



# Nomacopan Treatment of COVID-19 Pneumonia

September 1, 2020

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# Discussion Outline



- Akari introduction
- Nomacopan dual mode of action in both C5 and LTB4
- Nomacopan treatment for COVID-19 pneumonia
- Evidence supporting nomacopan as potential COVID-19 pneumonia treatment
- Nomacopan clinical studies, underway and planned, related to COVID-19 pneumonia

# Nomacopan: in clinical studies for COVID-19 pneumonia



- Strong rationale for role of C5 and LTB4 in treating multiple pathways involved COVID-19-driven pneumonia
- Nomacopan has two separate independent binding sites for C5 and LTB4
- Differentiated from competing treatments by inhibition of multiple inflammatory pathways
- Multiple integrated clinical programs
  - US : Expanded access program moving to proposed randomized study
  - Brazil : Recruitment to proof of principle study completed; Following DMSB plan to move to randomized study
  - UK : Collaborating with AGILE platform\* and analyzing observational study data
- Broad acting nature of nomacopan has potential applicability across range of lung conditions
- Safety and clinical potential of nomacopan underpinned by broader Phase 3 clinical program

\* AGILE-: Accelerating COVID-19 dRug Development - Phase 1/2 trial platform/ AGILE is a novel clinical trial platform seeking additional COVID-19 therapies. AGILE is led by the University of Liverpool, with support from the Liverpool School of Tropical Medicine, Southampton Clinical Trials Unit and Lancaster University

# COVID-19 program builds on nomacopan data from clinical testing in multiple preceding indications

Category	Disease	Preclinical	Phase 1	Phase 2	Phase 3
Pulmonary	COVID-19 pneumonia	○	—	○	
Dermatology	Bullous Pemphigoid	○	—	○	
Hematology	Thrombotic Microangiopathy	○	—		○
	Paroxysmal Nocturnal Hemoglobinuria *	○	—		○
Ophthalmology	Atopic Kerato-conjunctivitis	○	—	○	
Other	Back of the eye	○	○		

# Role of nomacopan in treating COVID-19 pneumonia

Reduce hospital stay, assisted ventilation and mortality by reducing severe inflammatory responses in COVID-19 pneumonia patients



**Anti-inflammatory treatment: nomacopan**

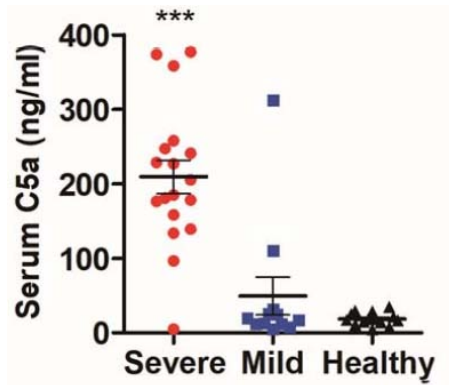
- Circa 5-10% of patients develop respiratory failure
- Inflammation caused by a dysregulated and overly vigorous immune response to COVID
  - Increased levels of neutrophils and production of cytokines (cytokine storm)
  - Tissue damage further amplifies inflammatory responses
- Treatment to inhibit parts of immune system directly involved with this inflammation, central to which are the complement (C5) and leukotriene (LTB<sub>4</sub>) pathways - both critical parts of this over-active innate immune response

# Scientific understanding of COVID-19 pneumonia has developed rapidly since the pandemic began

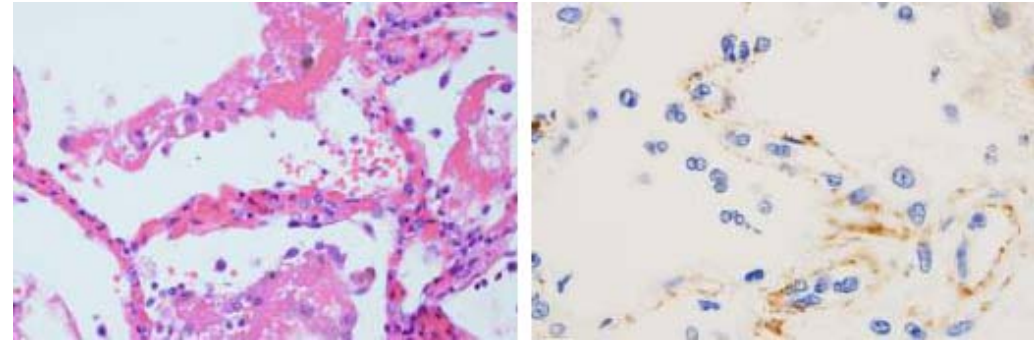
1. Initial focus on ARDS / cytokine storms
2. Vascular damage observed in autopsies of COVID-19 pneumonia patients
3. Elevated complement C5b9 and C5a reported in severe patients
4. Two step disease progression
5. Long term organ damage increasingly observed
6. Initial data on anti-inflammatories (IL-6, dexamethasone etc) mixed – still an urgent need for an effective treatment for hospitalised patients

# Pulmonary endothelial injury associated with dysregulation of complement

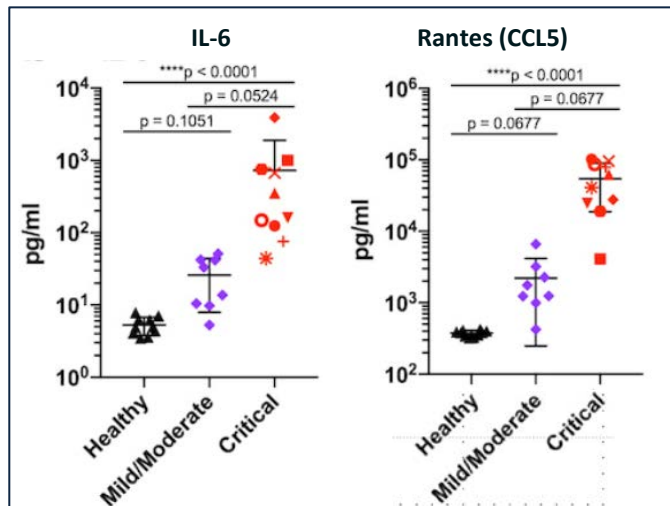
Gao et al sC5a levels in severe & mild SARS-CoV-2 pneumonia



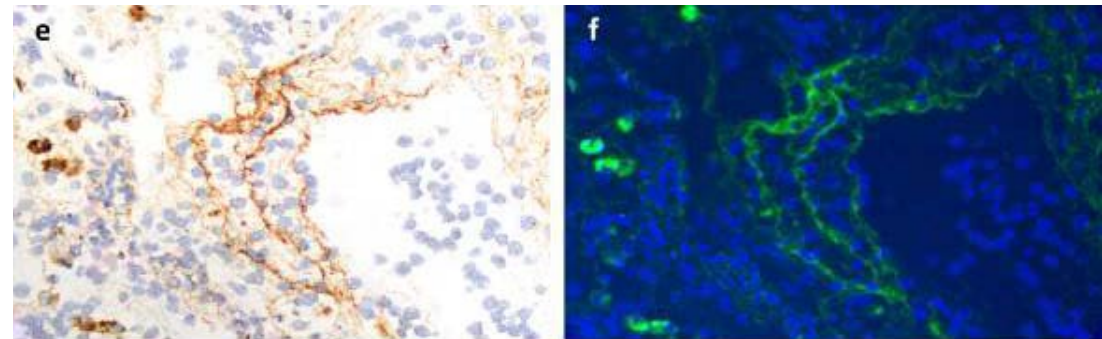
SARS-CoV-2 pneumonia with Thrombotic Microangiopathy (TMA) with C5a



Patterson et al IL-6 and Rantes levels in severe COVID



Terminal complement effector **C5b-9** in the alveolar septa in SARS-coV-2 pneumonia



A clear association between Complement activation and COVID-19 pneumonia

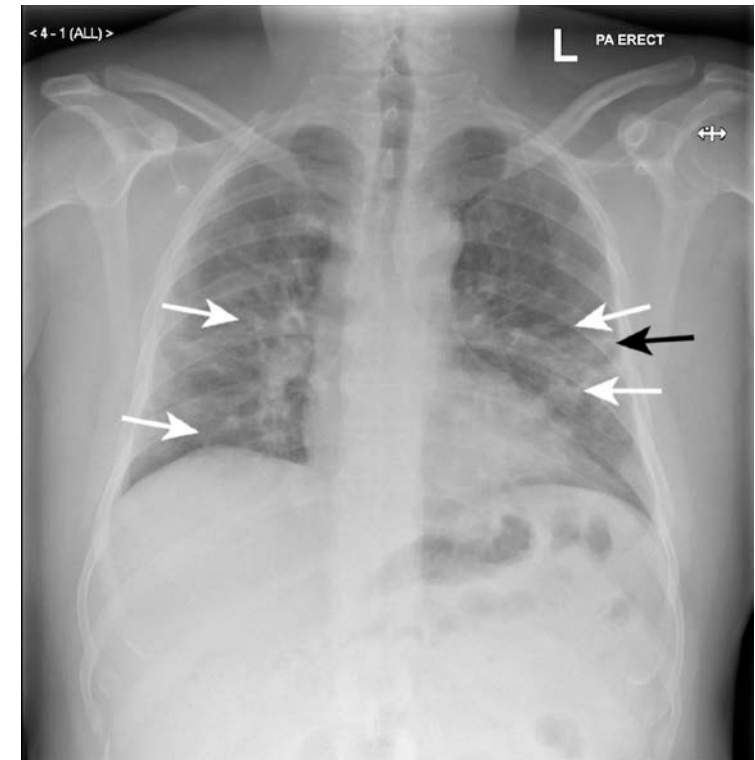


# Two step process to severe lung illness in COVID-19

## Development of severe respiratory illness

- Many patients with acute COVID-19 have symptoms involving their respiratory systems, characterized by dry cough, dyspnoea, hypoxaemia, and abnormal imaging results
- Although most patients had mild-to-moderate disease, 5–10% progress to severe or critical disease, including pneumonia and acute respiratory failure
- Severe cases describe a two-step disease progression, starting with a mild-to-moderate presentation, followed by a **secondary respiratory worsening 9–12 days** after the first symptom onset
- Respiratory deterioration is concomitant with extension of ground-glass lung opacities on chest CT scans, lymphocytopenia, and **high prothrombin time and D-dimer levels**

## Ground glass and streaking shadows



# COVID 19 pathology: Leukotriene and complement pathways

Leukotriene and complement are both key pathways in innate immune response and are believed to be strongly implicated in driving inflammation in COVID pneumonia

## Leukotriene

- Neutrophil accumulation (and associated NETs) in lungs is a key feature of COVID-pneumonia, resulting in cytokine storm and associated epithelial damage in the lung
- LTB4 is one of the most potent chemo attractants of neutrophils\* and elevated levels of leukotrienes in the lung are associated with ARDS
- Inhibition of leukotriene pathway is proven as a treatment for inflammation in lung

## Complement

- Levels of both C5a and C5b9 (by-products of C5 whose cleavage is inhibited by nomacopan) are correlated with COVID-19 pneumonia disease severity
- Complement activation associated with abnormal coagulation with both pulmonary and cutaneous thrombotic microangiopathy and related end organ damage

**Nomacopan has two separate independent binding sites and inhibits both the leukotriene and complement pathways**

# Two primary pathways driving COVID-19 pneumonia

## Nomacopan inhibits key COVID-19 pneumonia inflammatory pathways

COVID 19 believed to trigger multiple inflammatory pathways



### Complement (sC5b9 and C5a)

sC5b9 accrues in lung vascular tissue, C5a promotes thrombosis



Lung vascular damage and microthrombi lowered platelets and increased D-dimer



Dramatic reduction in lung perfusion, respiratory distress, microthrombi in lung and other tissues

### LTB4 and C5a

drive neutrophil trafficking and cytokine storm in the lung



Lung epithelial damage raised neutrophils and cytokines



Acute Respiratory Distress

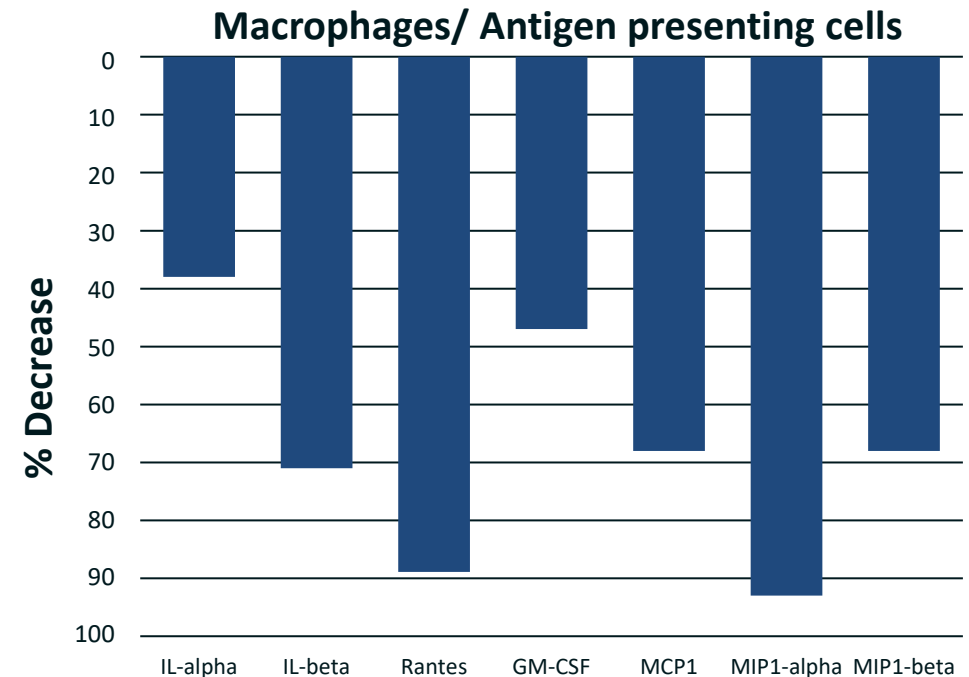
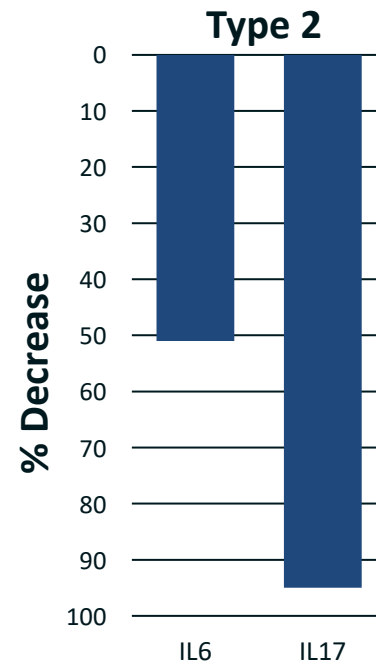
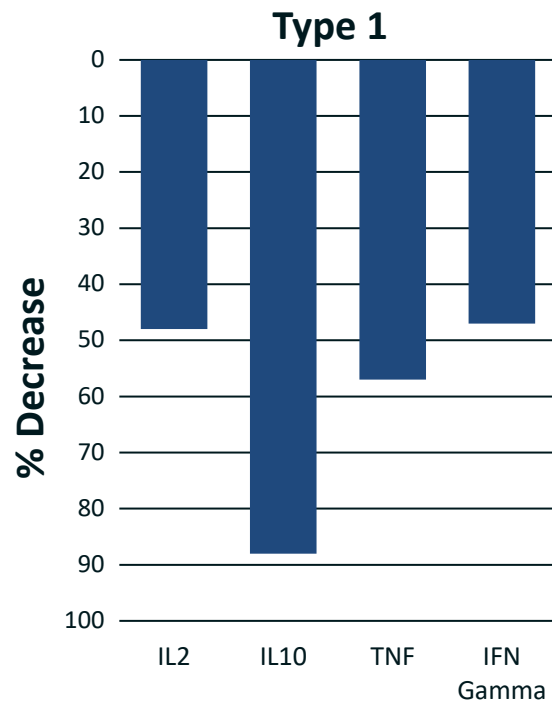


Oxygen support, ventilation, multi organ damage

# Nomacopan inhibits downstream cytokine & chemokine signaling cascades implicated in COVID pathology

Inflammatory markers inhibited by nomacopan in polymicrobial sepsis mouse model

## Cytokines Inhibited by nomacopan

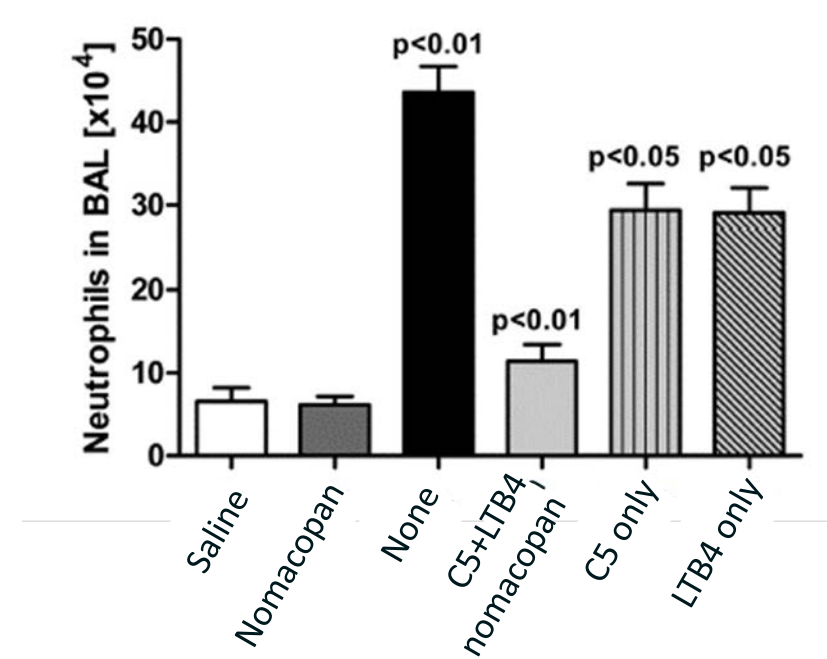
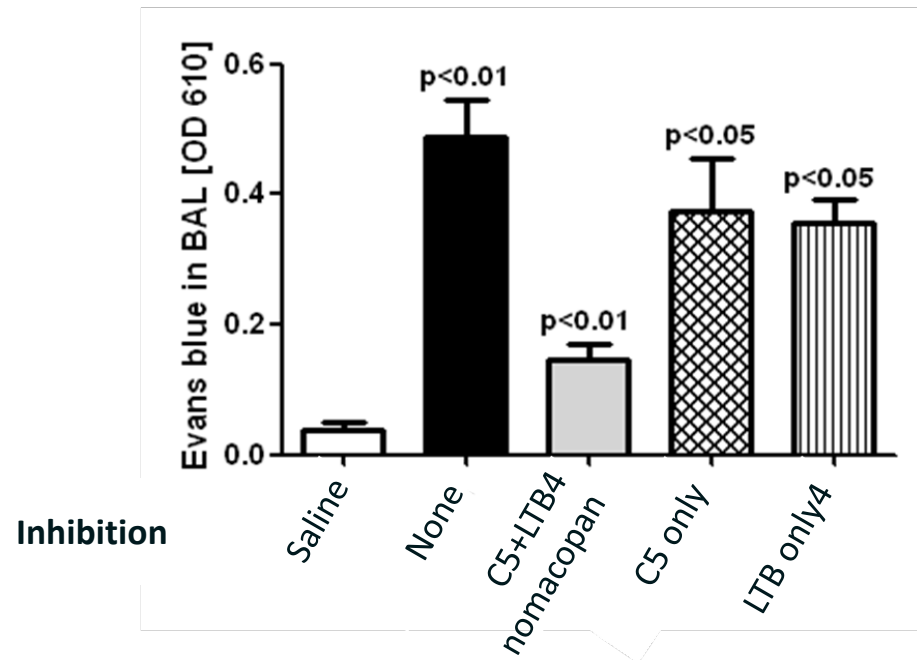


Source: Nomacopan (coversin) data adapted from Figs. 1, 2 & 3 of Huber-Lang et al. J Immunol 2014; 192:5324 – 5331 ;

COVID activity taken from : Mehta P et al. COVID-19: consider cytokine storm syndromes and immunosuppression. Lancet, March 16 2020; 395(10229): 1033 – 1034

# Nomacopan's dual inhibition of C5 & LTB4 inhibition more effective than inhibiting C5 or LTB4 alone

## Lung model of immune-complex alveolitis Dual inhibition superior to C5 or LTB4 inhibition alone



- Two forms of Nomacopan one inhibiting C5+LTB4, the other inhibiting C5 only (pre-saturated with LTB4)
- LTB4 only is MK886 a leukotriene inhibitor that inhibits 5-lipoxygenase activator protein (FLAP)
- Source : Roversi et al 2013

# Clinical treatment guidelines based on growing understanding of COVID-19 pneumonia

## Multiple Pathways

- Anticipated need to inhibit multiple pathways
- Complement and cytokines play an important role



Nomacopan inhibits complement and leukotriene pathways

## Patient Segmentation

- Timing critical: disease changes dramatically by time on ventilator
- Heterogenous patients – biomarker helpful to focus treatment
- Need to get patients off treatment quickly once improved, long term immunosuppressant use clinically undesirable



Nomacopan rapid on/off inhibition of C5 and LTB4

## Standard of Care Treatment

- SOC changed – dexamethasone and remdesivir improve outcomes in specific patient groups
- Long term monitoring important; widespread organ damage



Nomacopan has potential to be additive to SOC

## Clinical Trials

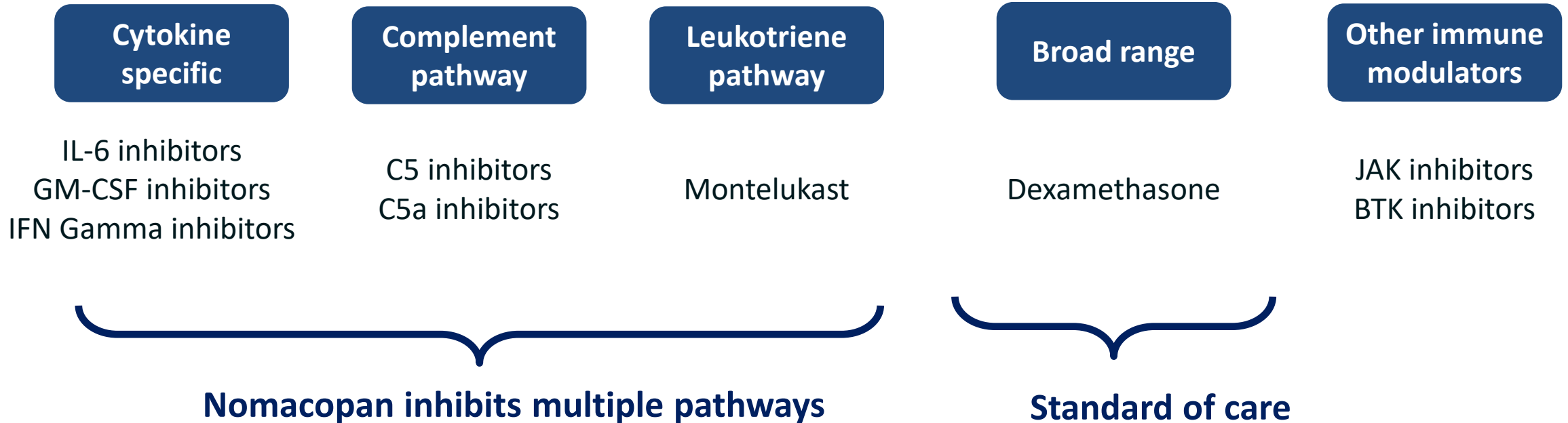
- Clinical trials need to be randomized, clinically relevant and with latest SOC



Primary end point normalization of oxygen

# Different approaches to inhibiting inflammatory pathways

In trials for COVID pneumonia



- Nomacopan blocks multiple cytokines through inhibiting the complement and leukotriene pathways; thrombosis increasingly linked to amplified complement activity (both C5a and C5b9)
- Nomacopan inhibits different pathways to remdesivir and dexamethasone (SOC); potential to be additive

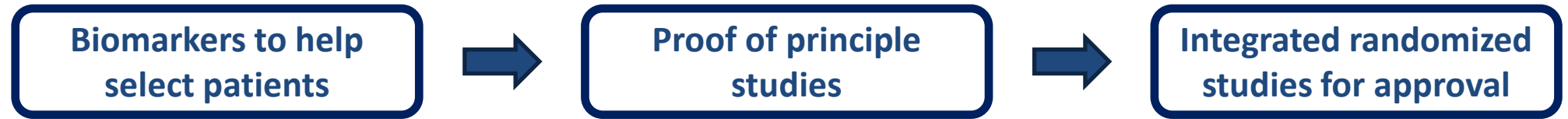
# Planned randomized clinical study design: Key considerations

- Randomize patients 2:1
- Patients on supplementary oxygen between 5-20 litres/minute
- Primary end point is time to normalisation of oxygen - easily measured using a pulse oximeter
- Nomacopan administered daily sub cutaneous for up to 14 days
- Key secondary end points to include need for intubation and assisted ventilation and survival
- Each individual study powered with circa 60 patients
- Nomacopan additive to current standard of care: dexamethasone and remdesivir where available

**COVID-19 programs build on existing clinical experience in the use of nomacopan, including >35 cumulative patient-years of safety data with no reported drug related SAEs, and clinical responses across a range of inflammatory conditions in Phase 2 / Phase 3 development**



# Ongoing and planned COVID-19 pneumonia clinical programs



## United Kingdom

- Observational biomarker study to identify COVID-19 patients suitable for nomacopan. Data collected on ~50 patients; sample analysis expected Q4 2020
- Ongoing longitudinal study: samples from patients with worsening disease
- Selected by AGILE platform

## United States

- Initial proof of principle treatment in patients with COVID-19 pneumonia via expanded access programs
- Proposed multi-center investigator-led randomized study in regulatory submission

## Brazil

- Recruitment completed into initial proof of principle treatment in patients
- Potential progression to randomized controlled study if review by Data and Safety Monitoring Board (DSMB) is successful

# Nomacopan: in clinical studies for COVID-19 pneumonia



- Strong rationale for role of C5 and LTB4 in treating multiple pathways involved COVID-19-driven pneumonia
- Differentiated from competing treatments by inhibition of multiple inflammatory pathways
- Multiple integrated clinical programs with readouts expected in 2020
- Broad acting nature of nomacopan has potential applicability across range of lung conditions
- Safety and clinical potential of nomacopan underpinned by broader clinical program



# Nomacopan Treatment of COVID-19 Pneumonia

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