As mentioned, we would like to share with you our thoughts on where we could be of value fighting the COVID-19 crisis. As Pacmed, we want to offer our resources and competences to contribute in these pressing times. We ask your honest opinion, criticism and own ideas on where we could add value, since we do not want to unnecessarily involve ICU physicians in these ideas until we are not absolutely sure about the potential added value of this time investment.

We believe we can develop solutions for three pressing problems ICU physicians face in the current situation:

1) Selecting the best treatment for each COVID-19 patient admitted to ICU.

Since more and more COVID-19 patients are being admitted to ICUs, it is important to gain as much knowledge as possible on the optimal treatment protocol to yield the best results. Especially in a situation where little data is available and where medical professionals are under a lot of pressure trying to save as many lives as possible.

We understand that the ICUs are working in a standardized and protocolized way. COVID-19 protocols are currently in place or being developed, and ICU physicians are already doing everything they can to mitigate the effects of the virus for the admitted patients.

We believe, however, that we can add value by performing smart analysis and gain insights from the experience of previous COVID-19 patients on the different ICUs in Europe. By developing machine learning models to predict the disease progression of confirmed COVID-19 patients, we can:

- Compare treatment regimes and outcomes, correcting for factors such as age, comorbidity, treatment variables, etc
- Predict risk of mortality, need of mechanical ventilation, risk of severe complications, etc
- Report on which characteristics of COVID-19 patients and there treatments are responsible for a high predicted risk of the above outcomes, as well as the desired outcomes, which would hopefully lead to (improved) guidelines on the treatment of COVID-19 patients

2) Managing capacity of the ICU by predicting LOS and anticipate on ramping up regular and elective care.

Demand for ICU beds is likely to surpass ICU capacity in the weeks to come. Hospitals are working day and night to free up ICU capacity. Even the scenario where the current capacity of 1150 beds is extended to an extra 850 beds is unlikely to be sufficient. It is crucial to manage the ICU capacity in a smart way to yield the best results given the scarce capacity and resources.

It is still unclear which COVID-19 patients end up on the ICU and how long they will stay. This makes it difficult to manage ICU capacity well now, and makes it challenging to know when there will be available capacity for non-COVID-19 care. Currently, patients are identified as high-risk if they meet certain conditions, such as old age or the presence of comorbidities (hypertension, diabetes, etc.). Although these risk factors for outcome severity are in line with recent publications from China[1,2,3], they do not encompass all patients as the risk factors for severe illness are not yet clear[4]. For example, in the same findings from China, 37% of Covid-19 patients admitted to the ICU did not have any comorbidities[1], as did 40% of the Covid-19 patients that died in hospital[2,3]. It remains unclear what the role of old age is in these patient groups. Especially in view of the demand surpassing capacity in many

countries, clinicians need a sharper understanding of risk factors and real-time support in forecasting the trajectory of the disease.

By better understanding which patients are likely to survive and how long they will stay at the ICU, ICU capacity can be managed better on a local but also regional and national level. The first step we can take is to predict how many patients will be admitted to the ICU based on the number of admissions per hospital and the percentage of patients ending up in the ICU, for different patient groups (age, sex, pre-existing conditions, clinical history, clinical measurements, scans, diagnoses, etc). This needs to be combined with a Length of Stay prediction based on retrospective data of COVID-19 patients currently in ICU to understand at which point capacity needs to be freed up or patients need to be transported to other hospitals so they can start preparing.

3) Using the right triage criteria in case ICU capacity is running out.

As mentioned above, it is likely we will get to a point where we need to decide which patients to admit to the ICU and which patients have too little chance to survive with good prospective long-term outcomes. Based on the insights on optimal treatment protocol and predictions on outcomes, we can gradually gain more insight in which patients have the best survival chances with best outcomes.

For all three directions, we would need patient-level clinical information, as detailed as possible. This could include age, sex, pre-existing conditions and clinical history, clinical measurements and imagins scans. Using the data of hospitals where the prevalence of COVID-19 patients on the ICU is already high, for example in collaboration with ESICM, is desirable. We do however think we can be of value even with little data, providing continuously updating reporting to support the formulation of guidelines on best treatment and capacity protocols. The Dutch NICE database could be a feasible starting point for this solution. Also, since Pacmed already collaborates with several academic and top clinical ICUs in the Netherlands, these collaborations can form a starting point in acquiring the needed data.

We have to make sure to minimize the time investment of healthcare professionals in these collaborations. We are open and flexible to find a way which works best and work together with any kind of hospital or NICE experts. We are also open to provide a team that works alongside the hospital and NICE data-experts to create high performing teams and add value instantly. Our data-scientist, -engineers, consultants, medical doctors and other experts are also used to working remotely.

We have extensive experience in guaranteeing that our projects and way of working are compliant with relevant laws and regulations like the GDPR. Based on a first exploration, we consider there to be a number of options under the GDPR for the execution of a project in such a way that the legislation would not form a constraint or a reason for additional time investment from our partners, especially not from ICU physicians. Our legal counsel can work side by side with the legal counsels of your organizations to further the legal argumentation in support of this project. This will save valuable time from ICU physicians and legal counselors. In terms of setting up a contract for the collaboration and ensuring compliance with data processing legislation, we can ensure the minimal requirements are taken care of quickly and workout the details on the go or in a later stage. In light of the current situation, we find that taking action quickly is important.

1. https://jamanetwork.com/journals/jama/fullarticle/2761044
2. https://www.medrxiv.org/content/10.1101/2020.02.25.20027664v1.full.pdf
3. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30566-3/fulltext#seccestitle150
4. https://www.cdc.gov/coronavirus/2019-ncov/hcp/clinical-guidance-management-patients.html