumab in ClinicalTrials.gov and EUdraCT registers.

Okt 2020: keine weiteren Studien

Results of publications

There are no published RCTs related to effectiveness and safety of lenzilumab for Covid-19.

A multicenter, phase 3, randomized, double-blinded, controlled, clinical trial with lenzilumab for the prevention of ARDS and/or death in hospitalized patients with pneumonia associated with coronavirus 2 (SARS-CoV-2) infection in COVID-19 patients is ongoing in US (NCT04351152). The primary objective of this study is to assess whether the use of lenzilumab in addition to current standard of care can alleviate the immune-mediated cytokine release syndrome (CRS) and reduce the time to recovery in 300 hospitalized patients with severe or critical COVID-19 pneumonia, with estimated completion date on September 2020 [37].

Phase 3 RCT an hospitalisierten Pts mit Lungenentzündung 300 Pts.

3.24 Vitamin D

About the drug under consideration

Vitamin D (ergocalciferol-D2, cholecalciferol-D3) is a fat-soluble vitamin increases the intestinal absorption of calcium and phosphate. Vitamin D is absorbed from the intestine and transported by protein binding in the blood to the liver (first hydroxylation to 25-hydroxycholecalciferol) and to the kidney (2nd hydroxylation to 1,25- dihydroxycholecalciferol, active metabolite responsible for increasing calcium absorption). It has been claimed as potentially protective against the infection since it may be associated with immunocompetence, inflammation, aging, and those diseases involved in determining the outcomes of COVID-19 [175]. VIOLET RCT (NCT03096314) of early high-dose enteral vitamin D3 supplementation in critically ill, vitamin D–deficient patients who were at high risk for death did not provide an advantage over placebo with respect to 90-day mortality or other, nonfatal outcomes among critically ill, vitamin D–deficient patients [176]. RCTs to assess efficacy and safety of vitamin D in COVID-19 patients are underway.

protektive Wirkung gegen Infekte bekannt

assoziiert mit guter Immunantwort

VIOLET
RCT zu hoch-dosiertem Vit D3 zur Supplementierung kein Vorteil

mehrere klinische Studien laufend

Vitamin D is not authorised in Covid-19 patients (EMA, FDA).

The **US COVID-19 Treatment Guidelines Panel** stated that there are **insufficient data** to recommend either **for or against** the use of vitamin D for the prevention or treatment of COVID-19 [125].

US COVID-19 Treatment Guidelines Panel: insuffiziente Datenlage

Withdrawn, suspended or terminated studies

No withdrawn, suspended or terminated interventional studies were found on Vitamin D in ClinicalTrials.gov and EUdraCT registers.

Results of publications

Entrenas Castillo et al. 2020 [177] published results from parallel pilot randomized open label, double-masked clinical trial on 76 consecutive patients hospitalized with COVID-19 infection in Spain (NCT04366908). Eligible patients were allocated at a 2 calcifediol:1 no calcifediol ratio, through electronic randomization on the day of admission to take oral calcifediol (0.532 mg), or not. Patients in the calcifediol treatment group continued with oral calcifediol (0.266 mg) on day 3 and 7, and then weekly until discharge or ICU admission. Of 50 patients treated with calcifediol, one required admission to the ICU (2%), while of 26 untreated patients, 13 required admission (50 %), $p < 0.001$. Calcifediol or 25-hydroxyvitamin D, a main metabolite of vitamin D, significantly reduced the need for ICU treatment of patients requiring hospitalization due to proven COVID-19:

RCT
76 hospitalisierte Pts

Vorteil bei Verhinderung von ICU Verschlechterung der Erkrankung

Univariate Risk Estimate Odds Ratio for ICU in patients with Calcifediol treatment versus without Calcifediol treatment: 0.02 (95 %CI 0.002- 0.17). Multivariate Risk Estimate Odds Ratio for ICU in patients with Calcifediol treatment vs Without Calcifediol treatment ICU (adjusting by Hypertension and T2DM): 0.03 (95 %CI: 0.003-0.25). Of the patients treated with calcifediol, none died, and all were discharged, without complications. The 13 patients not treated with calcifediol, who were not admitted to the ICU, were discharged. Of the 13 patients admitted to the ICU, two died and the remaining 11 were discharged.

Rastogi et al. 2020 [178] published results from randomized, placebo-controlled trial (NCT04459247, SHADE) on 40 COVID-19 adult asymptomatic or mildly symptomatic SARS-CoV-2 RNA positive vitamin D deficient individuals (intervention (n=16) or control (n=24) group), with outcomes measure: Proportion of patients with SARSCoV-2 RNA negative before day-21 and change in inflammatory markers. 10 (62.5%) participants in the intervention group and 5 (20.8%) participants in the control arm ($p<0.018$) became SARS-CoV-2 RNA negative. Fibrinogen levels significantly decreased with cholecalciferol supplementation (intergroup difference 0.70 ng/ml; $p=0.007$) unlike other inflammatory biomarkers.

RCT
40 Patient*innen asymptomatisch oder mild symptomatisch

Reduktion Entzündungsmarker Fibrinogen

Murai et al. 2020 [179] presented as pre-print results from double-blind, randomised, placebo-controlled trial involving 240 hospitalised patients with severe COVID-19, in Brasil (NCT04449718). A single dose of 200,000 IU of vitamin D3 supplementation was safe and effective in increasing 25-hydroxyvitamin D levels, but did not significantly reduce hospital length of stay (hazard ratio, 1.12) or any other 10 clinically-relevant outcomes compared with placebo.

RCT
240 hospitalisierte Patient*innen
kein Unterschied bei Dauer des Krankenhausaufenthalts

Summary of Finding table related to **Vitamin D compared to Standard care/Placebo** for mild/moderate/severe COVID-19 patients, related to 3 RCTs mentioned above, is presented in Table 3.24-1 below. The evidence is very uncertain about the effect of Vitamin D on outcomes: All-cause mortality D14-D28 (RR 0.56, 95% CI 0.05 to 5.85, 2 RCTs, very low certainty of evidence) and WHO progression score (level 7 or above) D14-D28 (RR 0.04, 95% CI 0.01 to 0.29, 1 RCT, very low certainty of evidence). Vitamin D may not increase Adverse events (RR 2.98, 95% CI 0.12 to 72.30, 1 RCT, low certainty of evidence).

SoF von 3 RCTs
sehr unsichere Evidenz
ev. Verhinderung von Verschlechterung

*Table 3.24-1: Summary of findings table on **Vitamin D compared to standard care** (3 RCT:Entrenas Castillo, Rastogi, Murai) - https://covid-nma.com/living_data/index.php)*

Vitamin D compared to Standard care/Placebo for Mild/Moderate/Severe COVID-19

Patient or population: Mild/Moderate/Severe COVID-19
Setting: Worldwide
Intervention: Vitamin D
Comparison: Standard care/Placebo

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with Standard care/Placebo	Risk with Vitamin D				
Viral negative conversion D3 - not reported	-	-	-	-	-	outcome not yet measured or reported
Viral negative conversion D7 - not reported	-	-	-	-	-	outcome not yet measured or reported
Clinical improvement D7 - not reported	-	-	-	-	-	outcome not yet measured or reported
Clinical improvement D14-D28 - not reported	-	-	-	-	-	outcome not yet measured or reported
WHO Progression Score (level 6 or above) D7 - not reported	-	-	-	-	-	outcome not yet measured or reported
WHO Progression Score (level 6 or above) D14-D28 - not reported	-	-	-	-	-	outcome not yet measured or reported
WHO progression score (level 7 or above) D7 - not reported	-	-	-	-	-	outcome not yet measured or reported
WHO progression score (level 7 or above) D14-D28	500 per 1,000	**20 per 1,000** (5 to 145)	**RR 0.04** (0.01 to 0.29)	76 (1 RCT) [b]	⨁◯◯◯ VERY LOW [c,d,e]	
All-cause mortality D7 - not reported	-	-	-	-	-	outcome not yet measured or reported
All-cause mortality D14-D28	56 per 1,000	**31 per 1,000** (3 to 325)	**RR 0.56** (0.05 to 5.85)	313 (2 RCTs) [f]	⨁◯◯◯ VERY LOW [c,g,h]	
Adverse events	0 per 1,000	**0 per 1,000** (0 to 0)	**RR 2.98** (0.12 to 72.30)	237 (1 RCT) [i]	⨁⨁◯◯ LOW [h,j]	
Serious adverse events - not reported	-	-	-	-	-	outcome not yet measured or reported

*The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CI: Confidence interval; RR: Risk ratio

GRADE Working Group grades of evidence: High certainty: We are very confident that the true effect lies close to that of the estimate of the effect; **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different; **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect; **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations: a. Last updated: 06 December, 2020; b. Entrenas Castillo M, J Steroid Biochem Mo, 2020; c. Risk of bias downgraded by 1 level: some concerns regarding adequate randomization and deviations from intended interventions.; d. Indirectness downgraded by 1 level: results are from a single study from a single institution, therefore results in this population might not be generalizable to other settings.; e. Imprecision downgraded by 1 level: due to low number of events and participants.; f. Entrenas Castillo M, J Steroid Biochem Mo, 2020; Murai I, medRxiv, 2020; g. Inconsistency downgraded by 1 level: I^2=58.9%; h. Imprecision downgraded by 2 levels: due to very wide confidence interval consistent with the possibility for benefit and the possibility for harm and low number of events and participants.; i. Murai I, medRxiv, 2020; j. We presume that the adverse event rates and the corresponding relative risks, are similar across diverse settings; therefore not downgraded for indirectness.

3.25 Baricitinib

About the drug under consideration

Januskinase-Inhibitor

Baricitinib is a selective and reversible inhibitor of Janus kinase (JAK)1 and JAK2. Janus kinases (JAKs) are enzymes that transduce intracellular signals from cell surface receptors for a number of cytokines and growth factors involved in haematopoiesis, inflammation and immune function. Baricitinib (Olumiant) is indicated in EU for the treatment of moderate to severe active rheumatoid arthritis in adult patients who have responded inadequately to, or who are intolerant to one or more disease-modifying anti-rheumatic drugs and for the treatment of moderate to severe atopic dermatitis in adult patients who are candidates for systemic therapy [180, 181].

Baricitinib (Olumiant) in EU für moderate bis schwere rheumatoide Arthritis zugelassen

EMA: keine Zulassung für covid-19

Baricitinib (Olumiant) has not been approved by the European Medicines Agency (EMA). On November 19, 2020, the U.S. Food and Drug Administration (**FDA**) issued an **Emergency Use Authorization** (**EUA**) for the distribution and emergency use of baricitinib to be used **in combination with remdesivir** in **hospitalised adult and pediatric patients two years of age or older** with suspected or laboratory confirmed COVID-19 **who require supplemental oxygen, invasive mechanical ventilation, or extracorporeal membrane oxygenation** (ECMO) [182].

FDA Zulassung (EUA) als Kombinationstherapie mit Remdesivir hospitalisierte Patient*innen mit Bedarf zur Beatmung

US COVID-19 Treatment Guidelines Panel : suffiziente Datenlage

The **US COVID-19 Treatment Guidelines Panel** stated that there are **insufficient data** to recommend either **for or against** baricitinib in combination with remdesivir therapy in hospitalised patients with COVID-19 disease, in cases where corticosteroids can be used instead [125].

In the rare circumstances where corticosteroids cannot be used, the Panel recommends using baricitinib in combination with remdesivir for the treatment of COVID-19 in hospitalized, nonintubated patients who require oxygen supplementation **(BIIa).**

The Panel **recommends against** the use of baricitinib in the absence of remdesivir, except in a clinical trial **(AIII).**

There are insufficient data for the Panel to recommend either for or against the use of baricitinib in combination with corticosteroids for the treatment of COVID-19. Since both agents are potent immunosuppressants, there is potential for an additive risk of infection.

More data are needed to clarify the role of baricitinib in the management of COVID-19. Health care providers are encouraged to discuss participation in baricitinib clinical trials with their patients [125].

Withdrawn, suspended or terminated studies

keine Studien abgebrochen, zurückgezogen

No withdrawn, suspended or terminated interventional studies were found on baricitinib in ClinicalTrials.gov and EUdraCT registers.

Results of publications

ACTT-2
Baricitinib + Remdesivir vs. Remdesivir

Verkürzung der Erkrankung unter Kombinationstherapie

besser in Verhinderung von Fortschreiten de Erkrankung und bei Bedarf nach Beatmung

kein Unterschied bei Mortalität

On December 11, 2020, **Kalil et al.** [183] published results from the Adaptive COVID-19 Treatment Trial (**ACTT-2**) (**NCT04401579**), multicentre, double-blind, randomised, placebo-controlled trial evaluating **baricitinib plus remdesivir with remdesivir alone** in **hospitalised adults** with Covid-19 in eight countries. Patients treated with baricitinib in combination with remdesivir had a significant reduction in median time to recovery from 8 to 7 days compared to remdesivir. Patients receiving high-flow oxygen or noninvasive ventilation at enrollment had a time to recovery of 10 days with combination treatment and 18 days with remdesivir alone (rate ratio for recovery, 1.51; 95% CI, 1.10 to 2.08). Patients treated with baricitinib in combination with remdesivir were more likely to have a better clinical status at day 15 compared to patients treated with remdesivir. Patients with a baseline ordinal score of 6 who received combination treatment were most likely to have clinical improvement at day 15 (odds ratio, 2.2; 95% CI, 1.4 to 3.6). The proportion of patients who died by Day 29 was not statistically significant different between groups: the 28-day mortality was 5.1% in the combination group and 7.8% in the remdesivir group (hazard ratio for death, 0.65; 95% CI, 0.39 to 1.09). The incidence of new use of oxygen was statistically significant lower in the combination group than in the remdesivir group (22.9% vs. 40.3%; difference, -17.4 percentage points; 95% CI, -31.6 to -2.1), as was the incidence of new use of mechanical ventilation or ECMO (10.0% vs. 15.2%; difference, -5.2 percentage points; 95% CI, -9.5 to -0.9). The incidence of progression to death or noninvasive or invasive ventilation was lower in the combination group than in the remdesivir group (22.5% vs. 28.4%; rate ratio, 0.77; 95% CI, 0.60 to 0.98), as was the incidence of progression to death or invasive ventilation (12.2% vs. 17.2%; rate ratio, 0.69; 95% CI, 0.50 to 0.95).

5% der Patient*innen haben ≥ 3 Nebenwirkungen – in IG und KG

weniger SAE unter Kombinationstherapie

The most common grade 3 or 4 adverse events occurring in at least 5% of all patients were hyperglycemia, anemia, decreased lymphocyte count, and acute kidney injury. The incidence of these adverse events was similar in the two treatment groups. Serious adverse events were statistically significant less frequent in the combination group than in the remdesivir group (16.0% vs. 21.0%; difference, -5.0 percentage points; 95% CI, -9.8 to -0.3; p=0.03), as were new infections (5.9% vs. 11.2%; difference, -5.3 percentage points; 95% CI, -8.7 to -1.9; p=0.003).

3.26 Molnupiravir

About the drug under consideration

antivirales Medikament
ähnlich Remdesivir
aber orale Verabreichung

Molnupiravir is the orally available pro-drug of the nucleoside analogue N4-hydroxycytidine (NHC), which has shown potent anti-influenza virus activity in mice, guinea pigs, ferrets and human airway epithelium organoids. Animal study in ferrets showed that therapeutic treatment of infected animals with molnupiravir (MK-4482/EIDD-2801) twice a day significantly reduced the SARS-CoV-2 load in the upper respiratory tract and completely suppressed spread to untreated contact animals [184, 185].

Molnupiravir attacks the same viral enzyme as Gilead's Remdesivir, but it can be taken orally. This would allow an administration at home and, therefore, earlier in the course of the disease. According to Ridgeback Biotherapeutics, molnupiravir has an extremely high barrier to resistance. According to Merck Sharp & Dohme/ MSD, molnupiravir is aimed at the treatment of Covid-19 in patients hospitalised due to mild, moderate or severe disease, and non-hospitalized patients with mild or moderate disease [185].

frühere Verabreichung zu Hause daher möglich

hospitalisierte, aber auch milde und moderate Erkrankung

Molnupiravir is not approved by the European Medicines Agency (EMA) or the American Food and Drug Administration (FDA) [185].

weder von EMA noch FDA zugelassen

Withdrawn, suspended or terminated studies

No withdrawn, suspended or terminated interventional studies were found on molnupiravir in ClinicalTrials.gov and EUdraCT registers.

Results of publications

There are no published RCTs related to effectiveness and safety of molnupiravir for Covid-19. It is currently investigated in phase 1/2, 2 and 2/3 clinical trials (NCT04405570, NCT04405739, NCT04575584, NCT04575597, ISRCTN27106947), in hospitalised and non-hospitalised aduls with COVID-19.

keine RCTs derzeit in Phase 1/ 2, 2 und 1/ 3 Studien mit verschiedenen Pts. Populationen

3.27 Ivermectin

About the drug under consideration

Ivermectin (manufactured by Merck Sharp & Dohme as Mectizan and Stromectol tablets a 3 mg) is a semisynthetic, anthelmintic agent for oral administration. Ivermectin is derived from the avermectins, a class of highly active broad-spectrum, anti-parasitic agents isolated from the fermentation products of Streptomyces avermitilis. It is indicated for the treatment of the following infections: Strongyloidiasis of the intestinal tract and the treatment of onchocerciasis due to the nematode parasite Onchocerca volvulus, https://www.merck.com/product/usa/pi_circulars/s/stromectol/stromectol_pi.pdf. On the WHO's Model List of Essential Medicines it is retained in the form of a 3 mg tablet. For parasitic infections in adults, ivermectin is commonly administered as a single 12 mg oral dose (0.2mg/kg).

zugelassen als Mectizan und Stromectol gegen parasitäre Infektionen

(z.B. Onchozerkose)

Recently, Caly et al. 2020 [186] reported that ivermectin in vitro is an inhibitor of the causative virus (SARS-CoV-2), with a single addition to Vero-hSLAM cells 2 h post infection with SARS-CoV-2 able to effect ~5000-fold reduction in viral RNA at 48 h. Ivermectin therefore warrants further investigation for possible benefits in humans. Ivermectin is not approved for Covid-19 by the European Medicines Agency (EMA) or the American Food and Drug Administration (FDA).

von EMA und FDA nicht für covid-19 zugelassen

The **US COVID-19 Treatment Guidelines Panel** recommends **against** ivermectin therapy in patients with COVID-19 disease, except in a clinical trial (**AIII**) [125].

US COVID-19 Treatment Guidelines Panel : nur in klinischen Studien

Withdrawn, suspended or terminated studies

No withdrawn, suspended or terminated interventional studies were found on ivermectin in COVID-19 patients in ClinicalTrials.gov and EUdraCT registers.

keine abgebrochenen oder zurückgezogenene Studien

Results of publications

Several RCTs compared **ivermectin vs standard care**, published in scientific journals or as preprint, showed positive or negative results on different clinical outcomes in COVID-19 patients [187-192]. **Podder et al. 2020** [187] published negative results from single-centre, open-label, randomised controlled trial in 62 mild to moderate COVID-19 patients. Total recovery time from the onset of symptoms to complete resolution of symptoms was not significantly different (intervention arm 10.09 ± 3.236 days, compared to 11.50 ± 5.32 days in the control arm (95% CI -0.860,3.627, p>0.05). The same was true for results of negative repeat RT- PCR.

mehrere RCTs

RCT, 62 Pts. milde bis moderate Krankheit

kein Unterschied

Krolewiecki et al. 2020 [188] published positive results from a pilot, randomised, controlled, outcome-assessor blinded clinical trial with the goal of evaluating the antiviral activity of high dose ivermectin in **mild or moderate COVID-19** patients (NCT004381884). 45 patients were randomized in a 2:1 ratio to standard of care plus oral ivermectin at 0.6 mg/kg/day for 5 days versus standard of care. There was no difference in viral load reduction between groups but a significant difference in reduction was found in patients with higher median plasma ivermectin levels (72% IQR 59 – 77) versus untreated controls (42% IQR 31 – 73) (p=0.004). The mean ivermectin plasma concentration levels also showed a positive correlation with viral decay rate (r:0.47, p=0.02). Adverse events were reported in 5 (33%) patients in the controls and 13 (43%) in the ivermectin treated group, without a relationship between ivermectin plasma levels and adverse events.

RCT, 45 Pts. milde bis moderate Krankheit
kein Unterscheid bei Viruslastreduktion, aber bei Pts. mit höherPlasma Konzentration

Ahmed et al. 2020 [189] published positive results from randomised, double-blind, placebo-controlled trial in 72 **hospitalised** adult SARS-CoV-2 patients who were assigned to one of three groups: oral ivermectin alone (12 mg once daily for 5 days), oral ivermectin in combination with doxycycline (12 mg ivermectin single dose and 200 mg doxycycline on day 1, followed by 100 mg every 12 h for the next 4 days), and a placebo control group. Clinical symptoms of fever, cough, and sore throat were comparable among the three groups. Virological clearance was earlier in the 5-day ivermectin treatment arm when compared to the placebo group (9.7 days vs 12.7 days; p=0.02), but this was not the case for the ivermectin + doxycycline arm (11.5 days; p=0.27). There were no severe adverse drug events recorded in the study.

RCT, 72 Pts, hospitalisiert

klinische Symptome: kein Unterschied
gewisse zeitlcie Verkürzung der Viruslast

Chachar et al. 2020 [190] published negative results from open label randomised control tria in 50 **mild COVID-19** patients, divided into two groups: Ivermectin group received 12mg stat and then 12 mg after 12 hours and 12mg after 24 hours, and control group. There was no significant difference on outcome improvement of symptoms between case group who were given ivermectin along with symptomatic treatment and control group who were only given symptomatic treatment without ivermectin, on day 7 at follow up (p=0.500).

RCT, 50 Pts. milde Erkrankung

kein Unterschied

Niaee et al. 2020 [191] published positive results from 45-days randomised, double-blind, placebo-controlled, multicenter, phase 2 clinical trial in 180 **mild to severe hospitalised COVID-19** patients (IRCT20200408046987N1). The participants were randomly allocated to six arms including common regimens (Hydroxychloroquine 200mg/kg twice per day), placebo plus common regime, single dose ivermectin (200mcg/Kg, 1 pill per day), three low interval doses of ivermectin (200, 200, 200 mcg/Kg , 3 pills in 1, 3 and 5 interval days), single dose ivermectin (400mcg/Kg, 2 pills per day), and three high interval doses of ivermectin (400, 200, 200 mcg/Kg, 4 pills in 1, 3 and 5 interval days). Ivermectin significantly reduced the rate of mortality, low O2 duration, and duration of hospitalization in adult COVID 19 patients.

RCT, 180 Pts. mild bis schwere Erkrankung, hospitalisiert

Vorteile bei Mortalität, Dauer der Hospitalisierung

Babalola et al. 2021 [192] published results from a translational proof of concept randomised, double blind placebo controlled, dose response, parallel group study of ivermectin efficacy in RT - PCR proven **mild to moderate COVID 19** positive patients (ISRCTN40302986). 62 patients were randomised to 3 treatment groups: ivermectin 6mg regime; ivermectin 12 mg regime (given Q84hrs for 2weeks); control group Lopinavir/Ritonavir. All groups plus standard of care. The Days to COVID negativity [DTN] was significantly and dose dependently reduced by ivermectin (p=0.0066). 12 mg ivermectin regime may have superior efficacy.

RCT, 62 Pts, milde bis moderate Erkrankung

Reduktion der Erkrankungsdauer

The metaanalysis ongoing and **Summary of findings table** related to **ivermectin vs standard care** will be added in the next version of this document.

eine Metaanalyse läuft derzeit

3.28 Aspirin (acetylsalicylic acid)

About the drug under consideration

Aspirin (acetylsalicylic acid) is a non-steroidal anti-inflammatory drug with strong anti-inflammatory, anti-thrombotic and analgesic pharmacological effects. Long-term low-dose aspirin (75-150 mg daily) can effectively prevent the incidence of ischaemic cardiovascular and cerebrovascular event. Acetylsalicylic acid inhibits the platelet activation: blocking the platelet cyclooxygenase by acetylation, it inhibits thromboxane A2 synthesis, a physiological activating substance released by the platelets and which would play a role in the complications of the atheromatosic lesions. The repeated doses from 20 to 325 mg involve an inhibition of the enzymatic activity from 30 to 95%. Due to the irreversible nature of the binding, the effect persists for the lifespan of a thrombocyte (7-10 days). The inhibiting effect does not exhaust during prolonged treatments and the enzymatic activity gradually begins again upon renewal of the platelets 24 to 48 hours after treatment interruption, https://www.medicines.org.uk/emc/product/2408/smpc.

nicht-steroidales Antirheumatikum

schmerzstillender, entzündungshemmender, fiebersenkender und Thrombozyten-aggregationshemmender Arzneistoff

Patients with COVID-19 are at higher risk of blood clots forming in their blood vessels. Platelets, small cell fragments in the blood that stop bleeding, seem to be hyperreactive in COVID-19 and may be involved in the clotting complications. Since aspirin is an antiplatelet agent, it may reduce the risk of blood clots in patients with COVID-19.

Patient*innen mit Covid-19 haben höheres Risiko für Bildung von Blutgerinnseln in Blutgefäßen

Chow et al. 2020 [193] published results from retrospective, observational cohort study of adult patients admitted with COVID-19 to multiple hospitals in the United States between March 2020 and July 2020. 412 patients were included in the study. 314 patients (76.3%) did not receive aspirin, while 98 patients (23.7%) received aspirin within 24 hours of admission or 7 days prior to admission. Aspirin use had a crude association with less mechanical ventilation (35.7% aspirin vs. 48.4% non-aspirin, p=0.03) and ICU admission (38.8% aspirin vs. 51.0% non-aspirin, p=0.04), but no crude association with in-hospital mortality (26.5% aspirin vs. 23.2% non-aspirin, p=0.51). After adjusting for 8 confounding variables, aspirin use was independently associated with decreased risk of mechanical ventilation (adjusted HR 0.56, 95% CI 0.37-0.85, p=0.007), ICU admission (adjusted HR 0.57, 95% CI 0.38-0.85, p=0.005), and in-hospital mortality (adjusted HR 0.53, 95% CI 0.31-0.90, p=0.02). There were no differences in major bleeding (p=0.69) or overt thrombosis (p=0.82) between aspirin users and non-aspirin users. Authors concluded that a sufficiently powered randomized controlled trial is needed to assess whether a causal relationship exists between aspirin use and reduced lung injury and mortality in COVID-19 patients.

retrospektive Kohortenstudie, 412 Pts

Vorteile bei künstlicher Beatmung und Intensivmedizin Spitalsmortalität

RCT für Nachweis einer Kausalität vonnöten

Aspirin is not approved for Covid-19 by the European Medicines Agency (EMA) or the American Food and Drug Administration (FDA).

Withdrawn, suspended or terminated studies

One RCT was found as withdrawn (NCT04343001) because grant not obtained. No suspended or terminated interventional studies were found on Aspirin in COVID-19 patients in ClinicalTrials.gov and EUdraCT registers.

1 RCT zurückgezogen (keine Finanzierung)

Results of publications

There are no published RCTs related to effectiveness and safety of Aspirin for Covid-19.

bislang keine RCTs veröffentlicht, aber klinische Untersuchung in RECOVERY

From 06 November 2020, Aspirin is being investigated in the world's largest clinical trial of treatments for patients hospitalised with COVID-19. The Randomised Evaluation of COVid-19 thERapY (**RECOVERY**) trial is taking place in 176 hospital sites across the UK, and has so far recruited over 16,000 patients, https://www.recoverytrial.net/news/aspirin-to-be-investigated-as-a-possible-treatment-for-covid-19-in-the-recovery-trial. It is anticipated that at least 2,000 patients will be randomly allocated to receive **Aspirin 150 mg daily plus usual standard-of-care**, and results will be **compared** with at least 2,000 patients who receive **standard-of-care** on its own. Patients will not be allocated to receive Aspirin if they have a known hypersensitivity to Aspirin; if they have experienced recent major bleeding or if they already take Aspirin or other antiplatelet agents. The main outcome RECOVERY will assess is mortality after 28 days. Other outcomes include the impact on hospital stay and the need for ventilation. It is likely to be several months before there is enough evidence to conclude whether Aspirin has a significant benefit in COVID-19 patients.

Studienarm mit Aspirin 2.000 Pts vs. SoC geplant

Ergebnisse erst in einigen Monaten zu erwarten

References

[1] Pang J., Wang M. X., Ang I. Y. H., Tan S. H. X., Lewis R. F., Chen J. I., et al. Potential Rapid Diagnostics, Vaccine and Therapeutics for 2019 Novel Coronavirus (2019-nCoV): A Systematic Review. J Clin Med. 2020;9(3). Epub 2020/03/01. DOI: 10.3390/jcm9030623

[2] Martin R., Löchel H., Welzel M., Hattab G., Hauschild A. and Heider D. CORDITE: The Curated CORona Drug InTERactions Database for SARS-CoV-2. iScience. 2020;23(7):101297-101297. DOI: 10.1016/j.isci.2020.101297.

[3] Boutron I. and al. e. Interventions for preventing and treating COVID-19: protocol for a living mapping of research and a living systematic review Zenodo. 2020;April 8(http://doi.org/10.5281/zenodo.3744600).

[4] Thorlund K., Dron L., Park J., Hsu G., Forrest J. and Mills E. A real-time dashboard of clinical trials for COVID-19. Lancet. 2020;April 24 (DOI:https://doi.org/10.1016/S2589-7500(20)30086-8).

[5] Chen Q., Allot A. and Lu Z. Keep up with the latest coronavirus research. Nature Communications. 2020;579(7798):193.

[6] Jackson L., Anderson E., Rouphael N., Roberts P., Makhene M., Coler R., et al. An mRNA Vaccine against SARS-CoV-2 — Preliminary Report. New England Journal of Medicine. 2020. DOI: 10.1056/NEJMoa2022483.

[7] Anderson E., Rouphael N., Widge A., Jackson L., Roberts P., Makhene M., et al. Safety and Immunogenicity of SARS-CoV-2 mRNA-1273 Vaccine in Older Adults. New England Journal of Medicine. 2020. DOI: 10.1056/NEJMoa2028436.

[8] Baden L., El Sahly H., Essink B., Kotloff K., Frey S., Novak R., et al. Efficacy and Safety of the mRNA-1273 SARS-CoV-2 Vaccine. New England Journal of Medicine. 2020. DOI: 10.1056/NEJMoa2035389.

[9] Zhu F., Li Y., Guan X., Hou L., Wang W., Li J., et al. Safety, tolerability, and immunogenicity of a recombinant adenovirus type-5 vectored COVID-19 vaccine: a dose-escalation, open-label, non-randomised, first-in-human trial. The Lancet. 2020;395(10240):1845-1854. DOI: 10.1016/S0140-6736(20)31208-3.

[10] Zhu F., Guan X., Li Y., Huang J., Jiang T., Hou L., et al. Immunogenicity and safety of a recombinant adenovirus type-5-vectored COVID-19 vaccine in healthy adults aged 18 years or older: a randomised, double-blind, placebo-controlled, phase 2 trial. The Lancet. 2020;396(10249):479-488. DOI: 10.1016/S0140-6736(20)31605-6.

[11] Keech C., Albert G., Cho I., Robertson A., Reed P., Neal S., et al. Phase 1–2 Trial of a SARS-CoV-2 Recombinant Spike Protein Nanoparticle Vaccine. New England Journal of Medicine. 2020. DOI: 10.1056/NEJMoa2026920.

[12] Folegatti P., Ewer K., Aley P., Angus B., Becker S., Belij-Rammerstorfer S., et al. Safety and immunogenicity of the ChAdOx1 nCoV-19 vaccine against SARS-CoV-2: a preliminary report of a phase 1/2, single-blind, randomised controlled trial. The Lancet. 2020;396(10249):467-478. DOI: 10.1016/S0140-6736(20)31604-4.

[13] Barrett J., Belij-Rammerstorfer S., Dold C., Ewer K., Folegatti P., Gilbride C., et al. Phase 1/2 trial of SARS-CoV-2 vaccine ChAdOx1 nCoV-19 with a booster dose induces multifunctional antibody responses. Nature Medicine. 2020. DOI: 10.1038/s41591-020-01179-4.

[14] Voysey M., Clemens S., Madhi S., Weckx L., Folegatti P., Aley P., et al. Safety and efficacy of the ChAdOx1 nCoV-19 vaccine (AZD1222) against SARS-CoV-2: an interim analysis of four randomised controlled trials in Brazil, South Africa, and the UK. The Lancet. DOI: 10.1016/S0140-6736(20)32661-1.

[15] Ramasamy M., Minassian A., Ewer K., Flaxman A., Folegatti P., Owens D., et al. Safety and immunogenicity of ChAdOx1 nCoV-19 vaccine administered in a prime-boost regimen in young and old adults (COV002): a single-blind, randomised, controlled, phase 2/3 trial. The Lancet. DOI: 10.1016/S0140-6736(20)32466-1.

[16] Logunov D., Dolzhikova I., Zubkova O., Tukhvatullin A., Shcheblyakov D., Dzharullaeva A., et al. Safety and immunogenicity of an rAd26 and rAd5 vector-based heterologous prime-boost COVID-19 vaccine in two formulations: two open, non-randomised phase 1/2 studies from Russia. The Lancet. 2020. DOI: 10.1016/S0140-6736(20)31866-3.

[17] Mulligan M., Lyke K., Kitchin N., Absalon J., Gurtman A., Lockhart S., et al. Phase I/II study of COVID-19 RNA vaccine BNT162b1 in adults. Nature. 2020. DOI: 10.1038/s41586-020-2639-4.

[18] Sahin U., Muik A., Derhovanessian E., Vogler I., Kranz L., Vormehr M., et al. COVID-19 vaccine BNT162b1 elicits human antibody and TH1 T-cell responses. Nature. 2020. DOI: 10.1038/s41586-020-2814-7.

[19] Polack F., Thomas S., Kitchin N., Absalon J., Gurtman A., Lockhart S., et al. Safety and Efficacy of the BNT162b2 mRNA Covid-19 Vaccine. New England Journal of Medicine. 2020. DOI: 10.1056/NEJMoa2034577.

[20] Xia S., Duan K., Zhang Y., Zhao D., Zhang H., Xie Z., et al. Effect of an Inactivated Vaccine Against SARS-CoV-2 on Safety and Immunogenicity Outcomes: Interim Analysis of 2 Randomized Clinical Trials. JAMA. 2020. DOI: 10.1001/jama.2020.15543.

[21] Mulligan M. An Inactivated Virus Candidate Vaccine to Prevent COVID-19. JAMA. 2020. DOI: 10.1001/jama.2020.15539.

[22] Xia S., Zhang Y., Wang Y., Wang H., Yang Y., Gao G., et al. Safety and immunogenicity of an inactivated SARS-CoV-2 vaccine, BBIBP-CorV: a randomised, double-blind, placebo-controlled, phase 1/2 trial. The Lancet Infectious Diseases. 2020. DOI: 10.1016/S1473-3099(20)30831-8.

[23] Zhang Y., Zeng G., Pan H., Li C., Hu Y., Chu K., et al. Safety, tolerability, and immunogenicity of an inactivated SARS-CoV-2 vaccine in healthy adults aged 18–59 years: a randomised, double-blind, placebo-controlled, phase 1/2 clinical trial. The Lancet Infectious Diseases. DOI: 10.1016/S1473-3099(20)30843-4.

[24] European Medicines Agency (EMA). International regulators align positions on phase 3 COVID-19 vaccine trials.: 09/07/2020. Available from: https://www.ema.europa.eu/en/news/international-regulators-align-positions-phase-3-covid-19-vaccine-trials.

[25] European Medicines Agency (EMA). EMA starts second rolling review of a COVID-19 vaccine. 2020 [cited 06/10/2020]. Available from: https://www.ema.europa.eu/en/news/ema-starts-second-rolling-review-covid-19-vaccine.

[26] European Medicines Agency (EMA). EMA receives application for conditional marketing authorisation of COVID-19 mRNA vaccine BTN162b2. 2020 [cited 01/12/2020]. Available from: https://www.ema.europa.eu/en/news/ema-receives-application-conditional-marketing-authorisation-covid-19-mrna-vaccine-bnt162b2.

[27] European Medicines Agency (EMA). EMA receives application for conditional marketing authorisation of Moderna COVID-19 vaccine. 2020 [cited 01/12/2020]. Available from: https://www.ema.europa.eu/en/news/ema-receives-application-conditional-marketing-authorisation-moderna-covid-19-vaccine.

[28] European Medicines Agency (EMA). EMA starts rolling review of Janssen's COVID-19 vccine Ad26.COV2.S. 2020 [cited 01/12/2020]. Available from: https://www.ema.europa.eu/en/news/ema-starts-rolling-review-janssens-covid-19-vaccine-ad26cov2s.

[29] European Medicines Agency (EMA). EMA recommends first COVID-19 vaccine for authorisation in the EU. News. 2020 [cited 21/12/2020]. Available from: https://www.ema.europa.eu/en/news/ema-recommends-first-covid-19-vaccine-authorisation-eu.

[30] European Medicines Agency (EMA). EMA recommends COVID-19 vaccine Moderna for authorisation in the EU. News 2020 [cited 06/01/2021]. Available from: https://www.ema.europa.eu/en/news/ema-recommends-covid-19-vaccine-moderna-authorisation-eu.

[31] Jackson L. A. Safety and Immunogenicity Study of 2019-nCoV Vaccine (mRNA-1273) for Prophylaxis SARS CoV-2 Infection. 2020 [cited 07.04.]. Available from: https://clinicaltrials.gov/ct2/show/NCT04283461.Jackson.

[32] European Medicines Agency (EMA). COVID-19 Vaccine Moderna – Product information. 2020. Available from: https://www.ema.europa.eu/en/documents/product-information/covid-19-vaccine-moderna-product-information_en.pdf.

[33] National Institute of Health (NIH). NIH clinical trial of investigational vaccine for COVID-19 begins. 2020 [cited 07.04.]. Available from: https://www.nih.gov/news-events/news-releases/nih-clinical-trial-investigational-vaccine-covid-19-begins.

[34] World Health Organisation (WHO). DRAFT landscape of COVID-19candidate vaccines –20 March 2020. 2020 [cited 31.03.2020]. Available from: https://www.who.int/blueprint/priority-diseases/key-action/novel-coronavirus-landscape-ncov-21march2020.PDF?ua=1.

[35] BioWorld. China approves first homegrown COVID-19 vaccine to enter clinical trials. [cited 02.03.2020]. Available from: https://www.bioworld.com/articles/433791-china-approves-first-homegrown-covid-19-vaccine-to-enter-clinical-trials.

[36] U.S. National Library of Medicine. A Phase I Clinical Trial in 18-60 Adults (APICTH). 2020. Available from: https://clinicaltrials.gov/ct2/show/NCT04313127.

[37] U.S. National Library of Medicine. ClinicalTrials.gov. Available from: https://clinicaltrials.gov/.

[38] University of Oxford. Oxford team to begin novel coronavirus vaccine research. 2020 [cited 03.04.2020]. Available from: http://www.ox.ac.uk/news/2020-02-07-oxford-team-begin-novel-coronavirus-vaccine-research.

[39] Denis M., Vanderweerd V., Verbeke R. and Van der Vliet D. Overview of information available to support the development of medical countermeasures and interventions against COVID-19. Living document. 2020 [cited 03.03.2020]. Available from: https://rega.kuleuven.be/if/pdf_corona.

[40] U.S. National Library of Medicine. A Study of a Candidate COVID-19 Vaccine (COV001). 2020. Available from: https://clinicaltrials.gov/ct2/show/NCT04324606.

[41] Mahase E. Covid-19: Oxford team begins vaccine trials in Brazil and South Africa to determine efficacy. BMJ. 2020;369:m2612. DOI: 10.1136/bmj.m2612.

[42] ISRCTNregistry. ISRCTN89951424. A phase III study to investigate a vaccine against COVID-19. 2020 [cited 13/07/2020]. Available from: https://doi.org/10.1186/ISRCTN89951424.

[43] Hodgson J. The pandemic pipeline. 2020 [cited 03.04.]. Available from: https://www.nature.com/articles/d41587-020-00005-z.

[44] European Medicines Agency (EMA). Comirnaty (COVID-19 mRNA vaccine [nucleoside modified]). EPAR – Product information. 2020. Available from: https://www.ema.europa.eu/en/medicines/human/EPAR/comirnaty.

[45] FierceBiotech. Pfizer, BioNTech strike COVID-19 deal, commit multiple R&D sites to vaccine development. 2020 [cited 07.04.]. Available from: https://www.fiercebiotech.com/biotech/pfizer-biontech-strike-covid-19-deal-commit-multiple-r-d-sites-to-vaccine-development.

[46] Walsh E., Frenck R., Falsey A., Kitchin N., Absalon J., Gurtman A., et al. RNA-Based COVID-19 Vaccine BNT162b2 Selected for a Pivotal Efficacy Study. medRxiv. 2020:2020.2008.2017.20176651. DOI: 10.1101/2020.08.17.20176651.

[47] Krammer F. SARS-CoV-2 vaccines in development. Nature. 2020. DOI: 10.1038/s41586-020-2798-3.

[48] Sinovac. Sinovac Announces Positive Preliminary Results of Phase I/II Clinical Trials for Inactivated Vaccine Candidate Against COVID-19. 2020. Available from: http://www.sinovac.com/?optionid=754&auto_id=904.

[49] Isakova-Sivak I. and Rudenko L. A promising inactivated whole-virion SARS-CoV-2 vaccine. The Lancet Infectious Diseases. 2020. DOI: 10.1016/S1473-3099(20)30832-X.

[50] Sadoff J., Le Gars M., Shukarev G., Heerwegh D., Truyers C., de Groot A., et al. Safety and immunogenicity of the Ad26.COV2.S COVID-19 vaccine candidate: interim results of a phase 1/2a, double-blind, randomized, placebo-controlled trial. medRxiv. 2020:2020.2009.2023.20199604. DOI: 10.1101/2020.09.23.20199604.

[51] Novavax. Novavax Awarded Funding from CEPI for COVID-19 Vaccine Development. 2020 [cited 06.04.]. Available from: https://ir.novavax.com/news-releases/news-release-details/novavax-awarded-funding-cepi-covid-19-vaccine-development.

[52] Nature. A surprising player in the race for a SARS-CoV-2 vaccine. 2020 [cited 06.04.]. Available from: https://www.nature.com/articles/d42473-020-00032-z.

[53] Drug Development and Delivery. Novavax Advances Development of Novel COVID-19 Vaccine. 2020 [cited 06.04.]. Available from: https://drug-dev.com/novavax-advances-development-of-novel-covid-19-vaccine/.

[54] Novavax. MATRIX-M™ ADJUVANT TECHNOLOGY. 2020 [cited 06.04.]. Available from: https://novavax.com/page/10/matrix-m-adjuvant-technology.html.

[55] Mahase E. Covid-19: What do we know so far about vaccine? . BMJ. 2020;369:m1679.

[56] Callaway E. The race for coronavirus vaccines. Nature. 2020;580(April 30).

[57] Le T. and al. e. The COVID-19 vaccine development landscape. 2020. Available from: https://www.nature.com/articles/d41573-020-00073-5.

[58] CureVac AG. What We Do - The Unlimited Possibilities of mRNA. . Tübingen, Germany: 2020 [cited 03/04/2020]. Available from: https://www.curevac.com/mrna-platform.

[59] CureVac AG. CureVac and CEPI extend their Cooperation to Develop a Vaccine against Coronavirus nCoV-2019. Tübingen, Germany: 2020 [cited 03/04/2020]. Available from: https://www.curevac.com/news/curevac-and-cepi-extend-their-cooperation-to-develop-a-vaccine-against-coronavirus-ncov-2019.

[60] Kremsner P., Mann P., Bosch J., Fendel R., Gabor J., Kreidenweiss A., et al. Phase 1 Assessment of the Safety and Immunogenicity of an mRNA- Lipid Nanoparticle Vaccine Candidate Against SARS-CoV-2 in Human Volunteers. medRxiv. 2020:2020.2011.2009.20228551. DOI: 10.1101/2020.11.09.20228551.

[61] European Medicines Agency (EMA). Update on remdesivir. Meeting highlights from the Committee for Medicinal Products for Human Use (CHMP) 25-28 May 2020.: 2020 [cited 14/06/2020]. Available from: https://www.ema.europa.eu/en/news/meeting-highlights-committee-medicinal-products-human-use-chmp-25-28-may-2020 https://www.ema.europa.eu/en/human-regulatory/overview/public-health-threats/coronavirus-disease-covid-19/treatments-vaccines-covid-19#remdesivir-section

[62] European Medicines Agency (EMA). Summary of opinion (initial authorisation. Veklury (remdesivir). 25/06/2020. Available from: https://www.ema.europa.eu/en/documents/smop-initial/chmp-summary-positive-opinion-veklury_en.pdf.

[63] Beigel J., Tomashek K., Dodd L., Mehta A., Zingman B., Kalil A., et al. Remdesivir for the Treatment of Covid-19 — Preliminary Report. New England Journal of Medicine. 2020. DOI: 10.1056/NEJMoa2007764.

[64] The European public assessment report (EPAR). Veklury: Product information. 2020 [cited 06/07/2020]. Available from: https://www.ema.europa.eu/en/documents/product-information/veklury-epar-product-information_en.pdf.

[65] European Medicines Agency (EMA). Meeting highlights from the Pharmacovigilance Risk Assessment Committee (PRAC) 28 September - 1 October 2020. 2020 [cited 02/10/2020]. Available from: https://www.ema.europa.eu/en/news/meeting-highlights-pharmacovigilance-risk-assessment-committee-prac-28-september-1-october-2020.

[66] Federal Drug Administration (FDA). Fact sheet for healthcare providers: Emergency use authorization (EUA) of Baricitinib. 2020. Available from: https://www.fda.gov/media/143823/download.

[67] Rochwerg B., Agoritsas T., Lamontagne F., Leo Y., Macdonald H., Agarwal A., et al. A living WHO guideline on drugs for covid-19. BMJ. 2020;370:m3379. DOI: 10.1136/bmj.m3379.

[68] World Health Organisation (WHO). Repurposed Antiviral Drugs for Covid-19 — Interim WHO Solidarity Trial Results. New England Journal of Medicine. 2020. DOI: 10.1056/NEJMoa2023184.

[69] National Institutes of Health (NIH). COVID-19 Treatment Guidelines Panel. Coronavirus Disease 2019 (COVID-19) Treatment Guidelines. 2020 [cited 13/07/2020]. Available from: https://www.covid19treatmentguidelines.nih.gov/.

[70] Wang Y., Zhang D., Du G. and al. e. Remdesivir in adults with severe COVID-19: a randomised, double-blind, placebo-controlled, multicentre trial. Lancet. 2020;published online April 29(https://doi.org/10.1016/S0140-6736(20)31022-9).

[71] Beigel J., Tomashek K., Dodd L., Mehta A., Zingman B., Kalil A., et al. Remdesivir for the Treatment of Covid-19 — Final Report. New England Journal of Medicine. 2020. DOI: 10.1056/NEJMoa2007764.

[72] Goldman D., Lye D. C., Hui D., Marks K., Bruno R., Montejano R., et al. Remdesivir for 5 or 10 Days in Patients with Severe Covid-19. New England Journal of Medicine. 2020. DOI: 10.1056/NEJMoa2015301.

[73] Spinner C., Gottlieb R., Criner G., Arribas López J., Cattelan A., Soriano Viladomiu A., et al. Effect of Remdesivir vs Standard Care on Clinical Status at 11 Days in Patients With Moderate COVID-19: A Randomized Clinical Trial. JAMA. 2020. Epub 2020/08/22. DOI: 10.1001/jama.2020.16349.

[74] Pan H., Peto R., Karim Q., Alejandria M., Henao-Restrepo A., García C., et al. Repurposed antiviral drugs for COVID-19 –interim WHO SOLIDARITY trial results. medRxiv. 2020:2020.2010.2015.20209817. DOI: 10.1101/2020.10.15.20209817.

[75] European network for health technology assessment (EUnetHTA). PTRCR15 Authoring Team. Remdesivir for the treatment of hospitalised patients with COVID-19 - Update 1. Rapid Collaborative. Diemen (The Netherlands): 2020. Available from: https://eunethta.eu/wp-content/uploads/2020/12/PTRCR15-update-1-December-2020-v1.0.pdf.

[76] Wang Y., Zhang D., Du G., Du R., Zhao J., Jin Y., et al. Remdesivir in adults with severe COVID-19: a randomised, double-blind, placebo-controlled, multicentre trial. Lancet. 2020;395(10236):1569-1578. Epub 2020/05/20. DOI: 10.1016/s0140-6736(20)31022-9.

[77] Should favipiravir be used for COVID-19? Ministry of Health Singapore and Agency for Care Effectiveness: 2020 [cited 06/04/2020]. Available from: https://www.moh.gov.sg/docs/librariesprovider5/clinical-evidence-summaries/favipiravir-for-covid-19-(26-march-2020).pdf.

[78] Dong L., Hu S. and Gao J. Discovering drugs to treat coronavirus disease 2019 (COVID-19). Drug Discoveries & Therapeutics. 2020;14(1):58-60. DOI: 10.5582/ddt.2020.01012.

[79] Chen C., Huang J., Cheng Z., Wu J., Chen S., Zhang Y., et al. Favipiravir versus Arbidol for COVID-19: A Randomized Clinical Trial. 2020.

[80] Lou Y., Liu L. and Qiu Y. Clinical Outcomes and Plasma Concentrations of Baloxavir Marboxil and Favipiravir in COVID-19 Patients: an Exploratory Randomized, Controlled Trial. medRxiv. 2020:2020.2004.2029.20085761. DOI: 10.1101/2020.04.29.20085761.

[81] Ivashchenko A., Dmitriev K., Vostokova N., Azarova V., Blinow A., Egorova A., et al. AVIFAVIR for Treatment of Patients with Moderate COVID-19: Interim Results of a Phase II/III Multicenter Randomized Clinical Trial. Clinical Infectious Diseases. 2020. DOI: 10.1093/cid/ciaa1176.

[82] Dabbous H., El-Sayed M., El Assal G., Elghazaly H., Ebeid F. F., Sherief A., et al. Research Square. 2020. DOI: 10.21203/rs.3.rs-83677/v1.

[83] Balykova L., Granovskaya M., Zaslavskaya K., Simakina E., Agaf'ina A., Ivanova A., et al. New possibilities for targeted antiviral therapy for COVID-19. Results of a multi center clinical study of the efficacy and safety of using the drug Areplivir. Infectious diseases: News, Opinions, Training. 2020;9:16-29. DOI: 10.33029/2305-3496-2020-9-3-16-29.

[84] Ruzhentsova T., Chukhliaev P., Khavkina D., Garbuzov A., Oseshnyuk R. and Soluyanova T. Phase 3 Trial of Coronavir (Favipiravir) in Patients with Mild to Moderate COVID-19. The Lancet. 2020;(Preprint). DOI: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3696907.

[85] Udwadia Z., Singh P., Barkate H., Patil S., Rangwala S., Pendse A., et al. Safety of Favipiravir, an Oral RNA-Dependent RNA Polymerase Inhibitor, in Mild-to-Moderate COVID-19: A Randomized, Comparative, Open-Label, Multicenter, Phase 3 Clinical TEfficacy and safety of favipiravir, an oral

RNA-dependent RNA polymerase inhibitor, in mild-to-moderate COVID-19: A randomized, comparative, open-label, multicenter, phase 3 clinical trial. International Journal of Infectious Diseases. DOI: 10.1016/j.ijid.2020.11.142.

[86] Doi Y., Hibino M., Hase R., Yamamoto M., Kasamatsu Y., Hirose M., et al. A prospective, randomized, open-label trial of early versus late favipiravir in hospitalized patients with COVID-19. Antimicrobial Agents and Chemotherapy. 2020:AAC.01897-01820. DOI: 10.1128/aac.01897-20.

[87] Zhao H., Zhu Q., Zhang C., Li J., Wei M., Qin Y., et al. Tocilizumab combined with favipiravir in the treatment of COVID-19: A multicenter trial in a small sample size. Biomedicine & Pharmacotherapy. 2020:110825. DOI: https://doi.org/10.1016/j.biopha.2020.110825.

[88] McKeage K., Perry C. M. and Keam S. J. Darunavir: a review of its use in the management of HIV infection in adults. Drugs. 2009;69(4):477-503.

[89] Chen J., Xia L., Liu L., Xu Q., Ling Y., Huang D., et al. Antiviral Activity and Safety of Darunavir/Cobicistat for the Treatment of COVID-19. Open Forum Infectious Diseases. 2020;7(7). DOI: 10.1093/ofid/ofaa241.

[90] Fujii S. and Hitomi Y. New synthetic inhibitors of C1r, C1 esterase, thrombin, plasmin, kallikrein and trypsin. Biochim Biophys Acta. 1981;661(2):342-345. Epub 1981/10/13. DOI: 10.1016/0005-2744(81)90023-1.

[91] Hoffmann M., Kleine-Weber H., Schroeder S., Kruger N., Herrler T., Erichsen S., et al. SARS-CoV-2 Cell Entry Depends on ACE2 and TMPRSS2 and Is Blocked by a Clinically Proven Protease Inhibitor. Cell. 2020;181. Epub 2020/03/07. DOI: 10.1016/j.cell.2020.02.052.

[92] Kawase M., Shirato K., van der Hoek L., Taguchi F. and Matsuyama S. Simultaneous treatment of human bronchial epithelial cells with serine and cysteine protease inhibitors prevents severe acute respiratory syndrome coronavirus entry. J Virol. 2012;86(12):6537-6545. Epub 2012/04/13. DOI: 10.1128/JVI.00094-12.

[93] Zhou Y., Vedantham P., Lu K., Agudelo J., Carrion R., Jr., Nunneley J. W., et al. Protease inhibitors targeting coronavirus and filovirus entry. Antiviral Res. 2015;116:76-84. Epub 2015/02/11. DOI: 10.1016/j.antiviral.2015.01.011.

[94] European network for health technology assessment (EUnetHTA). EUnetHTA Rolling Collaborative Review (RCR04). Authoring Team. Camostat for the treatment of Covid-19. Diemen (The Netherlands). 2020 [cited 15/08/2020]. Available from: https://eunethta.eu/wp-content/uploads/2020/08/EUnetHTA-Covid-19_RCR04_Camostat-v1.0.pdf.

[95] Apeiron Biologics. APN01. 2020 [cited 07.04.2020]. Available from: https://www.apeiron-biologics.com/project-overview/#APN01.

[96] Kuba K., Imai Y., Rao S., Gao H., Guo F., Guan B., et al. A crucial role of angiotensin converting enzyme 2 (ACE2) in SARS coronavirus-induced lung injury. Nature Medicine. 2005;11(8):875-879. Epub 2005/07/10. DOI: 10.1038/nm1267.

[97] Monteil V., Hyesoo Kwon, Patricia Prado, Astrid Hagelkrüys, Reiner A. Wimmer, Martin Stahl, et al. Inhibition of SARS-CoV-2 infections in engineered human tissues using clinical-grade soluble human ACE2. 2020 [cited 07.04.2020]. Available from: https://www.cell.com/pb-assets/products/coronavirus/CELL_CELL-D-20-00739.pdf.

[98] European network for health technology assessment (EUnetHTA). EUnetHTA Rolling Collaborative Review (RCR09). Authoring Team. APN01 for the Treatment of Covid19. Diemen (The Netherlands). 2020 [cited 15/08/2020]. Available from: https://eunethta.eu/wp-content/uploads/2020/08/EUnetHTA-Covid-19_RCR09_APN01_August2020_FINAL.pdf.

[99] European Medicines Agency. RoActemra (tocilizumab). Amsterdam: 2020. Available from: https://www.ema.europa.eu/en/medicines/human/EPAR/roactemra.

[100] Rosas I., Bräu N., Waters M., Go R., Hunter B., Bhagani S., et al. Tocilizumab in Hospitalized Patients With COVID-19 Pneumonia. medRxiv. 2020:2020.2008.2027.20183442. DOI: 10.1101/2020.08.27.20183442.

[101] Wang D., Fu B., Peng Z., Yang D. and Han M. Tocilizumab Ameliorates the Hypoxia in COVID-19 Moderate Patients with Bilateral Pulmonary Lesions: A Randomized, Controlled, Open-Label, Multicenter Trial. Preprints with The Lancet. 2020.

[102] Salama C., Han J., Yau L., Reiss W., Kramer B., Neidhart J., et al. Tocilizumab in nonventilated patients hospitalized with Covid-19 pneumonia. medRxiv. 2020:2020.2010.2021.20210203. DOI: 10.1101/2020.10.21.20210203.

[103] Hermine O., Mariette X., Tharaux P., Resche-Rigon M., Porcher R., Ravaud P., et al. Effect of Tocilizumab vs Usual Care in Adults Hospitalized With COVID-19 and Moderate or Severe Pneumonia: A Randomized Clinical Trial. JAMA Internal Medicine. 2020. DOI: 10.1001/jamainternmed.2020.6820.

[104] Salvarani C., Dolci G., Massari M., Merlo D., Cavuto S., Savoldi L., et al. Effect of Tocilizumab vs Standard Care on Clinical Worsening in Patients Hospitalized With COVID-19 Pneumonia: A Randomized Clinical Trial. JAMA Internal Medicine. 2020. DOI: 10.1001/jamainternmed.2020.6615.

[105] Stone J., Frigault M., Serling-Boyd N., Fernandes A., Harvey L., Foulkes A., et al. Efficacy of Tocilizumab in Patients Hospitalized with Covid-19. New England Journal of Medicine. 2020. DOI: 10.1056/NEJMoa2028836.

[106] Gordon A., Mouncey P., Al-Beidh F., Rowan K., Nichol A., Arabi Y., et al. Interleukin-6 Receptor Antagonists in Critically Ill Patients with Covid-19 – Preliminary report. medRxiv. 2021:2021.2001.2007.21249390. DOI: 10.1101/2021.01.07.21249390.

[107] Furlow B. COVACTA trial raises questions about tocilizumab's benefit in COVID-19. The Lancet Rheumatology. DOI: 10.1016/S2665-9913(20)30313-1.

[108] European Medicines Agency (EMA). EPAR summary for the public: Kevzara (sarilumab). 2017. Available from: https://www.ema.europa.eu/en/medicines/human/EPAR/kevzara.

[109] Institut national d'excellence en santé et en services sociaux (INESSS). COVID-19 et interférons. Québec, Qc: 2020. Available from: https://www.inesss.qc.ca/fileadmin/doc/INESSS/COVID-19/COVID-19_interferons.pdf.

[110] The European public assessment report (EPAR). Betaferon – Product information. Available from: https://www.ema.europa.eu/documents/product-information/betaferon-epar-product-information_en.pdf.

[111] The European public assessment report (EPAR). Extavia – Product information. Available from: https://www.ema.europa.eu/documents/product-information/extavia-epar-product-information_en.pdf.

[112] Hung I., Lung K., Tso E., Liu R., Chung T., Chu M., et al. Triple combination of interferon beta-1b, lopinavir–ritonavir, and ribavirin in the treatment of patients admitted to hospital with COVID-19: an open-label, randomised, phase 2 trial. The Lancet. 2020. DOI: 10.1016/S0140-6736(20)31042-4.

[113] Huang Y., Tang S., Xu X., Zeng Y., He X., Li Y., et al. No Statistically Apparent Difference in Antiviral Effectiveness Observed Among Ribavirin Plus Interferon-Alpha, Lopinavir/Ritonavir Plus Interferon-Alpha, and Ribavirin Plus Lopinavir/Ritonavir Plus Interferon-Alpha in Patients With Mild to Moderate Coronavirus Disease 2019: Results of a Randomized, Open-Labeled Prospective Study. Frontiers in Pharmacology. 2020;11(1071). DOI: 10.3389/fphar.2020.01071.

[114] Esquivel-Moynelo I., Perez-Escribano J., Duncan-Robert Y., Vazquez-Blonquist D., Bequet-Romero M., Baez-Rodriguez L., et al. Effect and safety of combination of interferon alpha-2b and gamma or interferon alpha-2b for negativization of SARS-CoV-2 viral RNA. Preliminary results of a randomized controlled clinical trial. medRxiv. 2020:2020.2007.2029.20164251. DOI: 10.1101/2020.07.29.20164251.

[115] Monk P., Marsden R., Tear V., Brookes J., Batten T., Mankowski M., et al. Safety and efficacy of inhaled nebulised interferon beta-1a (SNG001) for treatment of SARS-CoV-2 infection: a randomised, double-blind, placebo-controlled, phase 2 trial. The Lancet Respiratory Medicine. DOI: 10.1016/S2213-2600(20)30511-7.

[116] Davoudi-Monfared E., Rahmani H., Khalili H., Hajiabdolbaghi M., Salehi M., Abbasian L., et al. A Randomized Clinical Trial of the Efficacy and Safety of Interferon β-1a in Treatment of Severe COVID-19. Antimicrob Agents Chemother. 2020;64(9). Epub 2020/07/15. DOI: 10.1128/aac.01061-20.

[117] Rahmani H., Davoudi-Monfared E., Nourian A., Khalili H., Hajizadeh N., Jalalabadi N., et al. Interferon β-1b in treatment of severe COVID-19: A randomized clinical trial. International Immunopharmacology. 2020;88:106903. DOI: https://doi.org/10.1016/j.intimp.2020.106903.

[118] Casadevall A. and Pirofski L. The convalescent sera option for containing COVID-19. J Clin Invest. 2020;Mar 13(pii: 138003. doi: 10.1172/JCI138003. [Epub ahead of print]).

[119] Roback J. and Guarner J. Convalescent Plasma to Treat COVID-19 Possibilities and Challenges. JAMA. 2020;Mar 27(doi: 10.1001/jama.2020.4940. [Epub ahead of print]).

[120] Chen L., Xiong J., Bao L. and Shi Y. Convalescent plasma as a potential therapy for COVID-19. Lancet Infect Dis. 2020;Apr; 20(4):398–400. Published online 2020 Feb 2027. doi: 2010.1016/S1473-3099(2020)30141-30149.

[121] European Commission (EC). An EU programme of COVID-19 convalescent plasma collection and transfusion; Guidance on collection, testing, processing, storage, distribution and monitored use, Version 1.0 2020 [cited April 4]. Available from: https://ec.europa.eu/health/sites/health/files/blood_tissues_organs/docs/guidance_plasma_covid19_en.pdf.

[122] Food and Drud Administration (FDA). Recommendations for Investigational COVID-19 Convalescent Plasma. 2020 [cited April 13]. Available from: https://www.fda.gov/vaccines-blood-biologics/investigational-new-drug-ind-or-device-exemption-ide-process-cber/recommendations-investigational-covid-19-convalescent-plasma.

[123] Tanne J. Covid-19: FDA approves use of convalescent plasma to treat critically ill patients BMJ. 2020; Mar 26(368:m1256. doi: 10.1136/bmj.m1256.).

[124] Food and Drud Administration (FDA). FDA Issues Emergency Use Authorization for Convalescent Plasma as Potential Promising COVID–19 Treatment, Another Achievement in Administration's Fight Against Pandemic. 2020 [cited 23/08/2020]. Available from: https://www.fda.gov/news-events/press-announcements/fda-issues-emergency-use-authorization-convalescent-plasma-potential-promising-covid-19-treatment.

[125] National Institute of Health (NIH). COVID-19 Treatment Guidelines. 2020. Available from: https://covid19treatmentguidelines.nih.gov/introduction/.

[126] Li L., Zhang W., Hu Y., Tong X., Zheng S., Yang J., et al. Effect of Convalescent Plasma Therapy on Time to Clinical Improvement in Patients With Severe and Life-threatening COVID-19: A Randomized Clinical Trial. JAMA. 2020. DOI: 10.1001/jama.2020.10044.

[127] Gharbharan A., Jordans C., GeurtsvanKessel C., den Hollander J., Karim F., Mollema F., et al. Convalescent Plasma for COVID-19. A randomized clinical trial. medRxiv. 2020:2020.2007.2001.20139857. DOI: 10.1101/2020.07.01.20139857.

[128] Avendano-Sola C., Ramos-Martinez A., Munez-Rubio E., Ruiz-Antoran B., Malo de Molina R., Torres F., et al. Convalescent Plasma for COVID-19: A multicenter, randomized clinical trial. medRxiv. 2020:2020.2008.2026.20182444. DOI: 10.1101/2020.08.26.20182444.

[129] Agarwal A., Mukherjee A., Kumar G., Chatterjee P., Bhatnagar T., Malhotra P., et al. Convalescent plasma in the management of moderate COVID-19 in India: An open-label parallel-arm phase II multicentre randomized controlled trial (PLACID Trial). medRxiv. 2020:2020.2009.2003.20187252. DOI: 10.1101/2020.09.03.20187252.

[130] Agarwal A., Mukherjee A., Kumar G., Chatterjee P., Bhatnagar T. and Malhotra P. Convalescent plasma in the management of moderate covid-19 in adults in India: open label phase II multicentre randomised controlled trial (PLACID Trial). BMJ. 2020;371:m3939. DOI: 10.1136/bmj.m3939.

[131] Balcells M., Rojas L., Le Corre N., Martínez-Valdebenito C., Ceballos M., Ferrés M., et al. Early Anti-SARS-CoV-2 Convalescent Plasma in Patients Admitted for COVID-19: A Randomized Phase II Clinical Trial. medRxiv. 2020:2020.2009.2017.20196212. DOI: 10.1101/2020.09.17.20196212.

[132] Simonovich V., Burgos Pratx L., Scibona P., Beruto M., Vallone M., Vázquez C., et al. A Randomized Trial of Convalescent Plasma in Covid-19 Severe Pneumonia. N Engl J Med. 2020. Epub 2020/11/25. DOI: 10.1056/NEJMoa2031304.

[133] Libster R., Pérez Marc G., Wappner D., Coviello S., Bianchi A., Braem V., et al. Early High-Titer Plasma Therapy to Prevent Severe Covid-19 in Older Adults. New England Journal of Medicine. 2021. DOI: 10.1056/NEJMoa2033700.

[134] Marovich M., Mascola J. and Cohen M. Monoclonal Antibodies for Prevention and Treatment of COVID-19. JAMA. 2020. DOI: 10.1001/jama.2020.10245.

[135] Weinreich D., Sivapalasingam S., Norton T., Ali S., Gao H., Bhore R., et al. REGN-COV2, a Neutralizing Antibody Cocktail, in Outpatients with Covid-19. New England Journal of Medicine. 2020. DOI: 10.1056/NEJMoa2035002.

[136] Federal Drug Administration (FDA). Fact Sheet for Heatlh Care Providers: Emergency Use Authorization (EUA) of Casirivimab and Imdevimab. 2020. Available from: https://www.fda.gov/newsevents/press-announcements/coronavirus-covid-19-update-fda-authorizes-monoclonalantibodies-treatment-covid-19.

[137] Chen P., Nirula A., Heller B., Gottlieb R., Boscia J., Morris J., et al. SARS-CoV-2 Neutralizing Antibody LY-CoV555 in Outpatients with Covid-19. New England Journal of Medicine. 2020. DOI: 10.1056/NEJMoa2029849.

[138] ACTIV-3/TICO LY-CoV555 Study Group. A Neutralizing Monoclonal Antibody for Hospitalized Patients with Covid-19. New England Journal of Medicine. 2020. DOI: 10.1056/NEJMoa2033130.

[139] Zheng F., Zhou Y., Zhou Z., Ye F., Huang B., Huang Y., et al. A Novel Protein Drug, Novaferon, as the Potential Antiviral Drug for COVID-19. medRxiv. 2020:2020.2004.2024.20077735. DOI: 10.1101/2020.04.24.20077735.

[140] European network for health technology assessment (EUnetHTA). Rolling Collaborative Review (RCR13) Authoring Team. Interferon beta-1a (IFN β-1a) and Novaferon (Nova) for the treatment of COVID-19. Diemen (The Netherlands): EUnetHTA. 2020. Available from: https //www.eunethta.eu.

[141] Li C., Luo F., Liu C., Xiong N., Xu Z. and Zhang W. Engineered interferon alpha effectively improves clinical outcomes of COVID-19 patients. Research Square. 2020. DOI: 10.21203/rs.3.rs-65224/v1.

[142] European network for health technology assessment (EUnetHTA). Rolling Collaborative Review (RCR06) Authoring Team. Solnatide for the treatment of COVID-19. Diemen (The Netherlands). 2020 [cited 15/08/2020]. Available from: https://eunethta.eu/wp-content/uploads/2020/08/EUnetHTA-Covid-19_RCR06_SOLNATIDE_August2020_FINAL.pdf.

[143] Wang X., Cao R., Zhang H., Liu J., Xu M., Hu H., et al. The anti-influenza virus drug, arbidol is an efficient inhibitor of SARS-CoV-2 in vitro. Cell Discovery. 2020;6(1):28. DOI: 10.1038/s41421-020-0169-8.

[144] Li Y., Xie Z., Lin W., Cai W., Wen C., Guan Y., et al. Efficacy and safety of lopinavir/ritonavir or arbidol in adult patients with mild/moderate COVID-19: an exploratory randomized controlled trial. Med. 2020. DOI: https://doi.org/10.1016/j.medj.2020.04.001.

[145] Nojomi M., Yasin Z., Keyvani H., Makiani M., Roham M., Laali A., et al. Effect of Arbidol on COVID-19: A Randomized Controlled Trial. Research Square. 2020. DOI: 10.21203/rs.3.rs-78316/v1.

[146] Yethindra V., Tagaev T., Uulu M. and Parihar Y. Efficacy of umifenovir in the treatment of mild and moderate COVID-19 patients. International Journal of Research in Pharmaceutical Sciences. 2020;11(SPL1):506-509. DOI: https://doi.org/10.26452/ijrps.v11iSPL1.2839.

[147] Solinas C., Perra L., Aiello M., Migliori E. and Petrosillo N. A critical evaluation of glucocorticoids in the management of severe COVID-19. Cytokine & growth factor reviews. 2020:S1359-6101(1320)30161-30161. DOI: 10.1016/j.cytogfr.2020.06.012.

[148] Canadian Agency for Drugs and Technologies in Health (CADTH). Dexamethasone in the Treatment of Hospitalized Patients With COVID-19: A Critical Appraisal of the RECOVERY Trial. 2020. Available from: https://cadth.ca/sites/default/files/covid-19/ha0005-dexamethasone-fca-of-recovery.pdf.

[149] Government UK. World first coronavirus treatment approved for NHS use by government. [cited 16/06/2020]. Available from: https://www.gov.uk/government/news/world-first-coronavirus-treatment-approved-for-nhs-use-by-government.

[150] European Medicines Agency (EMA). Treatments and vaccine for COVID-19. Dexamethasone. 2020 [cited 04/09/2020]. Available from: https://www.ema.europa.eu/en/human-regulatory/overview/public-health-threats/coronavirus-disease-covid-19/treatments-vaccines-covid-19#dexamethasone--section.

[151] European Medicines Agency (EMA). EMA endorses use of dexamethasone in COVID-19 patients on oxygen or mechanical ventilation. EMA/483739/2020. 2020 [cited 18/09/2020]. Available from: https://www.ema.europa.eu/en/news/ema-endorses-use-dexamethasone-covid-19-patients-oxygen-mechanical-ventilation.

[152] Bani-Sadr F., Hentzien M., Pascard M., N'Guyen Y., Servettaz A., Andreoletti L., et al. Corticosteroid therapy for patients with COVID-19 pneumonia: a before-after study. Int J Antimicrob Agents. 2020;56(2):106077. Epub 2020/07/08. DOI: 10.1016/j.ijantimicag.2020.106077.

[153] Sterne J., Murthy S., Diaz J., Slutsky A., Villar J., Angus D., et al. Association Between Administration of Systemic Corticosteroids and Mortality Among Critically Ill Patients With COVID-19: A Meta-analysis. JAMA. 2020. Epub 2020/09/03. DOI: 10.1001/jama.2020.17023.

[154] The RECOVERY Collaborative Group. Dexamethasone in Hospitalized Patients with Covid-19 — Preliminary Report. New England Journal of Medicine. 2020. DOI: 10.1056/NEJMoa2021436.

[155] European network for health technology assessment (EUnetHTA). Rolling Collaborative Review (RCR08) Authoring Team. Dexamethasone for the treatment of COVID-19. Diemen (The Netherlands). 2020 [cited 15/08/2020]. Available from: https://eunethta.eu/wp-content/uploads/2020/08/EUnetHTA-Covid-19_RCR08_DEXAMETHASONE_August2020_FINAL.docx.pdf.

[156] Tomazini B., Maia I., Cavalcanti A., Berwanger O., Rosa R., Veiga V., et al. Effect of Dexamethasone on Days Alive and Ventilator-Free in Patients With Moderate or Severe Acute Respiratory Distress Syndrome and COVID-19: The CoDEX Randomized Clinical Trial. JAMA. 2020. DOI: 10.1001/jama.2020.17021.

[157] Prescott H. and Rice T. Corticosteroids in COVID-19 ARDS: Evidence and Hope During the Pandemic. JAMA. 2020. Epub 2020/09/03. DOI: 10.1001/jama.2020.16747.

[158] Dequin P., Heming N., Meziani F., Plantefève G., Voiriot G., Badié J., et al. Effect of Hydrocortisone on 21-Day Mortality or Respiratory Support Among Critically Ill Patients With COVID-19: A Randomized Clinical Trial. JAMA. 2020. Epub 2020/09/03. DOI: 10.1001/jama.2020.16761.

[159] Angus D., Derde L., Al-Beidh F., Annane D., Arabi Y., Beane A., et al. Effect of Hydrocortisone on Mortality and Organ Support in Patients With Severe COVID-19: The REMAP-CAP COVID-19 Corticosteroid Domain Randomized Clinical Trial. JAMA. 2020. Epub 2020/09/03. DOI: 10.1001/jama.2020.17022.

[160] Jeronimo C., Farias M., Val F., Sampaio V., Alexandre M., Melo G., et al. Methylprednisolone as Adjunctive Therapy for Patients Hospitalized With COVID-19 (Metcovid): A Randomised, Double-Blind, Phase IIb, Placebo-Controlled Trial. Clin Infect Dis. 2020. Epub 2020/08/14. DOI: 10.1093/cid/ciaa1177.

[161] Edalatifard M., Akhtari M., Salehi M., Naderi Z., Jamshidi A., Mostafaei S., et al. Intravenous methylprednisolone pulse as a treatment for hospitalised severe COVID-19 patients: results from a randomised controlled clinical trial. Eur Respir J. 2020. Epub 2020/09/19. DOI: 10.1183/13993003.02808-2020.

[162] Farahani R., Mosaed R., Nezami-Asl A., Chamanara M., Soleiman-Meigooni S., Kalantar S., et al. Evaluation of the Efficacy of Methylprednisolone Pulse Therapy in Treatment of Covid-19 Adult Patients with Severe Respiratory Failure: Randomized, Clinical Trial. Research Square. 2020. DOI: 10.21203/rs.3.rs-66909/v1.

[163] Borazan N. and Furst D. Nonsteroidal Anti-Inflammatory Drugs, Disease-Modifying Antirheumatic Drugs, Nonopioid Analgesics, & Drugs Used in Gout. In: B. Katzung, S. Masters and A. Trevor, editors. Basic and Clinical Pharmacology. New York: McGrawHill; 2012. p. 635-657.

[164] Deftereos S., Giannopoulos G., Vrachatis D., Siasos G., Giotaki S., Gargalianos P., et al. Effect of Colchicine vs Standard Care on Cardiac and Inflammatory Biomarkers and Clinical Outcomes in

Patients Hospitalized With Coronavirus Disease 2019: The GRECCO-19 Randomized Clinical Trial. JAMA Network Open. 2020;3(6):e2013136-e2013136. DOI: 10.1001/jamanetworkopen.2020.13136.

[165] Salehzadeh F., Pourfarzi F. and Ataei S. The Impact of Colchicine on The COVID-19 Patients; A Clinical Trial Study. BMC infectious diseases. 2020. DOI: 10.21203/rs.3.rs-69374/v1.

[166] Lopes M., Bonjorno L., Giannini M., Amaral N., Benatti M., Rezek U., et al. Beneficial effects of colchicine for moderate to severe COVID-19: an interim analysis of a randomized, double-blinded, placebo controlled clinical trial. medRxiv. 2020:2020.2008.2006.20169573. DOI: 10.1101/2020.08.06.20169573.

[167] European network for health technology assessment (EUnetHTA). Rolling Collaborative Review (RCR14) Authoring Team. Gimsilumab for the treatment of COVID-19. Diemen (The Netherlands): EUnetHTA; 2020. 2020. Available from: https://eunethta.eu/wp-content/uploads/2020/08/EUnetHTA-Covid-19_RCR15_Canakinumab_August2020_FINAL.pdf.

[168] A Study to Assess the Efficacy and Safety of Gimsilumab in Subjects With Lung Injury or Acute Respiratory Distress Syndrome Secondary to COVID-19 (BREATHE). 2020. Available from: https://clinicaltrials.gov/ct2/show/NCT04351243?term=gimsilumab&draw=2&rank=1.

[169] European Medicines Agency (EMA). Ilaris. Summary of Product Characteristics. 2020. Available from: https://www.ema.europa.eu/en/documents/product-information/ilaris-epar-product-information_en.pdf.

[170] European network for health technology assessment (EUnetHTA). Rolling Collaborative Procedure (RCR15). Authoring Team. Canakinumab for the treatment of Covid-19. Diemen (The Netherlands): EUnetHTA. 2020. Available from: https://eunethta.eu/wp-content/uploads/2020/08/EUnetHTA-Covid-19_RCR15_Canakinumab_August2020_FINAL.pdf.

[171] Study of Efficacy and Safety of Canakinumab Treatment for CRS in Participants With COVID-19-induced Pneumonia (CAN-COVID). 2020. Available from: https://clinicaltrials.gov/ct2/show/NCT04362813?term=canakinumab&draw=2&rank=4.

[172] Canakinumab in Covid-19 Cardiac Injury (The Three C Study). 2020. Available from: https://clinicaltrials.gov/ct2/show/NCT04365153?term=canakinumab&draw=4.

[173] Rizk J., Kalantar-Zadeh K., Mehra M., Lavie C., Rizk Y. and Forthal D. Pharmaco-Immunomodulatory Therapy in COVID-19. Drugs. 2020;80(13):1267-1292. Epub 2020/07/23. DOI: 10.1007/s40265-020-01367-z.

[174] Bonaventura A., Vecchié A., Wang T., Lee E., Cremer P., Carey B., et al. Targeting GM-CSF in COVID-19 Pneumonia: Rationale and Strategies. Front Immunol. 2020;11:1625. Epub 2020/07/29. DOI: 10.3389/fimmu.2020.01625.

[175] Ferrari D., Locatelli M., Briguglio M. and Lombardi G. Is there a link between vitamin D status, SARS-CoV-2 infection risk and COVID-19 severity? Cell Biochemistry and Function. 2020:1-13. DOI: https://doi.org/10.1002/cbf.3597.

[176] The National Heart Lung and Blood Institute PETAL Clinical Trials Network. Early High-Dose Vitamin D3 for Critically Ill, Vitamin D–Deficient Patients. New England Journal of Medicine. 2019;381(26):2529-2540. DOI: 10.1056/NEJMoa1911124.

[177] Entrenas Castillo M., Entrenas Costa L., Vaquero Barrios J., Alcalá Díaz J., López Miranda J., Bouillon R., et al. Effect of calcifediol treatment and best available therapy versus best available therapy on intensive care unit admission and mortality among patients hospitalized for COVID-19: A pilot randomized clinical study. The Journal of Steroid Biochemistry and Molecular Biology. 2020;203:105751. DOI: https://doi.org/10.1016/j.jsbmb.2020.105751.

[178] Rastogi A., Bhansali A., Khare N., Suri V., Yaddanapudi N., Sachdeva N., et al. Short term, high-dose vitamin D supplementation for COVID-19 disease: a randomised, placebo-controlled, study (SHADE study). Postgraduate Medical Journal. 2020:postgradmedj-2020-139065. DOI: 10.1136/postgradmedj-2020-139065.

[179] Murai I., Fernandes A., Sales L., Pinto A., Goessler K., Duran C., et al. Effect of Vitamin D_3 Supplementation vs Placebo on Hospital Length of Stay in Patients with Severe COVID-19: A

Multicenter, Double-blind, Randomized Controlled Trial. medRxiv. 2020:2020.2011.2016.20232397. DOI: 10.1101/2020.11.16.20232397.

[180] European Medicines Agency (EMA). Olimiant (baricitinib): EPAR – Medicine overview. 2020. Available from: https://www.ema.europa.eu/en/medicines/human/EPAR/olumiant.

[181] European network for health technology assessment (EUnetHTA). Rolling Collaborative Review (RCR18) Authoring Team. Baricitinib for the treatment of COVID-19. Diemen (The Netherlands): 2020. Available from: https://eunethta.eu/wp-content/uploads/2020/12/EUnetHTA-Covid-19_RCR18_Baricitinib_v1.0_FINAL.pdf.

[182] Federal Drug Administration (FDA). Fact sheet for healthcare providers emergency use authorization (EUA) of Baricitinib. 2020. Available from: https://www.fda.gov/media/143823/download.

[183] Kalil A., Patterson T., Mehta A., Tomashek K., Wolfe C., Ghazaryan V., et al. Baricitinib plus Remdesivir for Hospitalized Adults with Covid-19. New England Journal of Medicine. 2020. DOI: 10.1056/NEJMoa2031994.

[184] Cox R., Wolf J. and Plemper R. Therapeutic MK-4482/EIDD-2801 Blocks SARS-CoV-2 Transmission in Ferrets. Research Square. 2020:rs.3.rs-89433. DOI: 10.21203/rs.3.rs-89433/v1.

[185] European network for health technology assessment (EUnetHTA). Rolling Collaborative Review (RCR19) Authoring Team. Molnupiravir for the treatment of COVID-19. Diemen (The Netherlands): 2020. Available from: https://eunethta.eu/wp-content/uploads/2020/12/EUnetHTA-Covid-19_RCR19_Molnupiravir_v1.0_FINAL.pdf.

[186] Caly L., Druce J., Catton M., Jans D. and Wagstaff K. The FDA-approved drug ivermectin inhibits the replication of SARS-CoV-2 in vitro. Antiviral Research. 2020;178:104787. DOI: https://doi.org/10.1016/j.antiviral.2020.104787.

[187] Podder C., Chowdhury N., Sina M. and Haque W. Outcome of ivermectin treated mild to moderate COVID-19 cases: a single-centre, open-label, randomised controlled study. IMC Journal of Medical Science. 2020;14.

[188] Krolewiecki A., Lifschitz A., Moragas M., Travacio M., Valentini R., Alonso D., et al. Antiviral Effect of High-Dose Ivermectin in Adults with COVID-19: A Pilot Randomised, Controlled, Open Label, Multicentre Trial. Preprints with The Lancet. 2020 Available at SSRN: https://ssrn.com/abstract=3714649 or http://dx.doi.org/10.2139/ssrn.3714649

[189] Ahmed S., Karim M., Ross A., Hossain M., Clemens J., Sumiya M., et al. A five-day course of ivermectin for the treatment of COVID-19 may reduce the duration of illness. International Journal of Infectious Diseases. 2020;103:214-216. Epub 2020/12/06. DOI: 10.1016/j.ijid.2020.11.191.

[190] Chachar A., Khan K., Asif M., Tanveer K., Khaqan A. and Basri R. Effectiveness of Ivermectin in SARS-CoV-2/COVID-19 Patients. International Journal of Sciences. 2020;9(09):31-35. DOI: 10.18483/ijSci.2378.

[191] Niaee M., Gheibi N., Namdar P., Allami A., Zolghadr L., Javadi A., et al. Ivermectin as an adjunct treatment for hospitalized adult COVID-19 patients: A randomized multi-center clinical trial. Research Square. 2020. DOI: 10.21203/rs.3.rs-109670/v1.

[192] Babalola O., Bode C., Ajayi A., Alakaloko F., Akase I., Otrofanowei E., et al. Ivermectin shows clinical benefits in mild to moderate COVID19: A randomised controlled double blind dose response study in Lagos. medRxiv. 2021:2021.2001.2005.21249131. DOI: 10.1101/2021.01.05.21249131.

[193] Chow J., Khanna A., Kethireddy S., Yamane D., Levine A., Jackson A., et al. Aspirin Use is Associated with Decreased Mechanical Ventilation, ICU Admission, and In-Hospital Mortality in Hospitalized Patients with COVID-19. Anesth Analg. 2020. Epub 2020/10/24. DOI: 10.1213/ane.0000000000005292.

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