**CONCLUSIONS**

From an IP and innovation perspective, this article contributed to the scarce literature about the role of and challenges associated with IP during pandemics. Our findings were derived from analyzing, synthesizing, and interpreting secondary data from the COVID-19 pandemic from two major sources: 1) publicly available documents, such as newspaper articles, industry specific outlets, government reports, and announcements and 2) patent data. Obviously, our findings result only from observations of one ongoing pandemic and thus need to be verified further and interpreted with care. We find that what makes it difficult for IP to be given its required considerations during the early stage of a pandemic is the enormous sense of urgency, which draws decision makers’ attention to huge and undoubtedly urgent operational challenges.

With this article, we hopefully contribute a set of arguments to raise awareness why IP needs to be dealt with earlier rather than later during a pandemic in order to avoid that IP-associated risks delay the mobilization of the resources so urgently needed for the research, development, and mass manufacturing of CC-P. This is particularly important as various responses to the pandemic are somehow technology related, which typically involves IP rights in some form. This article offered a set of contributions.

We summarized IP-related issues currently surfacing during the COVID-19 pandemic in a CC-IP roadmap. We identified four major groups of stakeholders that are mostly concerned with IP considerations. These include governments (and intergovernmental organizations, such as the WHO and WIPO) who are called upon to orchestrate pandemic responses, incumbent manufacturing firms in CC-S, as well as new entrants that enter CC-S to assist incumbents. New entrants include manufacturing firms that did not produce CC-P prior to a pandemic (Type 1 entrants), as well as voluntary grass root initiatives, start-ups, entrepreneurial scientists, etc. (Type 2 entrants). This article then identified and analyzed three scenarios in which different IP considerations emerge for the different stakeholder groups.

This article provided a terminology that helped to conceptualize IP considerations in times of pandemics or global health crises that call for urgent and large-scale actions from various innovation stakeholders that suddenly find themselves engaged in new relationships that are associated with various IP associated uncertainties, not the least related to the use and sharing of IP with the particular problem that negotiating licensing agreements is typically time consuming. We also provided a language for policy makers and other decision makers to articulate and discuss IP challenges during pandemics, which might evolve further with specific terms being added gradually or notions being revised as we go along. We proposed a framework that visualizes how industrial organization could change throughout pandemics. That can serve as an analytical framework for other and particularly follow up studies.

Results from our patent analysis show that research and IP protection for corona virus-related inventions is not new. Patent protection for different forms of corona virus already exists, but not for the particular corona virus type SARS-CoV-2 that causes the COVID-19 disease. It appears evident that there is a time lag between outbreaks and the materialization of patents and a number of references to NPL, which shows the urgency of scientists for open data to put the information in the public domain. Any patent analysis is historic, thus limited to existing IP, even with a delay as patent applications get published 18 months after filing. Any patent analysis thus does not capture innovations currently being developed, even though these might result in patent applications, with some of them possibly even having been submitted. Following a systematic identification of CC-P, further specific patent analysis should be conducted to learn more about the owners of IP related to those, which can then, e.g., inform policy makers and help owners of CC-IP to form consortia with others who own complementary IP and identify opportunities for further repurposing of production capacities.

For policy and decision makers, we provide a summary of approaches to address IP concerns during the COVID-19 pandemic, such as compulsory licensing, IP pooling, and IP pledges. We derive initial guiding principles for policy makers toward using IP to maximize innovation incentives for CC-P until these are developed and then shift gradually to use policy measures to facilitate access to these key innovations, such as the vaccine. These should be subject to future scrutiny and needs further work to identify relevant literature from innovation economics. A more advanced IP risk analysis would be helpful to understand the risks for relevant stakeholders during the different pandemic phases, i.e., before/after certain key innovations have been developed, which could then provide relevant input to appropriate policy responses.

In fact, currently, we lack systematically collected evidence documenting the extent to which IP issues actually present a barrier or are a perceived possible future problem (risk) and to what extent for different actors. Evidence for this could be created for instance through a survey to those developing and manufacturing CC-P. This would provide a more sound basis for conversations with decision makersabout the importance of IP issues during a pandemic.