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Post COVID Syndrom – aktueller Stand der Wissenschaft



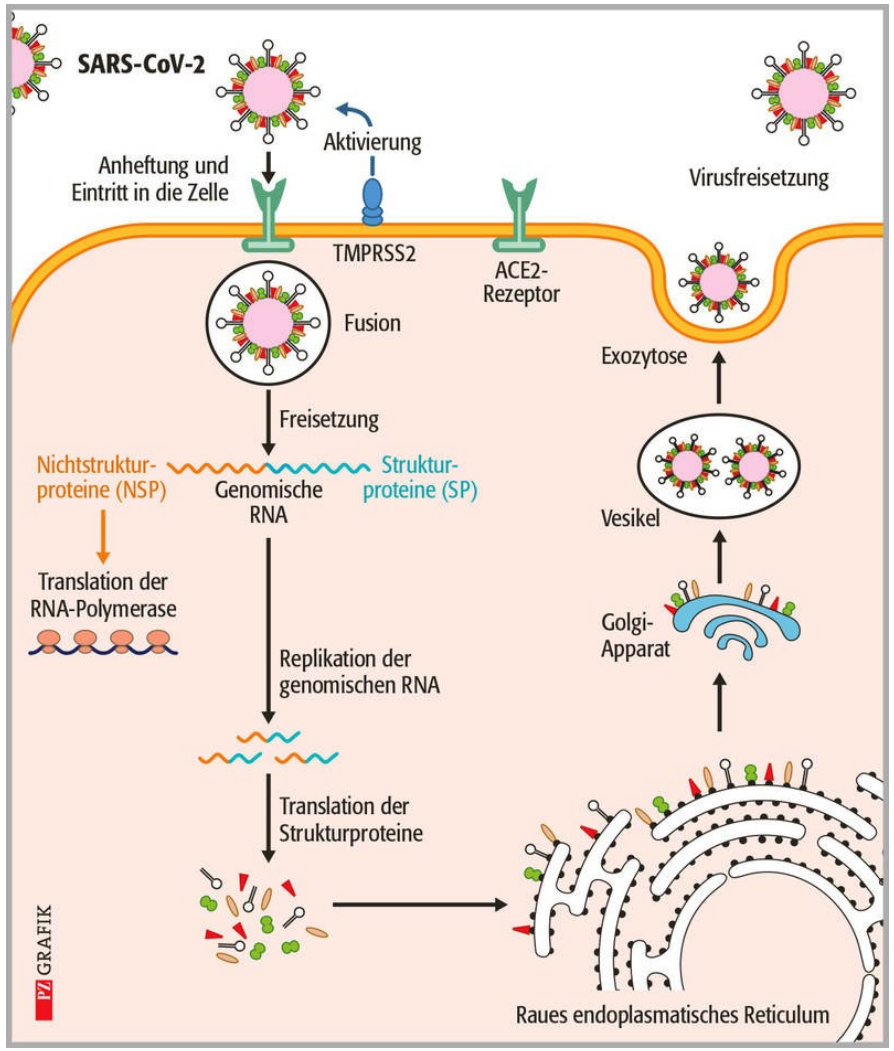
Long-Covid-Forscherin über Corona

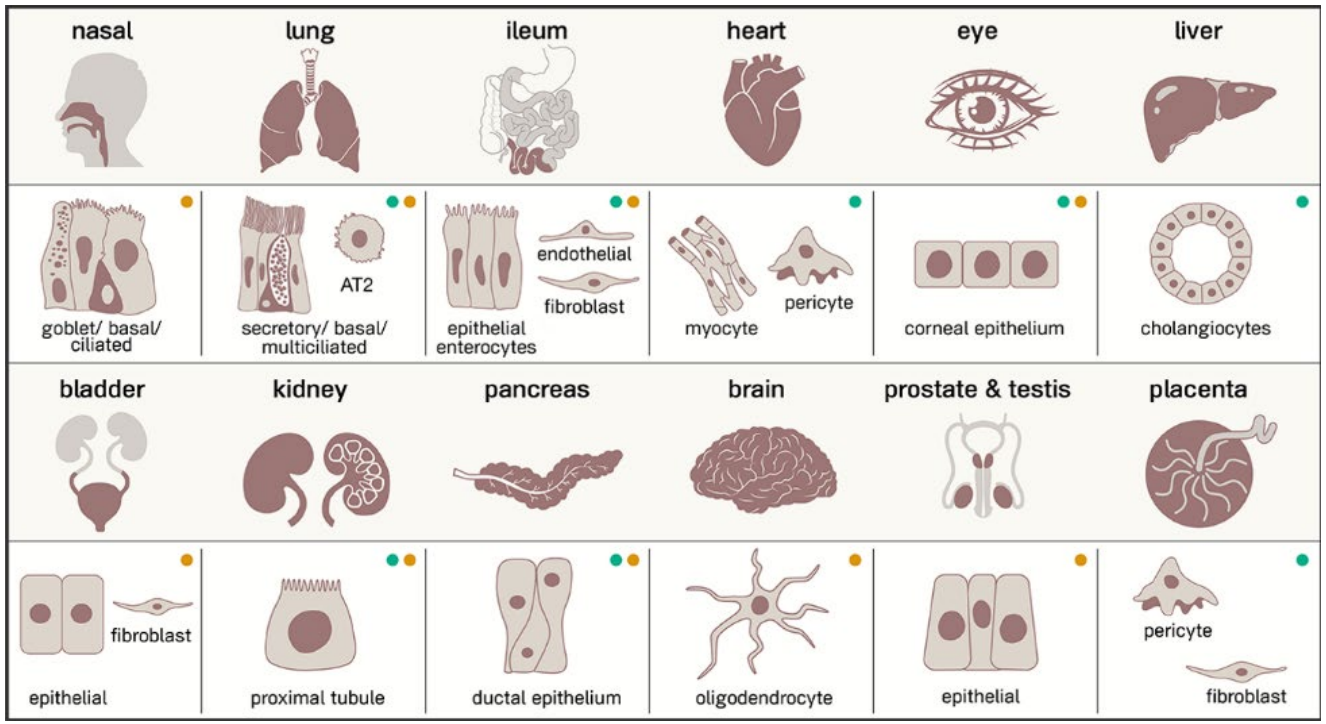
S+ »Diese Krankheit kann Leben zerstören«

Yale-Professorin Akiko Iwasaki gehört zu den weltweit besten Immunologinnen: Hier verrät sie, wie sie gegen toxische Chefs kämpft, was Long-Covid-Erkrankten helfen könnte und warum sie bis heute Maske trägt.

Der Spiegel, März 2024

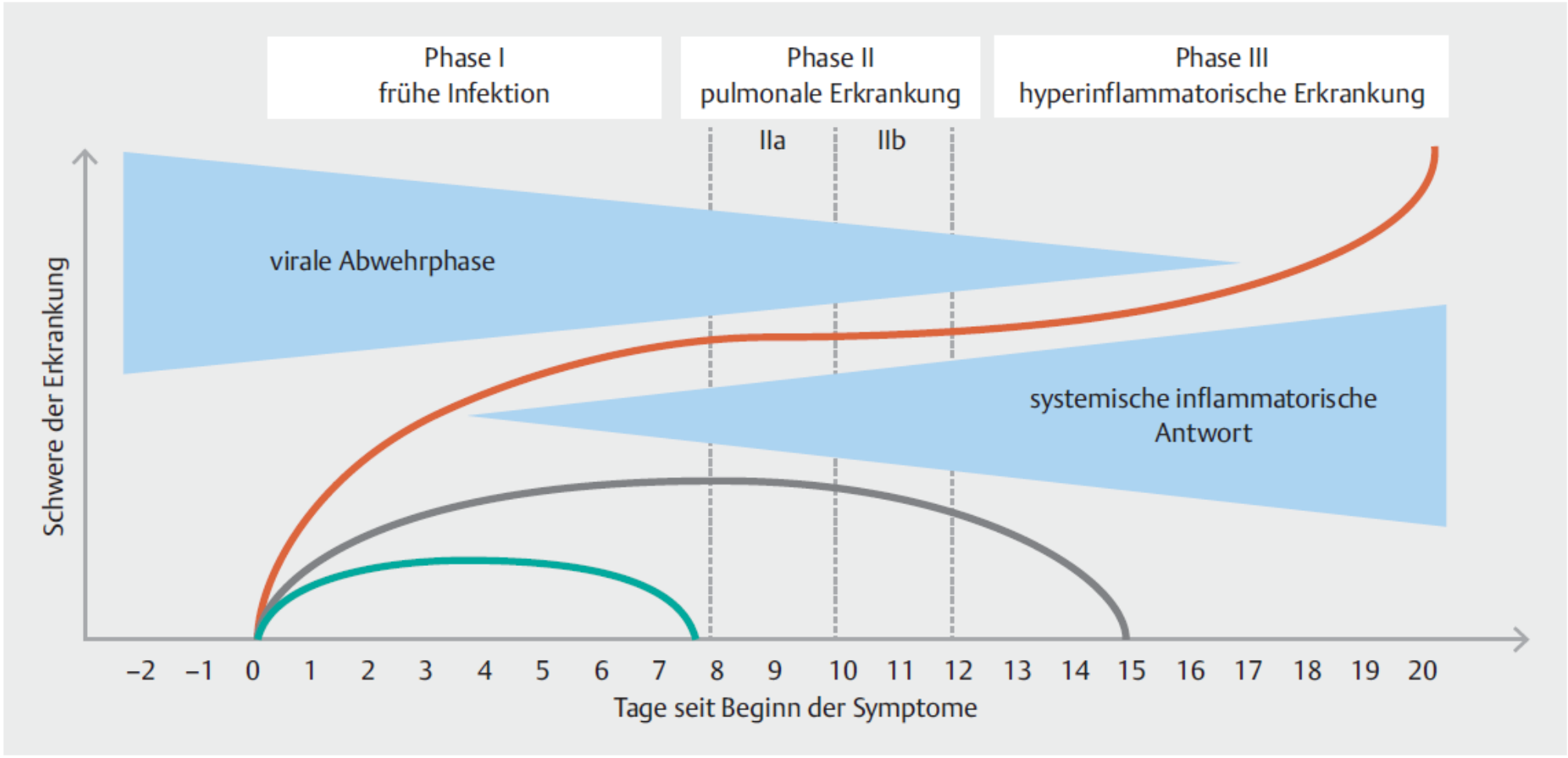
COVID-19 – Spike Protein und ACE2 Receptor





Pharmazeutische Zeitung 10.05.2020, Bild: PZ/Stephan Spitzer Baraniuk 04/2021 The Scientist.

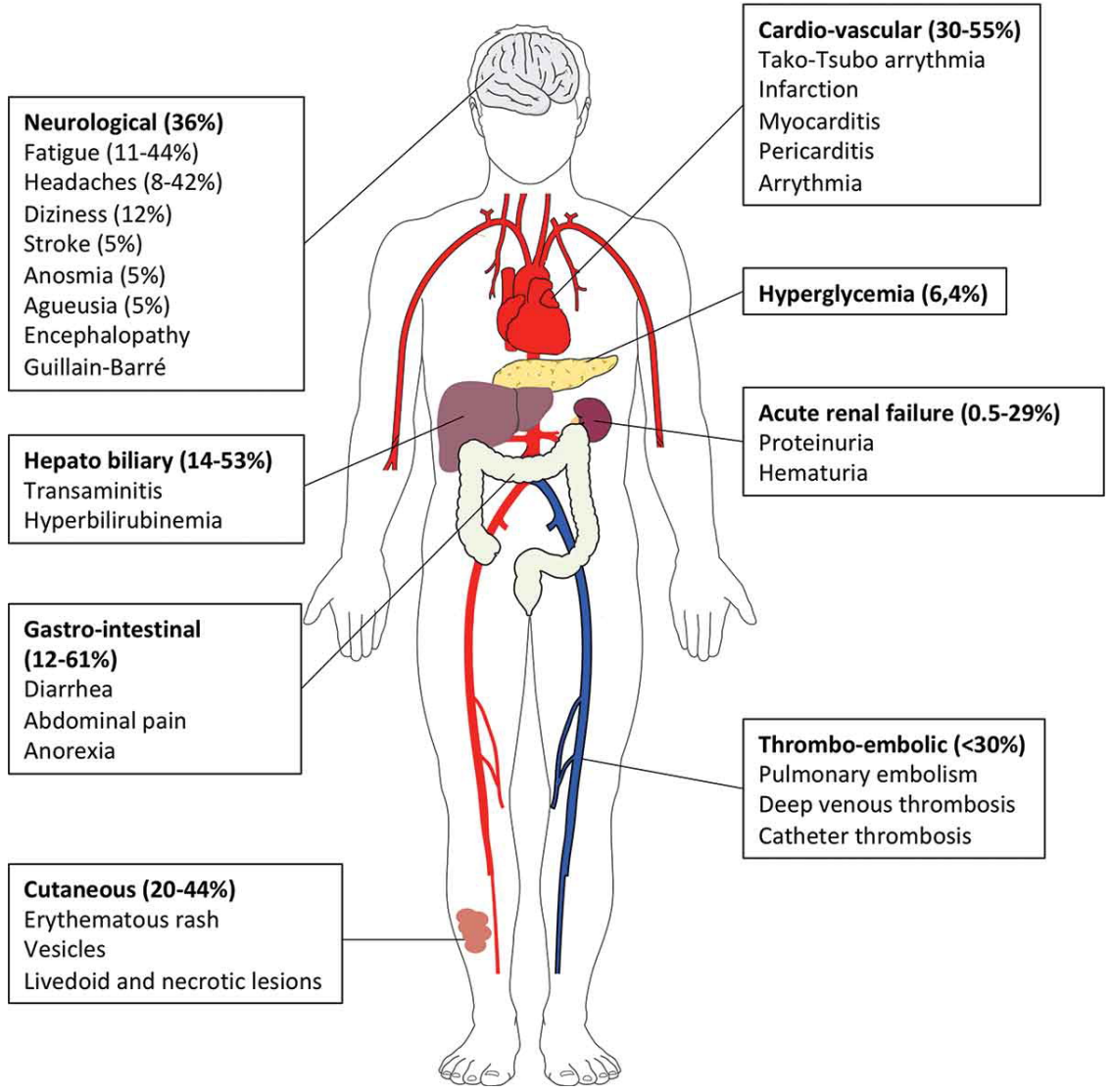
COVID-19 akute Erkrankung – klinischer Verlauf



► **Abb. 1** Bedeutung der viralen Abwehr und der systemischen inflammatorischen Antwort für die Klinik von Patienten mit COVID-19. Klinische Verläufe von COVID-19 (leicht: grün; schwer: grau; kritisch: rot) werden im zeitlichen Verlauf dargestellt [14, 15].

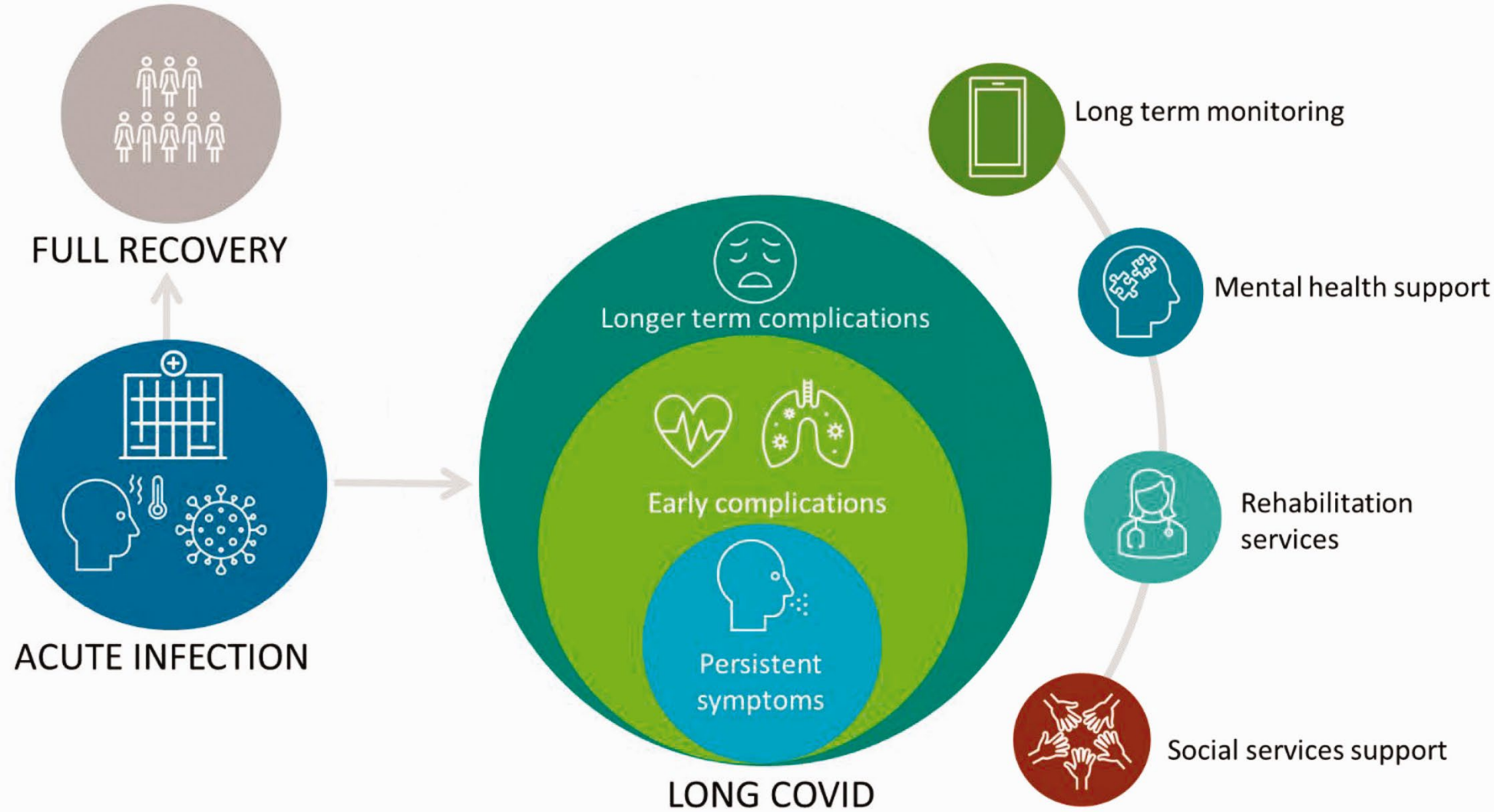
Positionspapier. DGP.

COVID-19 – Extrapulmonale Symptome



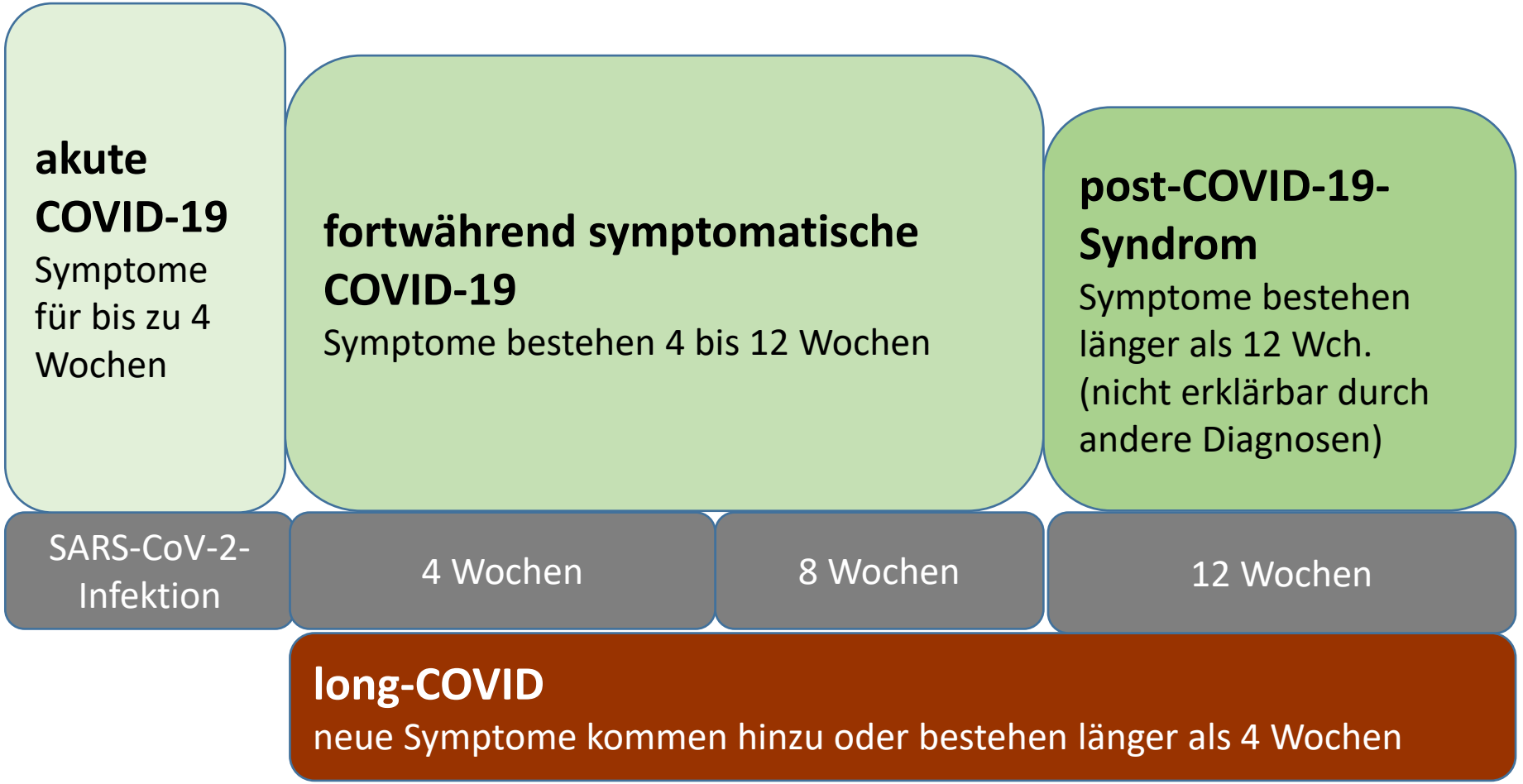
Cléa Melenotte et al. OncoImmunology 2020, 9: 1. DOI: 10.1080/2162402X.2020.1807836.

COVID-19 Klinische Verlaufsformen



Positionspapier zur praktischen Umsetzung der apparativen Differenzialtherapie der akuten respiratorischen Insuffizienz bei COVID-19. Deutsche Gesellschaft für Pneumologie und Beatmungsmedizin e.V. (DGP)

COVID 19 Nomenklatur



COVID 19 Nomenklatur

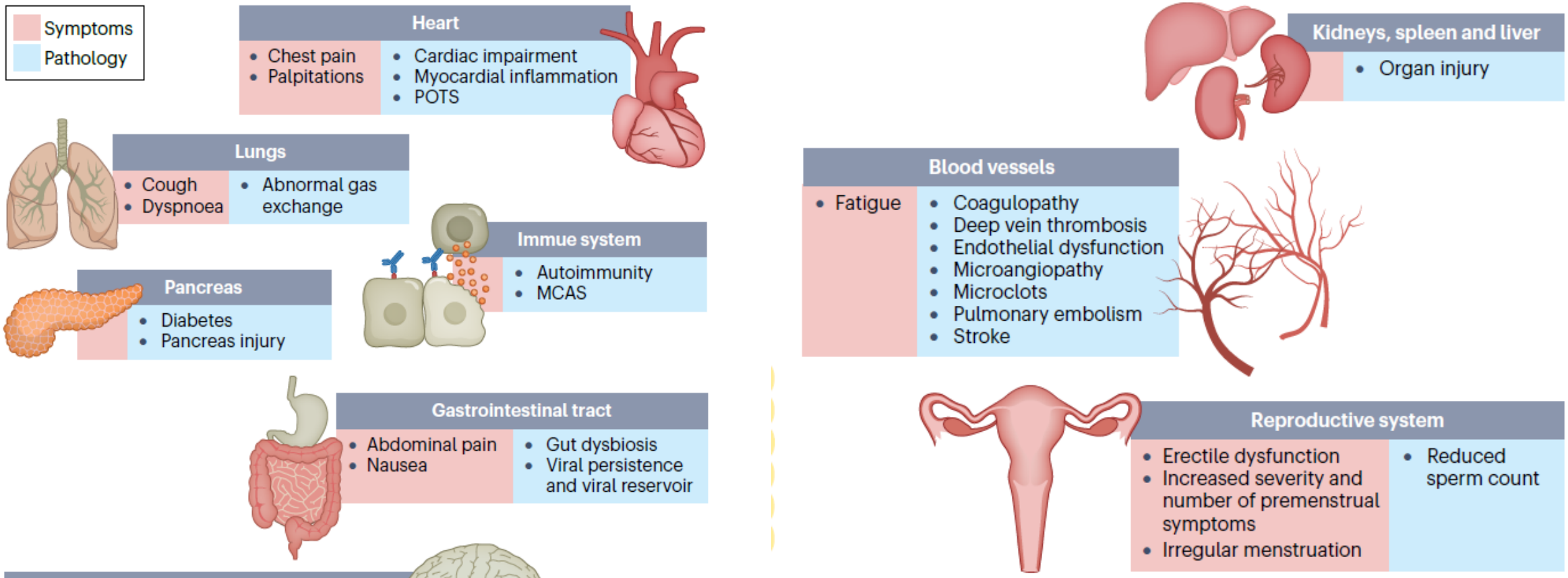
A clinical case definition of post COVID-19 condition by a Delphi consensus

6 October 2021

World Health Organization

Post COVID-19 condition occurs in individuals with **a history of probable or confirmed SARS-CoV-2** infection, **usually 3 months from the onset of COVID-19 with symptoms that last for at least 2 months and cannot be explained by an alternative diagnosis.** Common symptoms include **fatigue, shortness of breath, cognitive dysfunction** but also others (see Table 3 and Annex 2) which generally have an **impact on everyday functioning.** Symptoms may be **new onset,** following initial recovery from an acute COVID-19 episode, or **persist** from the initial illness. Symptoms may also **fluctuate** or **relapse** over time. A separate definition may be applicable for children.

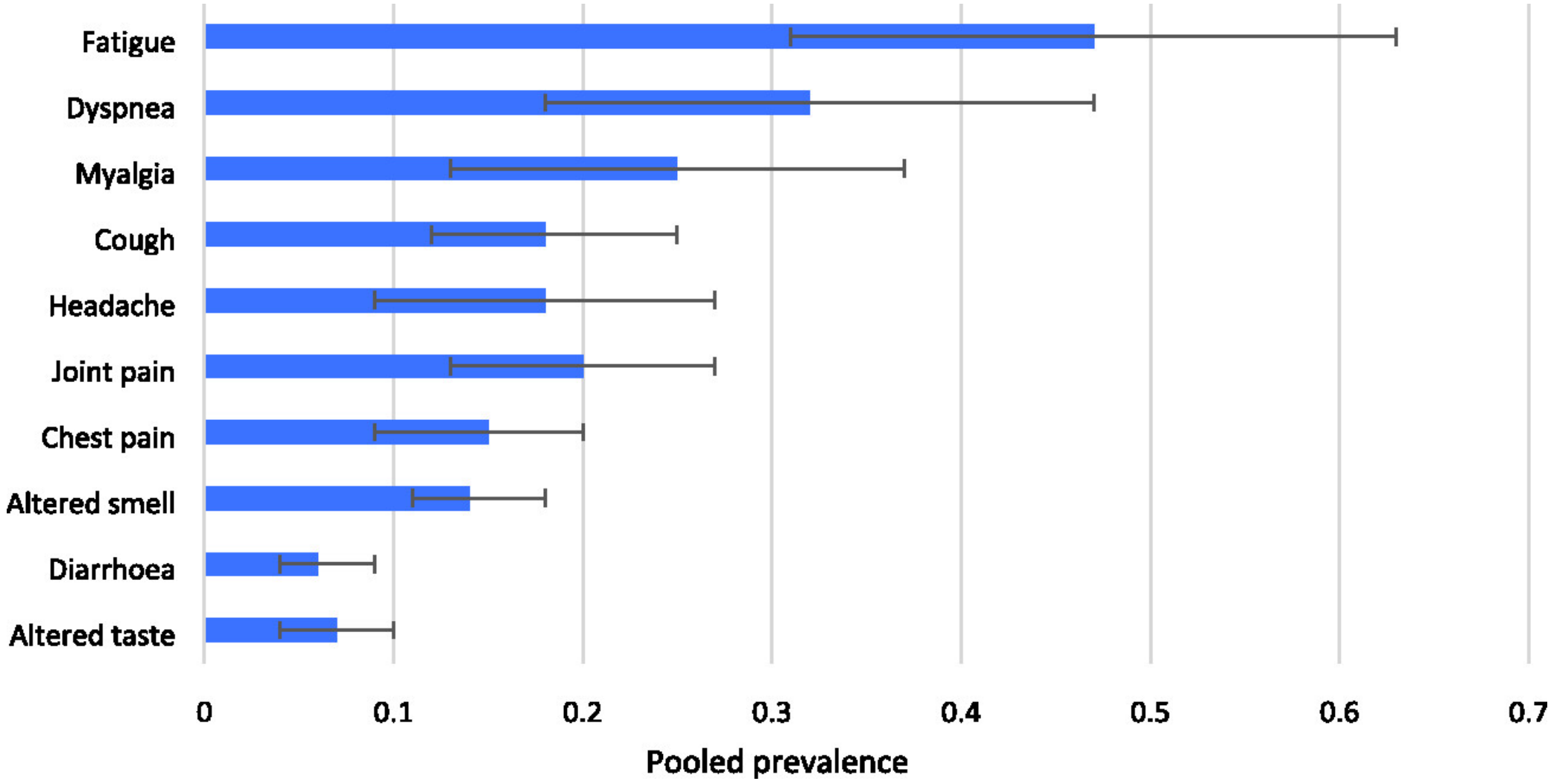
Symptomspektrum post-COVID 19 Syndrom



65.000.000 Fälle weltweit
10–30% Inzidenz in ambulanten Fällen
50–70% Inzidenz in hospitalisierten Fällen

Davis et al. Nat Rev Microbiol. 2023 Jan 13:1-14. doi: 10.1038/s41579-022-00846-2.

Häufigkeit von Post-COVID-Symptomen



Post COVID – Herausforderung Diagnostik

Organbezogene Störungen mit morphologischem Substrat bei PCS

Organ	klinische Symptomatik	morphologische Manifestation und Befunde		patho-physiologische Mechanismen
		Bildgebung	Histologie, Immunhistologie, Molekularpathologie	
olfaktorisch/gustatorisches System siehe auch „ZNS und PNS“	Verlust oder Verminderung der Riech- u. Geschmackssinne (-Dysgeusie, Anosmie)	CT und MRT: diffus erhöhte Signalintensität des Riechkolbens, hyperintensive Foci oder Mikroblutungen, Verklumpung und Ausdünnung der Riechhäute (e46)	Leukozyten-Infiltration der Lamina propria mit apoptotischer Schädigung von Geschmacksknospen, Riechnervenfasern und zentralnervösem Riechzentrum Autopsie: fokale Atrophie des olfaktorischen Epithels (37)	ACE2-Rezeptoren im ZNS (olfaktorischer Bulbus, Amygdala, Hippocampus, Temporallappen, posteriorer cingulärer Cortex, Hirnstamm)
Lunge, obere Atemwege	Dyspnoe, persist. Husten, Exazerbation von Asthma (38)	CT: persistierende Veränderungen, z. B. Milchglastrübung, interstitielle Verdickungen, periphere Retikulation, Fibrosierung, Bronchiektasien (e1)	unspezifische interstitielle Pneumonie (UIP), diffus alveoläre Fibrose und Vernarbung, organisierende Pneumonie (e47), Endothelitis, Mikrohämorrhagien (e48), IHC-Nachweis von $ACE2^+$ in der Lunge (spez. Typ-II-Pneumozyten und Alveolarmakrophagen) (e49)	persist. SARS-CoV-2-RNA im Lungengewebe (Virusreservoir) mit Überaktivierung der Alveolarepithelien ($ACE2^+$) u. Reduktion der Alveolarmakrophagen, Entwicklung einer chron. vernarbenden Entzündung (e21); Nachweis von „profibrotic macrophage responses“ (e50, e51)
Herz/Myokard	atyp. Brustschmerz, thorakales Druckgefühl, Tachykardie, Palpitation (38, 39), Lungenstauung, Herzrhythmusstörungen, Perikardreiben	cMRI: COVID-19-assoziierte myokardiale Inflammation (e51)	endomyokardiale Biopsien: aktive lymphozytäre Inflammation (e51), Thromben in kleinen und größeren kardialen Gefäßen (39, e48), IHC-Nachweis von $ACE2^+$ in den Myozyten (e49)	persist. virale Last induziert in $ACE2^+$-Myozyten und Myokardium Entzündung mit proinflammatorischen Zellen, infiltrierenden Monozyten, Neutrophilen und plasmazytoiden dendritischen Zellen (e21)
Gehirn (ZNS) und peripheres Nervensystem (PNS) siehe auch „olfaktorisch/gustatorisches System“	Müdigkeit, Fatigue, Nebel im Gehirn („brain fog“), Kopfschmerzen, Gedächtnis/Konzentrationsstörungen, diverse psychiatrische Alterationen, Taubheitsgefühl, Tremor	18F-FDG-PET-basiertes Neuroimaging: hypometabolische ZNS-Regionen (olfaktorischer Gyrus, Temporallappen, inkl. Amygdala, Hippocampus, Hypothalamus, Hirnstamm, Kleinhirn) (e52)	virale Neuroinvasion, neuroimmunologische Reaktion im peripheren und zentralen Nervensystem mit gestörter Blut-Hirn-Schranke; autoptischer Nachweis von ACE2 in Zellen des Hirnstamms	Hypothese: neurotropes SARS-CoV-2 (infiziert neuronale Zellkulturen und Organoide) befällt $ACE2^+$-Zellen (Neurone, Astrozyten) und Zellen des Hirnstamms (e53)

Hallek et al. Deutsches Ärzteblatt. Jg. 120. Heft 4. 27. Januar 2023

Risikofaktoren für das post COVID Syndrom

KASTEN

Risikofaktoren für ein Post-COVID-Syndrom (2, 24, 33–36, e41–e44)

- **biografische Faktoren**
  - kaukasische Bevölkerung
  - mittleres Lebensalter
  - weibliches Geschlecht
- **vorbestehende Erkrankungen**
  - Asthma bronchiale
  - schlechte psychische Gesundheit
  - Diabetes mellitus
  - Bluthochdruck
  - Fettleibigkeit
- **COVID-19-spezifisch**
  - multiple (> 5) akute Symptome
  - hohe akute Viruslast
  - niedrige baseline SARS-CoV-2-IgG
  - Durchfall
  - Impfstatus

(Aus [6]: Abdruck mit freundlicher Genehmigung der BÄK)

Hallek et al. Deutsches Ärzteblatt. Jg. 120. Heft 4. 27. Januar 2023

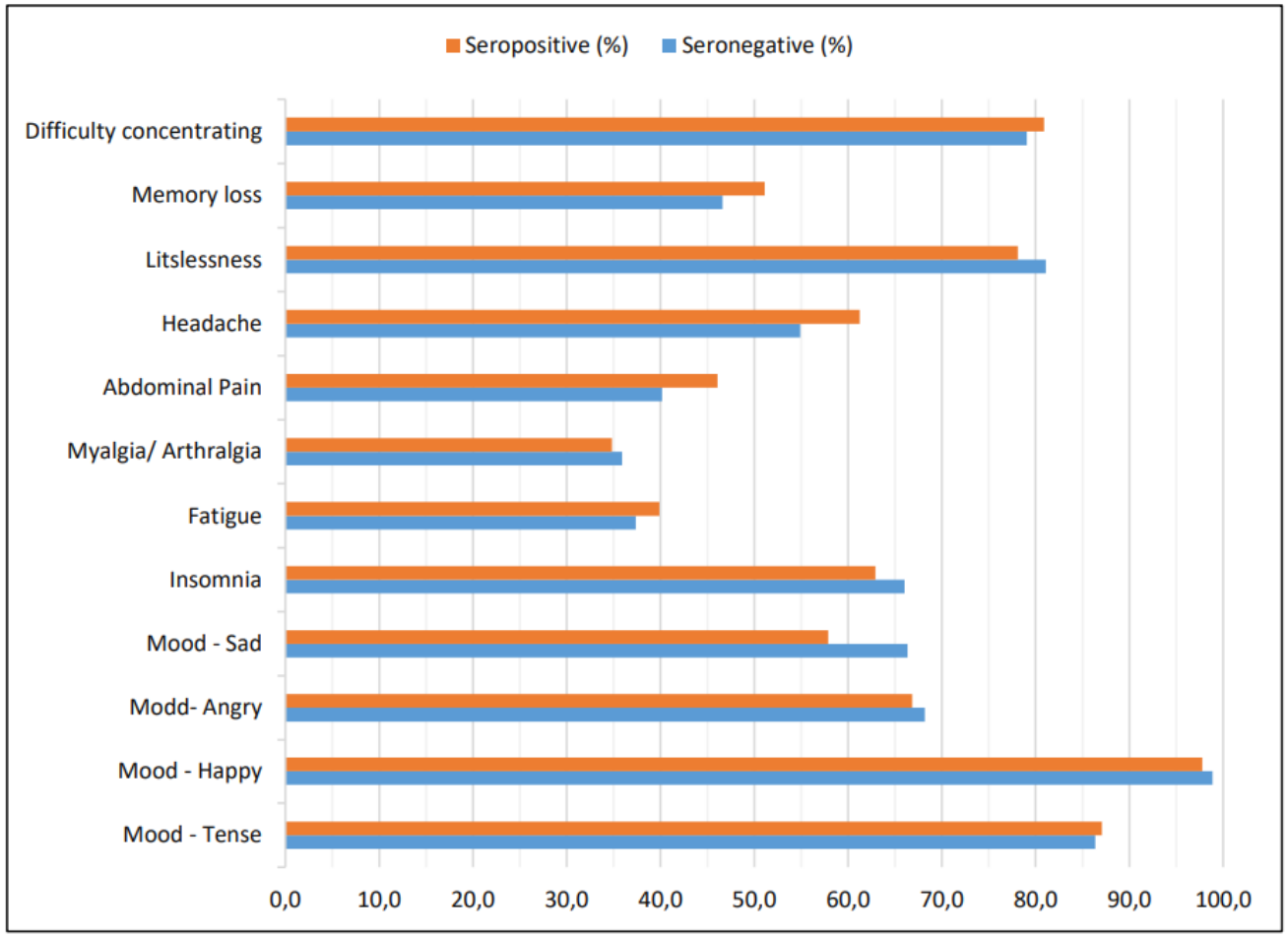
Long COVID Forschung – eine Herausforderung Hintergrundrauschen

- Initiale Vermischung mit Post-Intensive Care Syndrom
- Durch eine intensivmedizinische Behandlung verursacht, z.B.:
  - Muskelschwäche
    - 30% nach Beatmung
    - 50% nach Blutvergiftung
  - Kognitive Probleme, Nervenschäden
    - 30-80% nach längerem Aufenthalt

www.sccm.org/MyICUCare/THRIVE/Post-intensive-Care-Syndrome

Long COVID Forschung – eine Herausforderung Hintergrundrauschen

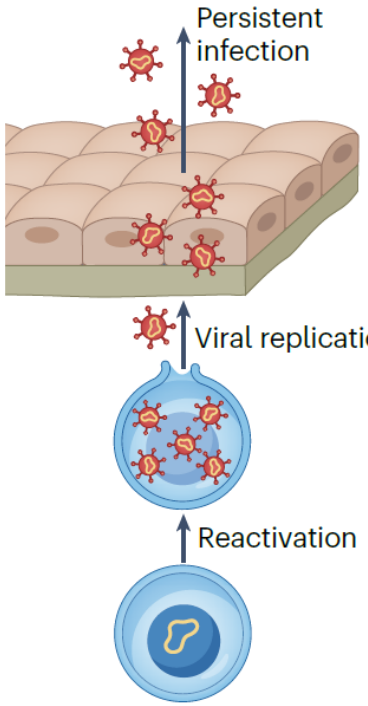
- 1.560 Schülerinnen und Schüler (Klasse 8-12) in Sachsen
- 1.365 (88%) seronegativ, 188 (12%) seropositiv
- Keine signifikanten Unterschiede bzgl. Symptomen zwischen den Gruppen



https://doi.org/10.1101/2021.05.11.21257037

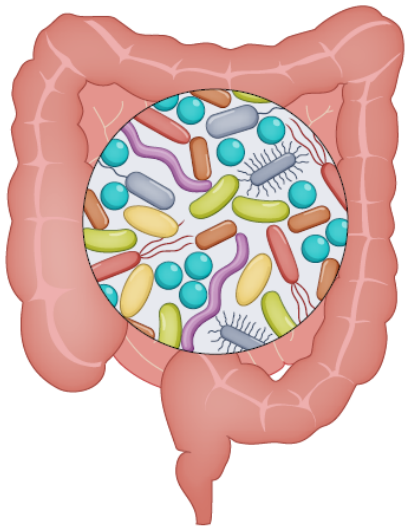
Potentielle Ursachen

Immune dysregulation



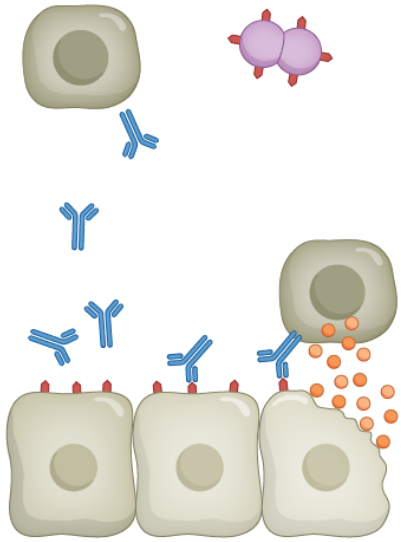
Immune dysregulation, with or without reactivation of underlying pathogens, including herpesviruses such as EBV and HHV-6

Microbiota dysbiosis



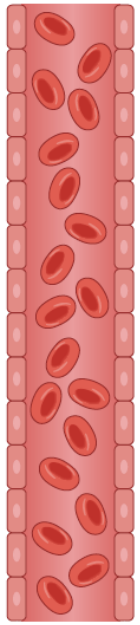
Impacts of SARS-CoV-2 on the microbiota and virome (including SARS-CoV-2 persistence)

Autoimmunity and immune priming



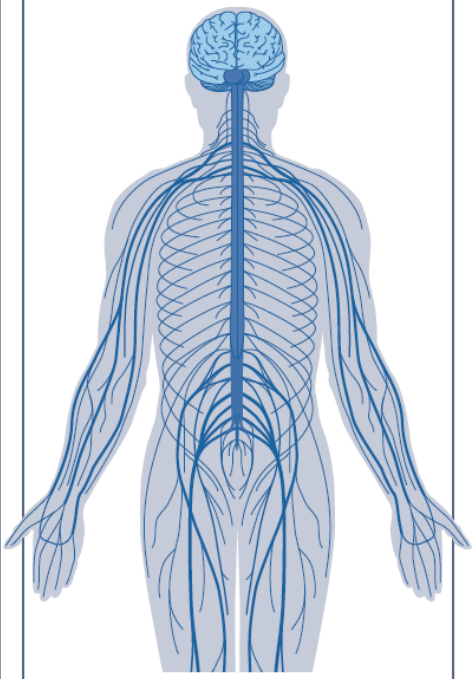
Autoimmunity and primed immune cells from molecular mimicry

Blood clotting and endothelial abnormalities



Microvascular blood clotting with endothelial dysfunction

Dysfunctional neurological signalling



Dysfunctional signalling in the brainstem and/or vagus nerve

Davis et al. Nat Rev Microbiol. 2023 Jan 13:1-14. doi: 10.1038/s41579-022-00846-2.

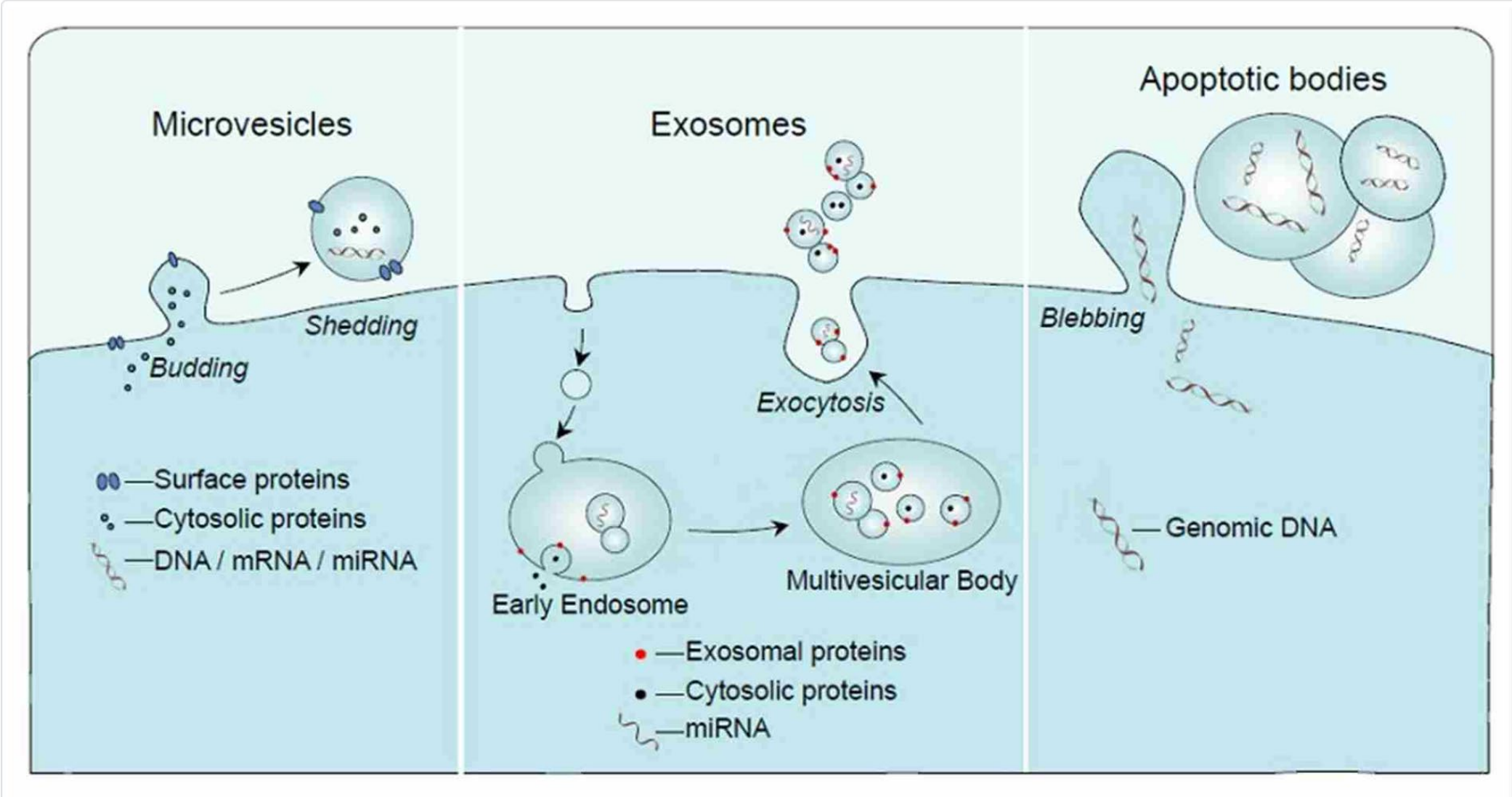
Potentielle Ursachen – Virale Persistenz

	RNA	Protein	PASC symptoms	Location
Tissue (biopsy)				
Goh et al.[39]	√	S, N	√	Appendix, skin and breast tissues 163 and 426 d after COVID-19
Zollner et al.[38]	√	N	√	Gut mucosa/epithelium tissue ~7 months after COVID-19
deMelo et al.[27]	√	N	√	Olfactory neuroepithelium tissue 110–196 d after COVID-19
Gaebler et al.[33]	√	N	No	Intestinal tissue ~4 months after COVID-19
Cheung et al.[114]	√	S, N	NM	Colon, appendix, ileum, hemorrhoid, liver, gallbladder and lymph nodes 9–180 d after COVID-19
Hany et al.[29]	NM	N	NM	Gastric and gallbladder tissues 274–380 d after COVID-19
Miura et al.[30]	√	N	No	Adenoid tonsil, adenoid tissue, nasal cytobrush and nasal wash from children with no documented COVID-19 or upper airway infection in the month before collection
Xu et al.[37]	√	NM	No	Child adenoid and tonsil tissue up to 303 d after COVID-19
Peluso et al.[24]	√	NM	√	Colorectal lamina propria tissue 158–676 d after COVID-19
Yao et al.[25]	√	S,N	√	Fungiform papillae tongue tissue 6–63 weeks after COVID-19
Tissue (autopsy)				
Stein et al.[31]	√	N	NM	Dozens of human body and brain tissue types at least 31 d and up to 230 d after COVID-19
Roden et al.[32]	√	NM	NM	Lung tissue up to 174 d after COVID-19
Rendiero et al.[26]	NM	S	NM	Lung tissue up to 359 d after COVID-19
Stool				
Natarajan et al.[115]	√	NM	√	Stool up to 230 d after COVID-19
Yonker et al.[84]	√	S, N	√	RNA in stool of children with MIS-C 13–62 d after COVID-19, S and N protein in plasma
Jin et al.[116]	√	S	NM	Neonatal stool in infants born to mothers whose COVID-19 symptoms resolved more than 10 weeks before delivery
Blood				
Schultheiß et al.[40]	NM	S1	√	Plasma at a median time of 8 months after COVID-19
Swank et al.[41]	NM	S, S1, N	√	Plasma up to 12 months after COVID-19
Peluso et al.[44]	NM	S1, N	√	Plasma neuron-derived EVs 35–84 d after COVID-19
Peluso et al.[42]	NM	S1, S, N	√	Plasma up to 16 months after COVID-19
Craddock et al.[45]	√	S	√	Spike linked to EVs in samples obtained at least 8–12 weeks (up to 1 year) after COVID-19
Tejerina et al.[117]	√	NM	√	Plasma at a median time of 55 d after COVID-19 (also found in stool/urine at the same median time point)

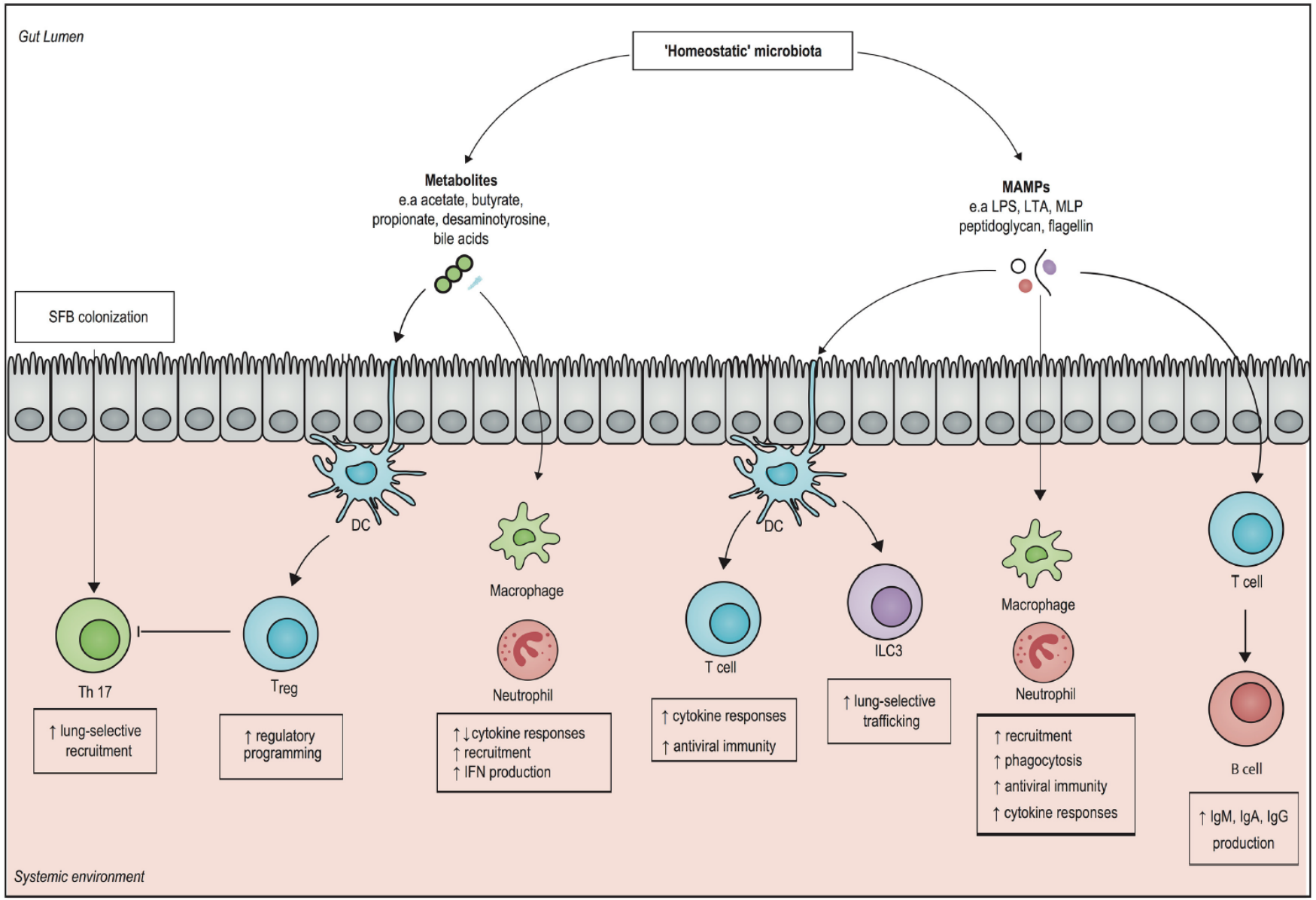
√, identified; No, not present; NM, not measured; S and S1, spike protein.

Wang et al. Front. Cell. Infect. Microbiol., 05 April 2022. Sec. Clinical Microbiology. Volume 12 - 2022 | https://doi.org/10.3389/fcimb.2022.861703

Potentielle Ursachen – Virale Persistenz
Rolle extrazellulärer Vesikel

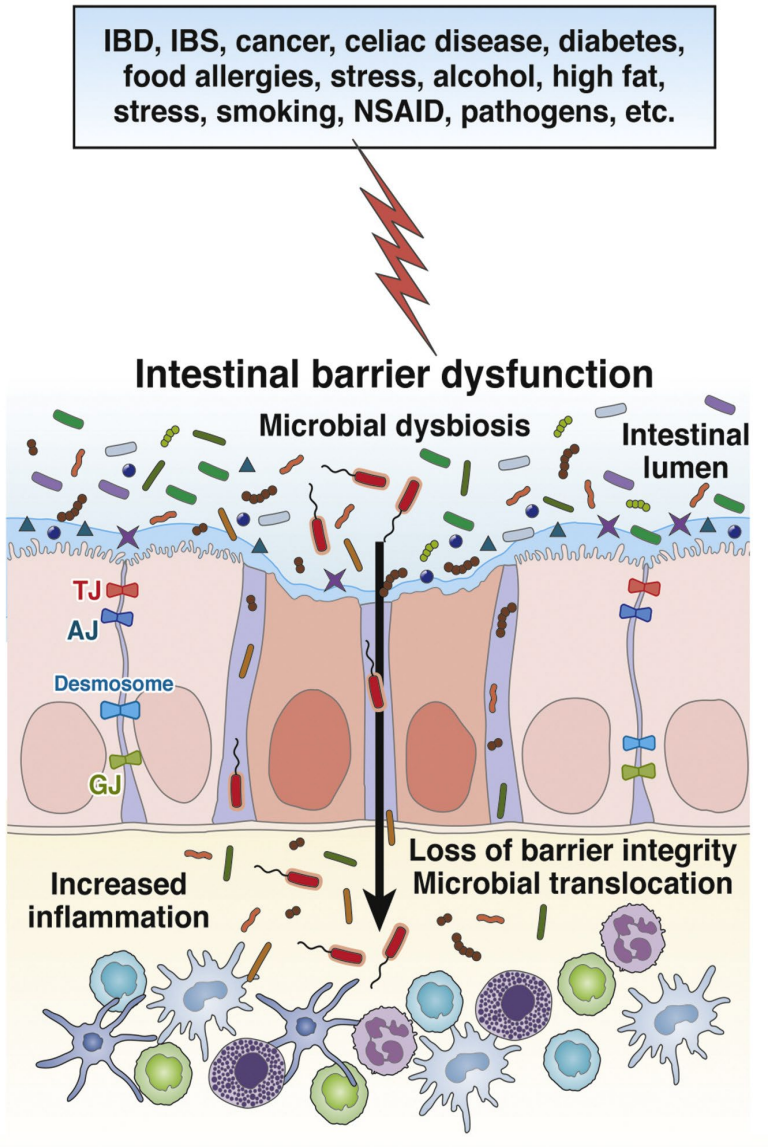


Darm-Immunachse



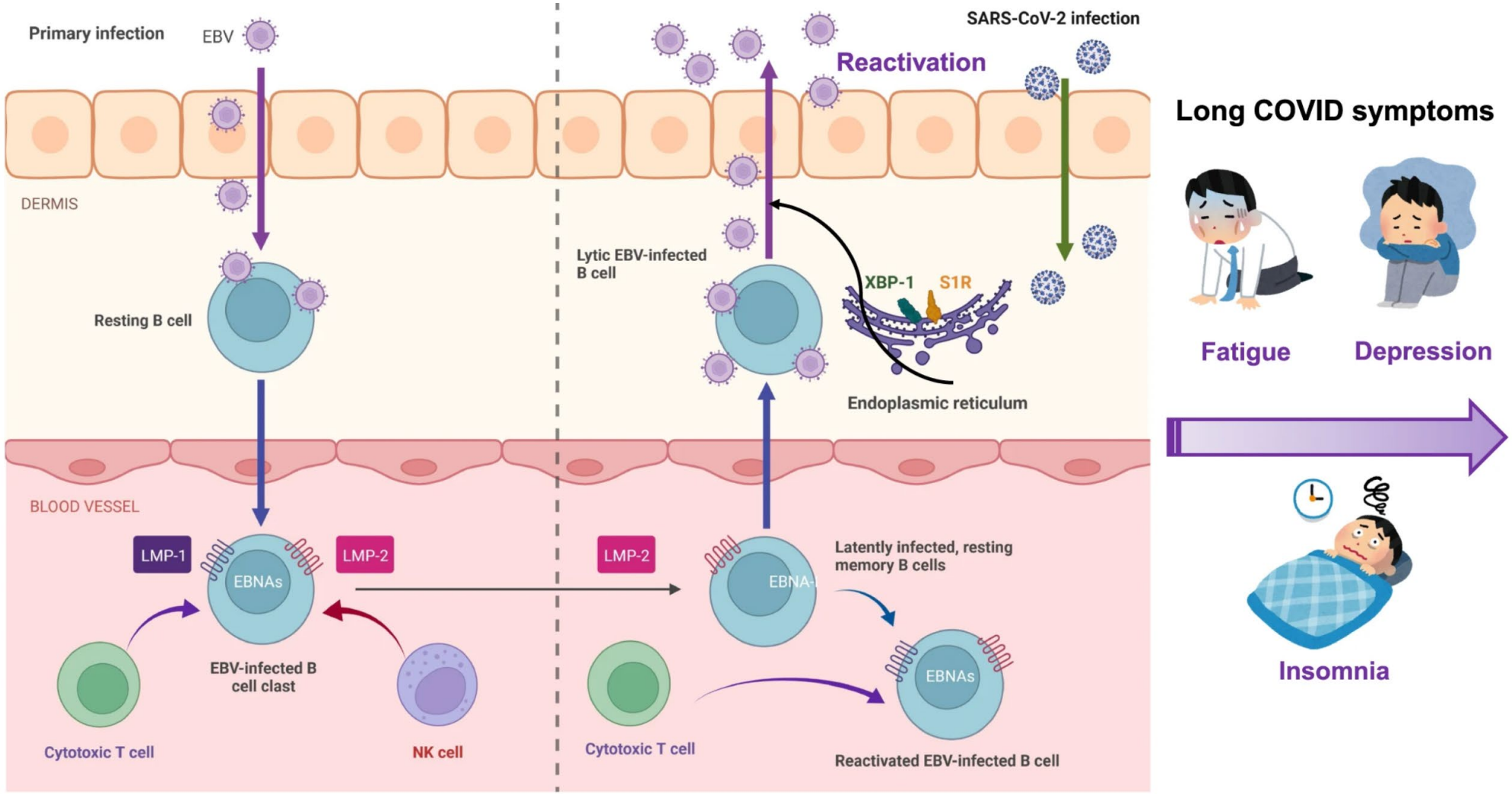
Haak et al. Front Immunol. 2018 Sep 10;9:2042.

Intestinale Barrierestörung → Inflammation



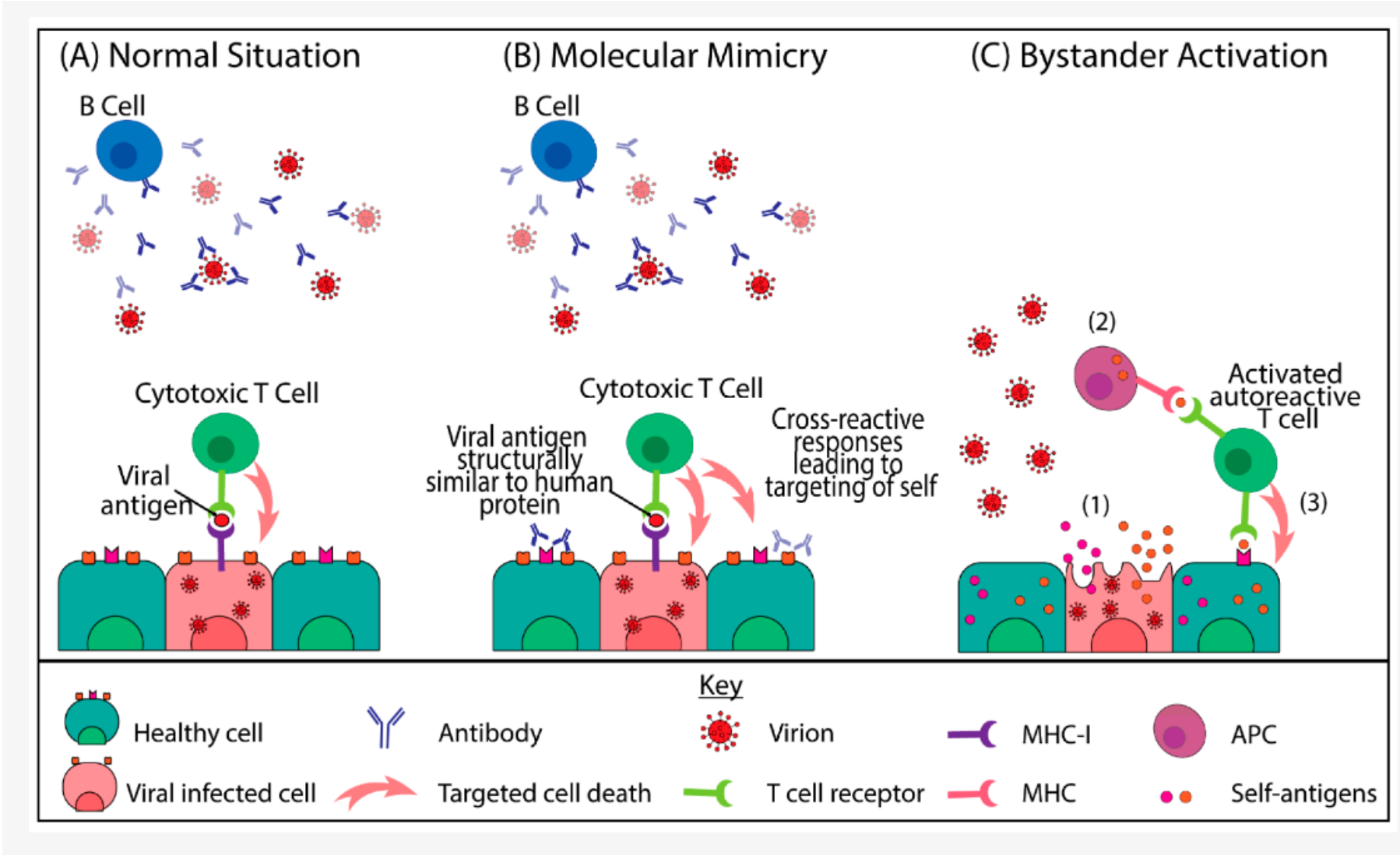
Ghosh et al. Cellular and Molecular Gastroenterology and Hepatology 2021 111463-1482DOI: (10.1016/j.jcmgh.2021.02.007).

EBV Reaktivierung → Inflammation



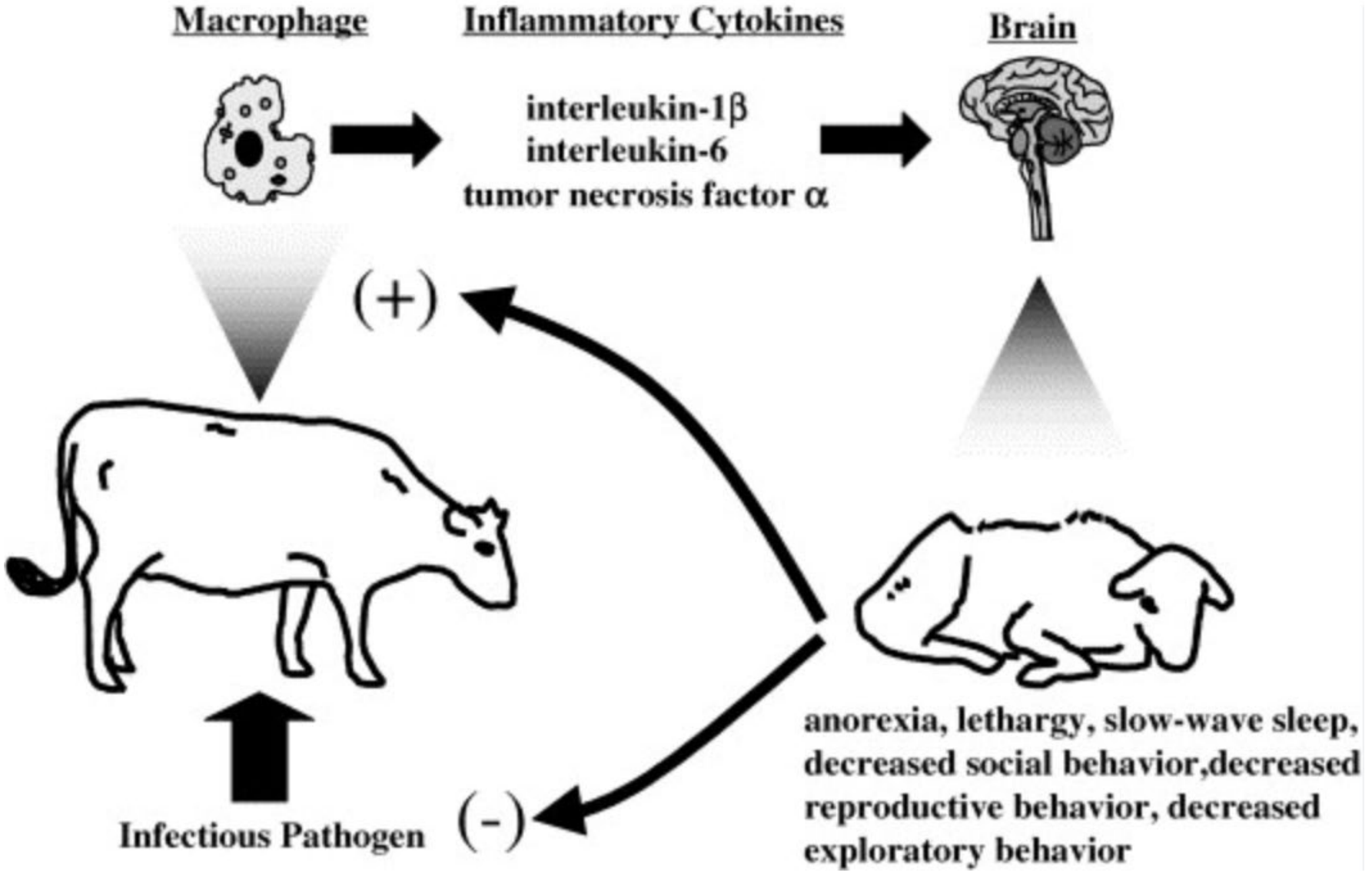
Hashimoto et al. *Mol Psychiatry* (2023). https://doi.org/10.1038/s41380-023-02161-5

Molekulares Mimikry → Inflammation



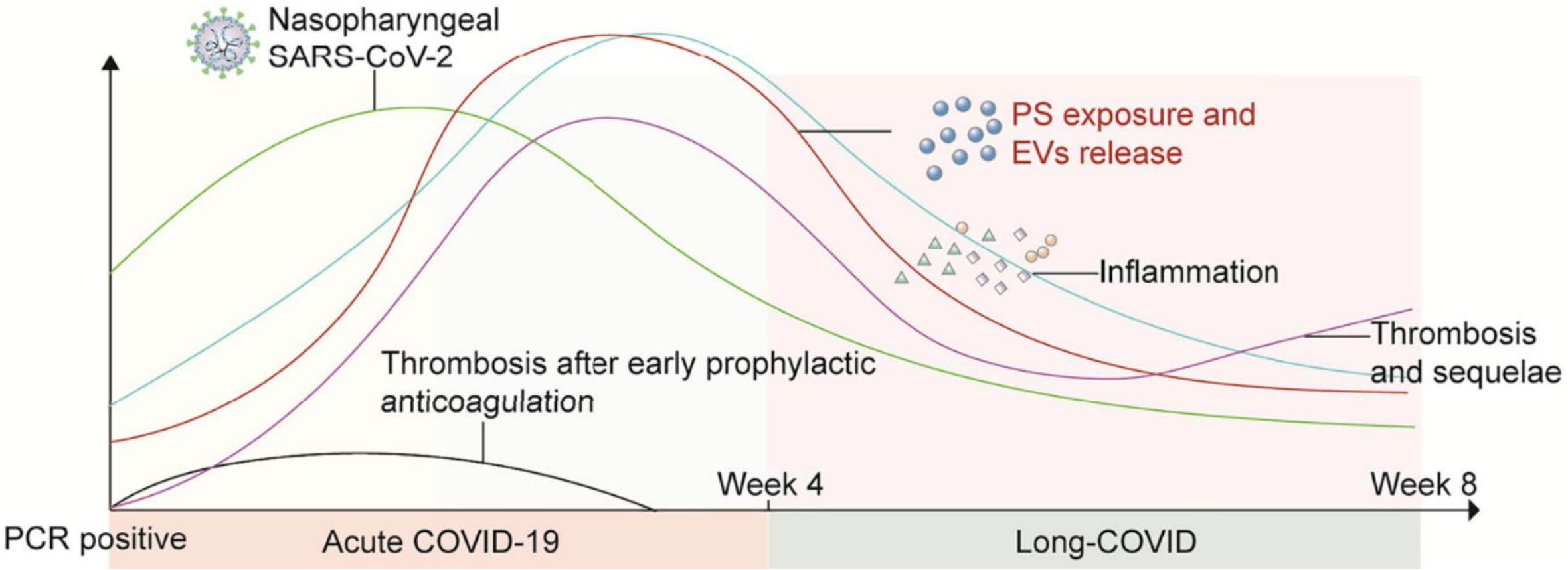
Moody et al. Int. J. Mol. Sci. 2021. 22(16), 8965; https://doi.org/10.3390/ijms22168965

Inflammation → Vagus → Krankheitsverhalten



Johnson et al. Veterinary Immunology and Immunopathology. Volume 87, Issues 3–4, 10 September 2002, Pages 443-450

Inflammation → Thrombosen → Inflammation



Wang et al. Front. Cell. Infect. Microbiol., 05 April 2022. Sec. Clinical Microbiology. Volume 12 - 2022 | https://doi.org/10.3389/fcimb.2022.861703

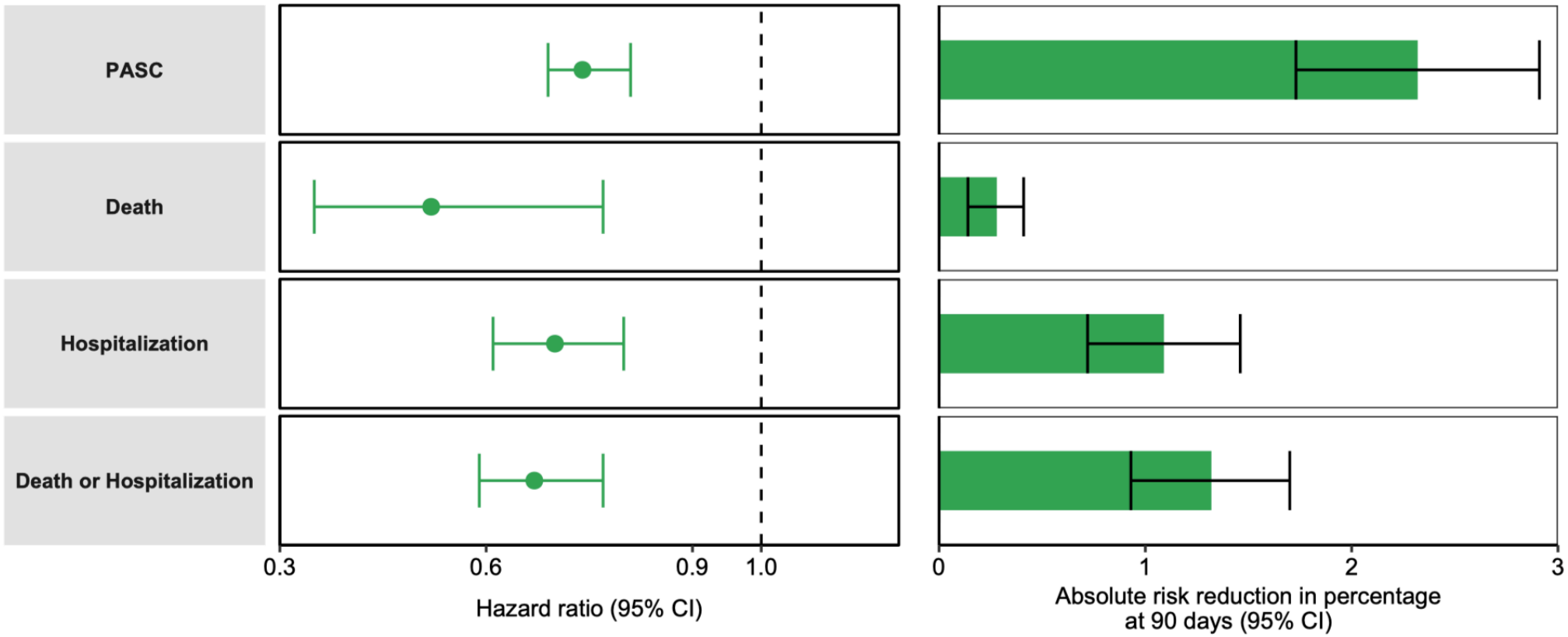
Inflammation → Thrombosen → Inflammation

References	Population	Purpose	Results	Conclusions
(Giannis et al., 2020)	N=4906	Postdischarge thromboembolic outcomes and mortality	VTE was diagnosed in 76 patients (1.55%) postdischarge and included 44 DVTs (0.90%), 42 PEs (0.85%), 2 splanchnic vein thrombosis (0.04%), and 3 other vein thromboses (0.06%).	Postdischarge VTE, ATE, and ACM occurred frequently after COVID-19 hospitalization. Postdischarge anticoagulation reduced risk by 46%.
(Patell et al., 2020)	N=163	Postdischarge thrombosis and hemorrhage	The cumulative incidence of thrombosis (including arterial and venous events) at day 30 following discharge was 2.5%; the cumulative incidence of venous thromboembolism alone at day 30 postdischarge was 0.6%.	The rates of thrombosis and hemorrhage appear to be similar following hospital discharge for COVID-19.
(Pasini et al., 2021)	N=75	Serum metabolic profile in pasc syndrome: clinical implication	All patients had very high serum concentrations of ferritin and D-Dimer. 73% had elevations in erythrocyte sedimentation rate and CRP. 27% had elevations in LDH.	The persistence of altered D-Dimer levels raises the possibility of long-term risks of thromboembolic disease.
(Pretorius et al., 2021)	N=49	Investigate whether the persistent symptoms of long-COVID are due to the presence of persistent circulating plasma microclots that are resistant to fibrinolysis.	The plasma samples from long COVID/PASC still contain large anomalous (amyloid) deposits (microclots).	Clotting pathologies in both acute COVID-19 infection and in long COVID/PASC might benefit from following a regime of continued anticlotting therapy to support the fibrinolytic system function.
(von Meijenfeldt et al., 2021)	N=52	Studied the hemostatic status of patients with a resolved COVID-19 infection.	One patient developed a deep vein thrombus with small pulmonary embolisms in the 4 months after hospital discharge. PAI-1 levels were higher in patients compared with controls, both on admission and at 4-month follow-up.	COVID-19 patients have sustained prothrombotic changes as evidenced by enhanced thrombin-generating capacity and decreased plasma fibrinolytic potential at 4 months after hospital discharge.

Zwischen 1,6 und 2,5% Thrombosen bei Entlassung

Wang et al. Front. Cell. Infect. Microbiol., 05 April 2022. Sec. Clinical Microbiology. Volume 12 - 2022 | https://doi.org/10.3389/fcimb.2022.861703

Protektive Maßnahmen – frühe Therapie



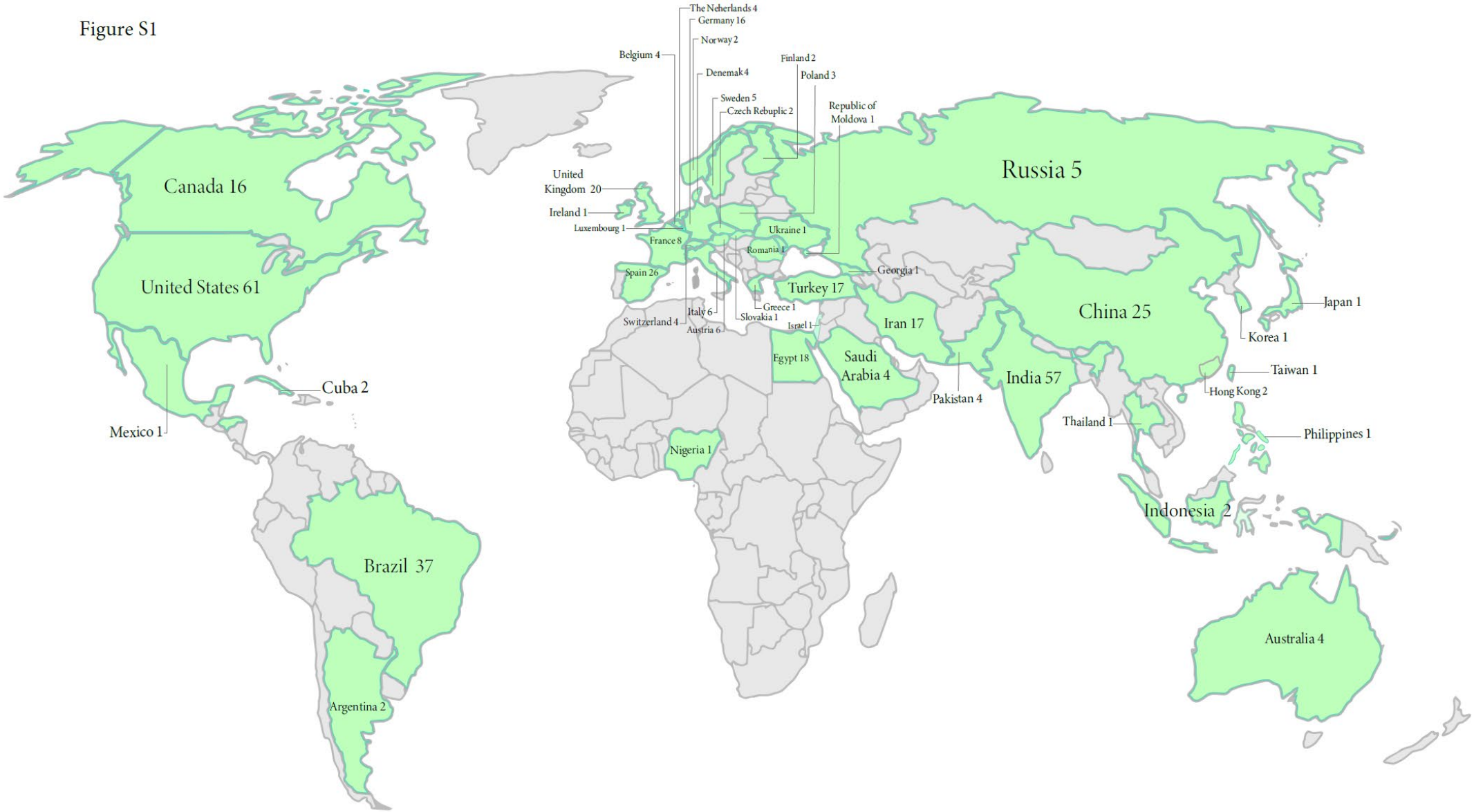
Nirmatrelvir/Ritonavir in der Frühphase reduziert Wahrscheinlichkeit von post COVID

Yan X et al.; medRxiv preprint doi: https://doi.org/10.1101/2022.11.03.22281783;

Preventive Maßnahmen - Impfung

Antonelli et al. The Lancet Infectious Diseases. VOLUME 22, ISSUE 1, P43-55, JANUARY 2022

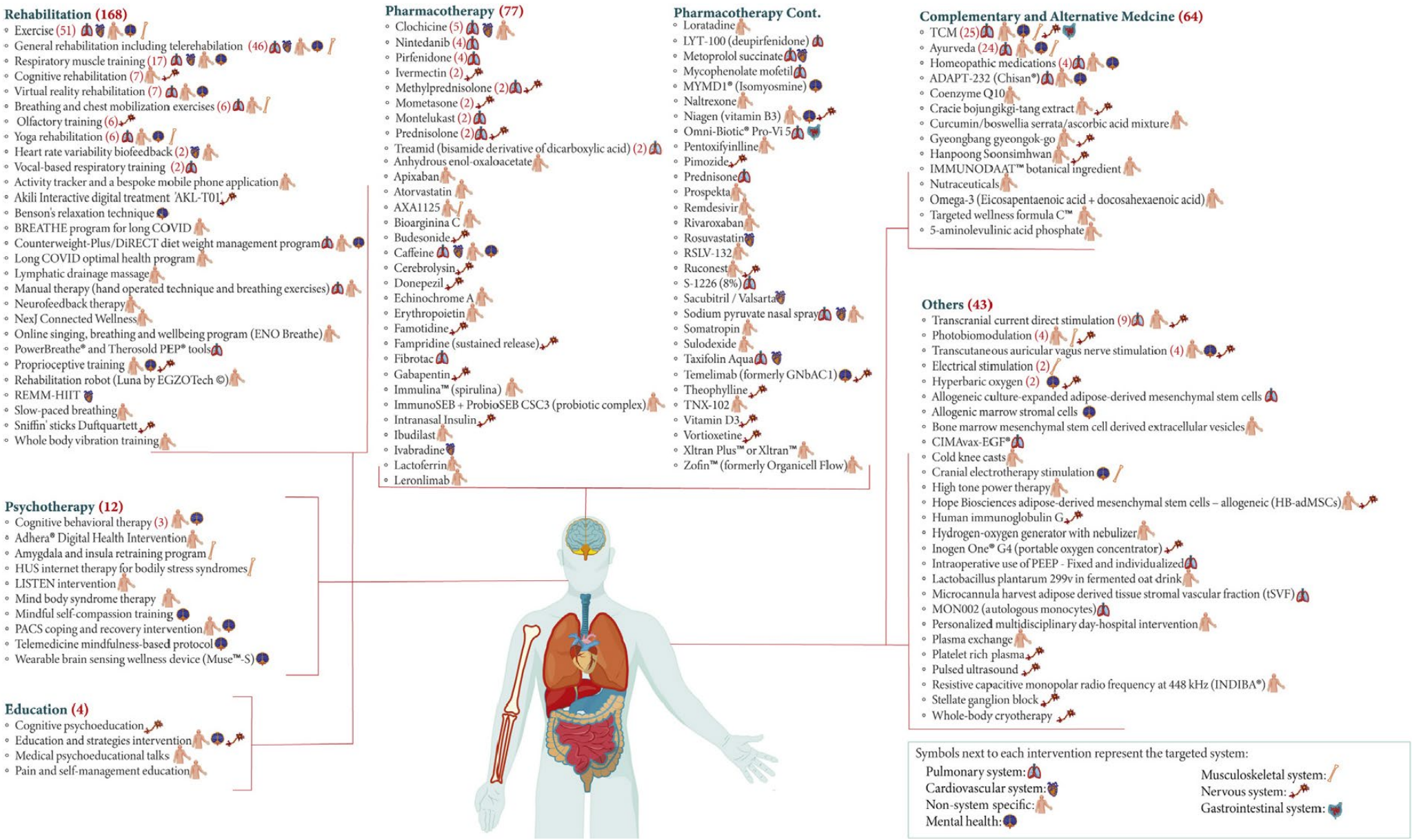
Therapiestudien alle Kategorien



N=388

Fawzy NA et al. Clin Microbiol Infect 2023; 570-577.

Therapiestudien alle Kategorien - Ansätze



Fawzy NA et al. Clin Microbiol Infect 2023; 570-577.

Therapiestudien alle Kategorien - Vergleichbarkeit

The top 20 primary outcome measures in terms of frequency (*N*)

Rank	Primary outcome measures	N
1	6-minute walk test	58
2	Pulmonary function testing	43
3	Changes in symptoms of PACS	24
4	36-Item Short-Form Survey	23
5	Cardiopulmonary exercise test/peak oxygen consumption ($VO_{2\ max}$)	20
6	European Quality of Life 5 Dimensions 5 Level Version	19
7	Visual Analogue Scale	17
8	Fatigue Severity Scale	16
9	Post-COVID-19 Functional Status Scale	12
10	Sniffin' Sticks Test	12
11	Modified Medical Research Council Dyspnea Scale	10
12	Chalder Fatigue Scale (CFQ-11)	9
13	Fibrosis in high-resolution computed tomography of the lung	9
14	Incidence of treatment-emergent adverse effects	9
15	Inspiratory muscle strength or maximal inspiratory pressure	9
16	Borg Dyspnea Scale	8
17	Changes in blood oxygenation	8
18	Fatigue Assessment Scale	8
19	Handgrip strength dynamometer	8
20	Routine blood test	7
20	SGRQ	7

PACS, post-acute COVID-19 syndrome; SGRQ, St. George's Respiratory Questionnaire.

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Therapiestudien – Randomisierte Kontrollierte Studien

Trial	Interventions under comparison	PC/subtype	Country	Current state	No. of subjects	NCT
Immunomodulatory						
Phase 2 RCT	IgG vs. methylprednisolone vs. saline	PC neurological	USA	Recruiting	45	NCT05350774
Phase 3 RCT (open)	Atorvastatin vs. standard care	LC neurocognitive	Australia	Recruiting	400	NCT04904536
Phase 2 RCT	Plasma Exchange Therapy vs. sham	PC	Spain	not yet recruiting	50	NCT05445674
Phase 2 RCT	Immunoadsorption vs. sham	PC ME/CFS (CCC) and autoantibodies	Germany	Not yet recruiting	66	NCT05710770
Phase 3 RCT	Montelukast vs. placebo	LC respiratory	Spain	Recruiting	284	NCT04695704
Phase 2 RCT	Ampligen vs. saline	PC ME/CFS (CDC)		Not yet recruiting	80	NCT05592418
Phase 3 RCT	Prednisolone (low dose) vs. placebo Vitamin B1/6/12 vs. placebo	PC	Germany	Recruiting	340	NCT05638633
Phase 2 RCT	Efgartigimod vs. placebo	PC POTS	USA	Recruiting	42	NCT05633407
Phase 2/3 RCT adaptive	Ibudilast vs. Pentoxifylline vs. placebo	PC	Canada	Not yet recruiting	1,000	NCT05513560
Phase 2 RCT	Baricitinib vs. placebo	PC cognitive	USA	Not yet recruiting	30	NCT05858515
Phase 2 RCT	BC007 aptamer vs. placebo	LC fatigue	Germany/ Europe	Not yet recruiting	114	EudraCT2022-003452-14
Phase 4 RCT	Loratidine vs. placebo	LC	India	Not yet recruiting	64	CTRI/2022/07/043679

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Therapiestudien – Randomisierte Kontrollierte Studien

TABLE 1 Randomized controlled trials in PCS registered in clinical trial platforms*.

Trial	Interventions under comparison	PC/subtype	Country	Current state	No. of subjects	NCT
Vascular						
Phase 2 RCT	Hyperbaric oxygen therapy vs. sham	PC or LC	Sweden	Recruiting	80	NCT04842448
Phase 2 RCT	Vericiguat vs. placebo	PC ME/CFS (CCC or IOM) and endothelial dysfunction	Germany	Not yet recruiting	104	NCT05697640
Antiviral						
Phase 2 RCT	Paxlovid vs. Ritonavir vs. placebo	PC	USA	Recruiting	200	NCT05576662
Phase 2 RCT	Temelimab vs. placebo	PC neuropsychiatric	Switzerland	Recruiting	200	NCT05497089
Phase 3 RCT	Meplazumab (anti-CD147) vs. placebo	PC (at least one symptom)	China	Not yet recruiting	144	NCT05813587
Neuro-modulators						
Phase 4 RCT (open)	Dextroamphetamine vs. app	PC cognitive	USA	Recruiting	120	NCT05597722
Phase 2 RCT	Low-dose Naltrexone (LDN) vs. placebo	PC ME/CFS	Canada	Not yet recruiting	160	NCT05430152
Phase 2 RCT	Lithium vs. placebo	LC fatigue and/or brain fog	USA	Recruiting	50	NCT05618587
Phase 2 RCT	Vortioxetine vs. placebo	PC cognitive	Canada	Complete	200	NCT05047952
Phase 2 RCT	Fampridine vs. placebo	PC cognitive	Switzerland	Recruiting	44	NCT05274477
Phase 2 RCT	Ketamine vs. placebo	PC depressive	USA	Recruiting	12	NCT05690503

*ClinicalTrials.gov, https://clinicaltrials.gov/; EU Clinical Trials Register https://www.clinicaltrialsregister.eu/; International Clinical Trials Registry Platform (ICTRP), https://www.who.int/clinical-trials-registry-platform (date 22.5.2023); RCT, randomized controlled trial; PC: Post-COVID-19 Condition or Syndrome, LC: Long Covid; NCT: National Clinical Trials Number = ClinicalTrials.gov Identifier.

Fawzy NA et al. Clin Microbiol Infect 2023; 570-577.

Impfung bei bestehendem post COVID

Bei bestehendem Post-COVID führte die COVID-19-Impfung zu einer Modifikation (Verbesserung und Verschlechterung) der Post-COVID-Symptome, die teilweise nur passager anhielt

(Arnold DT, et al.,. *Ann Intern Med.* 2021;174:1334–1336. doi: 10.7326/M21-1976.
Ayoubkhani D, et al. *BMJ.* 2022;377:e069676. doi: 10.1136/bmj-2021-069676.
Gaber TA-ZK et al.,https://www.bjmp.org/content/are-mrna-covid-19-8.
Strain WD et al.,. 2022;10:652. doi: 10.3390/vaccines10050652.)

In einer Studie konnte eine Reduktion der Post-COVID-induzierten Hausarztbesuche berichtet werden

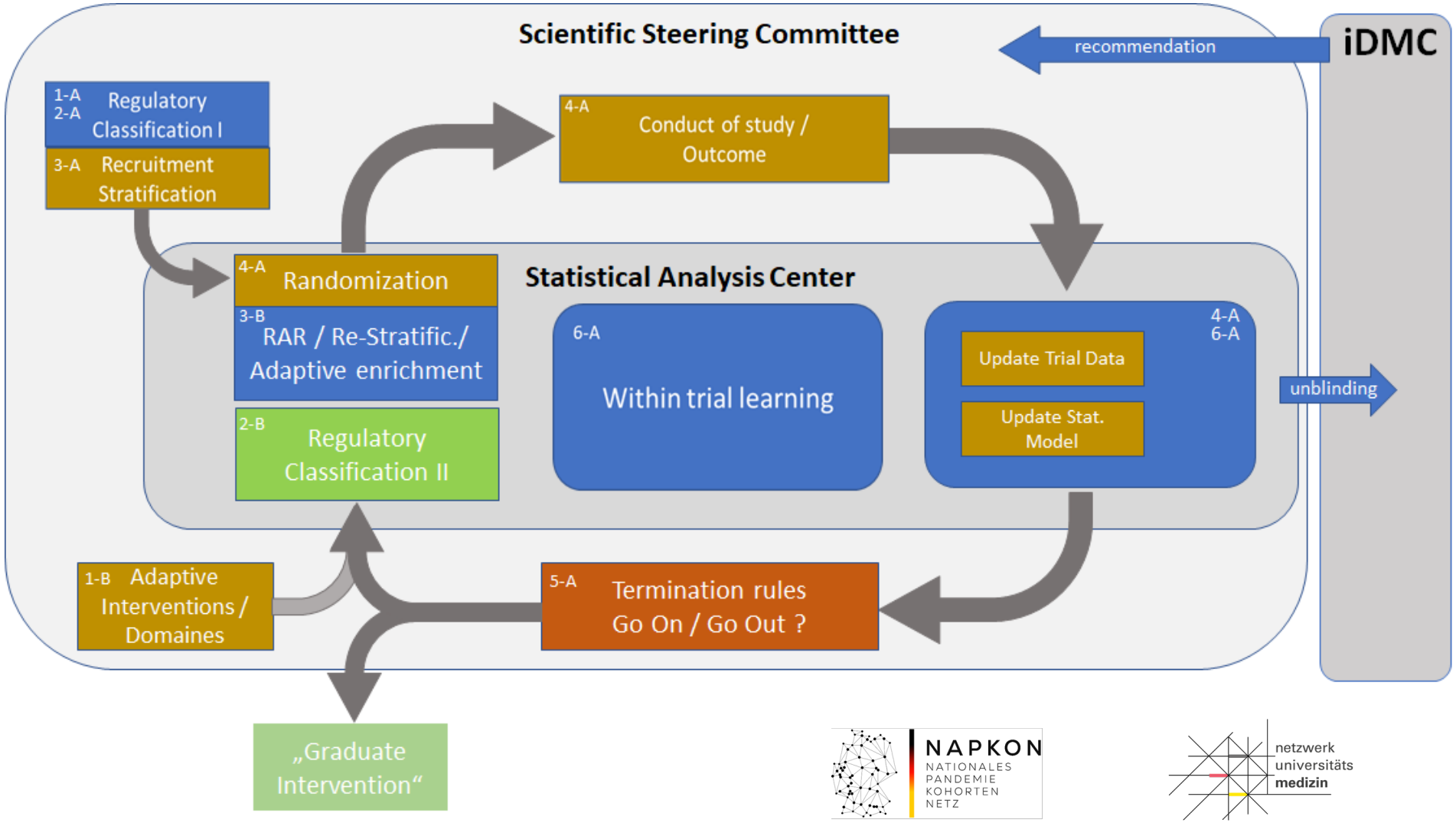
(Whittaker HR, et al. *BMJ.* 2021 doi: 10.1136/bmj-2021-065834)

Zwei Studien konnten keinen Einfluss der Impfung auf Post-COVID nachweisen

(Peghin M, et al. *Clin Microbiol Infect.* 2022 doi: 10.1016/j.cmi.2022.03.016.
Wisnivesky JP, et al (2022). https://link.springer.com/10.1007/s11606-022-07465-w.)

Ein therapeutischer Effekt kann aus der vorliegenden Evidenz nicht sicher abgeleitet werden.

Ausblick: RAPID – Randomized Assessments of Post COVID Syndrome Treatments



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Vidofludimus Calcium (IMU-838)

Dihydroorotate Dehydrogenase (DHODH) Inhibitior → hemmt Synthese des Nukleotides Pyrimidin →

a) Blockade der intrazellulären viralen Replikation → breite Wirksamkeit gegenüber verschiedenen Viren SARS-CoV-2, EBV, CMV und andere

b) Hemmung der Lymphozytenaktivierung → Reduktion der Freisetzung von Zytokinen (Botenstoffe der Entzündung) → anti-entzündliche Aktivität

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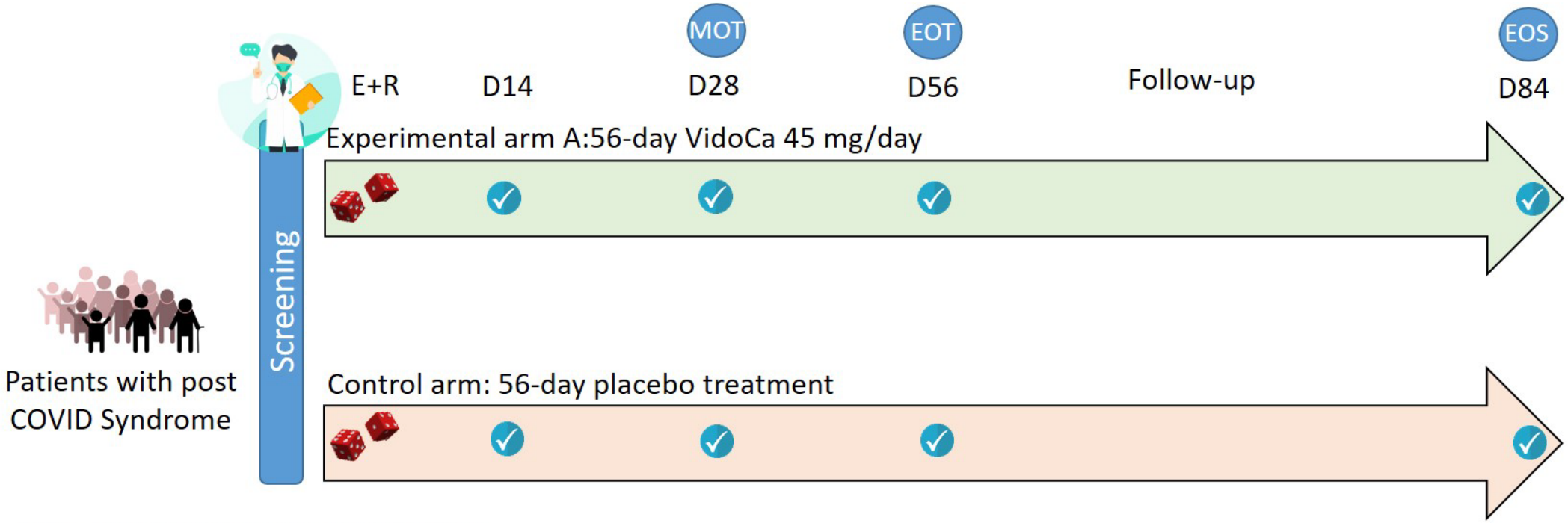
Studienablauf



E+R = Enrolment and randomization
EOT = end of treatment
EOS = end of study

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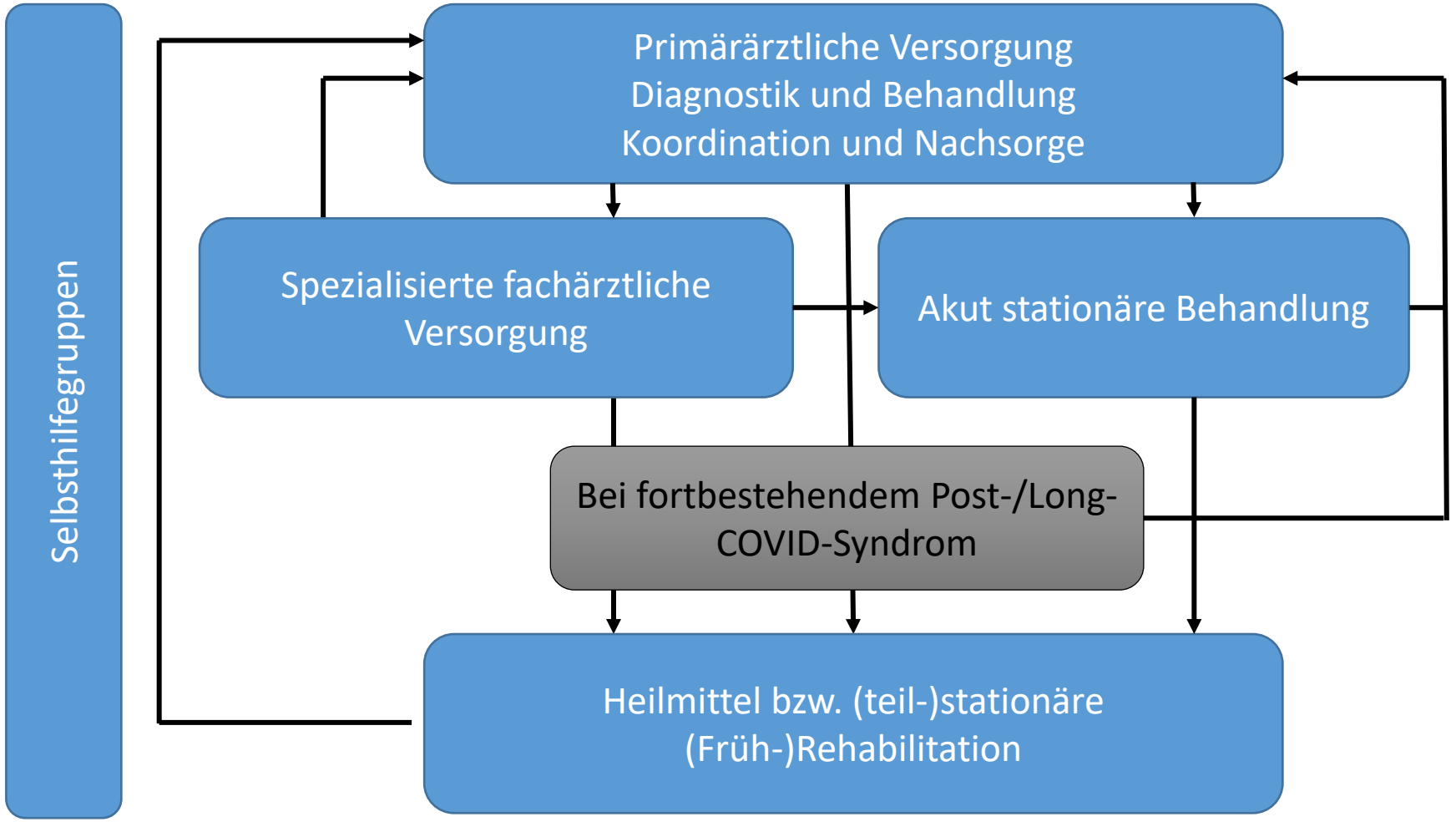
Versorgungskonzept



Hilfreiche Informationen

[Was ist Long COVID? — Deutsche Gesellschaft für ME/CFS (mecfs.de)]

Zusammenfassung

- Das post COVID Syndrom ist eine reale Erkrankung
- Höchst variabler Schweregrad und klinische Präsentation
- Entstehung von post COVID noch nicht vollständig geklärt, aber es gibt Fortschritte:
  - Viruspersistenz
  - Immunologisches Mimikry
  - Mikrobiomveränderungen
  - Thrombotische Aktivität
  - Vagusinflammation
- Patient:innen als wichtige Treiber der Beschreibung und Erforschung
- Betreuung von Patient:innen in post COVID Ambulanzen zeitintensiv und teuer
- Gleichzeitig hohe Nachfrage → fast alle Ambulanzen überfüllt
- Erste Therapiestudien weltweit initiiert

Vielen Dank für Ihre Aufmerksamkeit.

Nun zu Ihren Fragen,
die wir anonym behandeln.
Bitte schicken Sie diese an:

info@gesundheitsforum-ukf.de