Web-/APP-based connected care solution for COVID-19 in- and outpatient care

Timo Schinköthe, Mariano Rolando Gabri, Manfred Mitterer4, Pedro Gouveia, Volker Heinemann, Nadia Harbeck, Marion Subklewe

Table of Contents

Web-/APP-based connected care solution for COVID-19 in- and outpatient care

Timo SchinkötheMSc, PhD, ; Mariano Rolando GabriMSc, PhD, ; Manfred Mitterer4MD, ; Pedro GouveiaMD, ;
Volker HeinemannMD, ; Nadia HarbeckMD, ; Marion SubkleweMD,

Corresponding Author:
Timo SchinkötheMSc, PhD,
Phone: +49221 429 153 00
Email: t.schinkoethe@cankado.com

Abstract

Background: From a healthcare professional perspective, COVID-19 brings a lot of challenges but also increases the need for digital healthcare. Because healthcare professionals are also at risk of infecting themselves, in-person visits need to be reduced to an absolute minimum. Connected care solutions including telehealth, remote patient monitoring and secure communications between clinicians and their patients, may thus rapidly become the first choice in such public health emergencies.

Objective: The idea of the COVID-19 Caregiver Cockpit (C19CC) was to build a free-of-charge web-/APP-solution where all different scenarios and use-cases for health care professionals working in a COVID-19 environment can be covered.

Methods: The COVID-19 Caregiver Cockpit (C19CC) is an extension module inside the CANKADO environment. The underlying architecture of the multi-lingual CANKADO is a cloud-based electronic health record (EHR) with access rights management and function-based access options.

Results: Through non-structured interviews with physicians in different countries, taking care of COVID-19 patients, a couple of different scenarios were identified where telemedicine or connected care solution could rapidly improve patient care. These scenarios included outpatient care, discharge management, remote tracking of patients with chronic diseases, and including infected physicians under quarantine into telehealth services.

Conclusions: The COVID-19 Caregiver Cockpit is the result of an agile and iterative development process together with physicians. It aims to improve care and safety for those who are infected by COVID-19.

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**
   Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.
   Only make the preprint title and abstract visible.
   No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**
   Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain v
   Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <a href="http

Original Manuscript

Introduction

Health systems worldwide face an unprecedented new challenge with the rapid and unexpected increase of coronavirus disease 2019 (COVID-19), with the need to establish physical interaction limitations and self-reclusion for its prevention and slower spread. Today, COVID-19 is one of the main concerns for any individual. Without the establishment of isolation policies and practices of self-disinfecting and avoidance of interpersonal physical contact, potential infections would have resulted in 7 billion, and deaths would have reached 40 million around the world [1]. With striking exceptions, countries have adopted strict rules, and the expected deaths for this year will be much lesser than projected, but living in these conditions implies different levels of discomfort and distress. Half of the non-infected persons are feeling a moderate to severe psychological impact, and one third have moderate to severe anxiety [2]. eHealth technology can be a useful tool for supporting everyday care of patients as well as healthy people. The emergence of COVID-19 in 2019 may, therefore, cause the first significant steps towards digital support implementation or exploitation at a large scale in medicine. Experiences of population surveillance and disease monitoring of a population level can be seen.

From a healthcare professional perspective, COVID-19 brings many challenges but also rapidly increases the need for digital healthcare. Because healthcare professionals are also at risk of infecting themselves, in-person visits need to be reduced to an absolute minimum. Connected care solutions, including telehealth, remote patient monitoring, and secure communications between clinicians and their patients, may thus rapidly become the first choice in public health emergencies [3].

Many centers experience a rush of worried and infected people. A contact-free pre-screening tool is needed to optimize patient control. In another perspective, care management of patients with chronic diseases who are under treatment or observation is also challenging. The risk of getting infected while visiting outpatient departments should be minimized as much as possible.

Another problem is observed in the quickly established COVID-19 departments. Whereas usually, vital data are sent automatically to a centralized monitor, in these fast-implemented units, vital data exchange is missing. As inpatient resources are limited, a balanced way of early discharge and assurance of patient safety with remote monitoring is needed. Patients can go home and need to remain connected with real-time, electronic communication to a remote medical team until full recovery. A different use-case would be physicians who are themselves under COVID-19 quarantine. They cannot do in-person visits, but they can support patients via an easily accessible connected care platform.

The idea of the COVID-19 Caregiver Cockpit (C19CC) was to build a free-of-charge web-/APP-solution where all these different scenarios 1) patient screening and visit preparation, 2) remote monitoring, 3) hospital-ward cockpit, was supported within a single solution.

Material

The COVID-19 Caregiver Cockpit (C19CC) based on the existing CANKADO environment. The underlying architecture of the multi-lingual CANKADO is a cloud-based electronic health record (EHR) with access rights management and function-based access options [4]. Feature packages can be enabled and disabled according to patients' disease (e.g., diabetes, cancer) and healthcare professional category (e.g., oncologist, cardiologist, nurse, psychologist). Information is stored and encoded, allowing physicians and patients to see the EHR in their preferred language.

The CANKADO solution has been developed and operates according to ISO 27001 and ISO 13485. Continuous penetration tests are performed according to the Open Web Application Security Project (OWASP) guidelines.

CANKADO provides web- and APP-access. Patients can use the web-login under www.cankado.com or through the CANKADO Patient APP [5], [6] to access their data. Healthcare

professionals (HCP) can also use the web-access or the HCP Pro [7], [8]. Further connected APP's do exist but are not related to the COVID-19 module.

Results

In the first round, physicians in Argentina, Germany, Iran, Italy, Portugal, Switzerland, and the USA explained their challenges with COVID-19 patient care in a non-structured interview, followed by questions regarding opportunities to improve care using telemedicine or connected care application. Primary needs were described as keeping an overview within provisionary COVID-19 wards, pre-screening of a larger group of outpatients, keeping close and continuous contact with patients with chronic diseases (mainly cancer patients), improving discharge management and involving healthy physicians in quarantine.

Based on the collected feedback, the first version of the application was built. In the second round of interviews, the application was presented to the doctors, and their feedback was obtained. The most crucial change requests were to simplify the enrollment process, to reduce healthcare professionals workload, and to implement ways of contact-free interactions between physicians and patients (or separated by a window) with a smartphone APP for ward-doctors with immediate push notification. After implementing these additional requests, the application underwent a last round of review, of which the final results are described in the following.

The Personal Diary

Patients who want to track personal observations that may be related to COVID-19 can use the system as a personal diary. For that, they have to download the APP and select the COVID-19 extension during the registration process.

Features are categorized into three groups. After the registration process is completed, patients will receive a questionnaire as a primary assessment. The intention of that is to clarify general risk factors and relevant comorbidities. A second questionnaire asks for all cold symptoms according to the validated PRO-CTCAE questions [9]. This questionnaire is triggered once daily to keep asking the patient regularly. A third questionnaire is for continuously tracking necessary vital parameters like body temperature and respiratory rate. For those who have a pulse oximeter, oxygen saturation can also be documented. Furthermore, COVID-19 findings can also be put into the system (Figure 1).
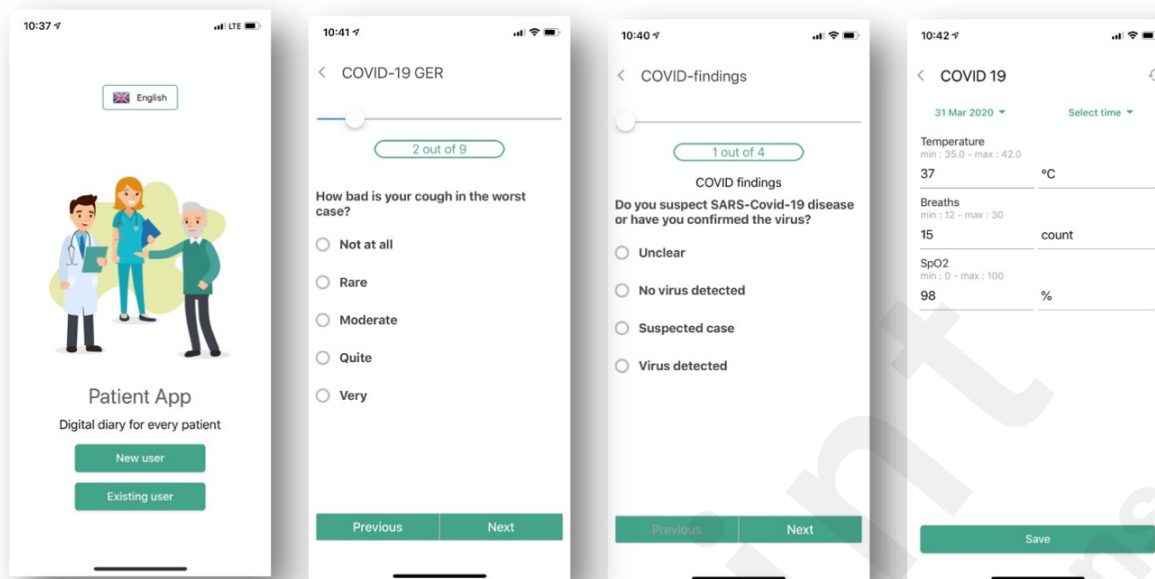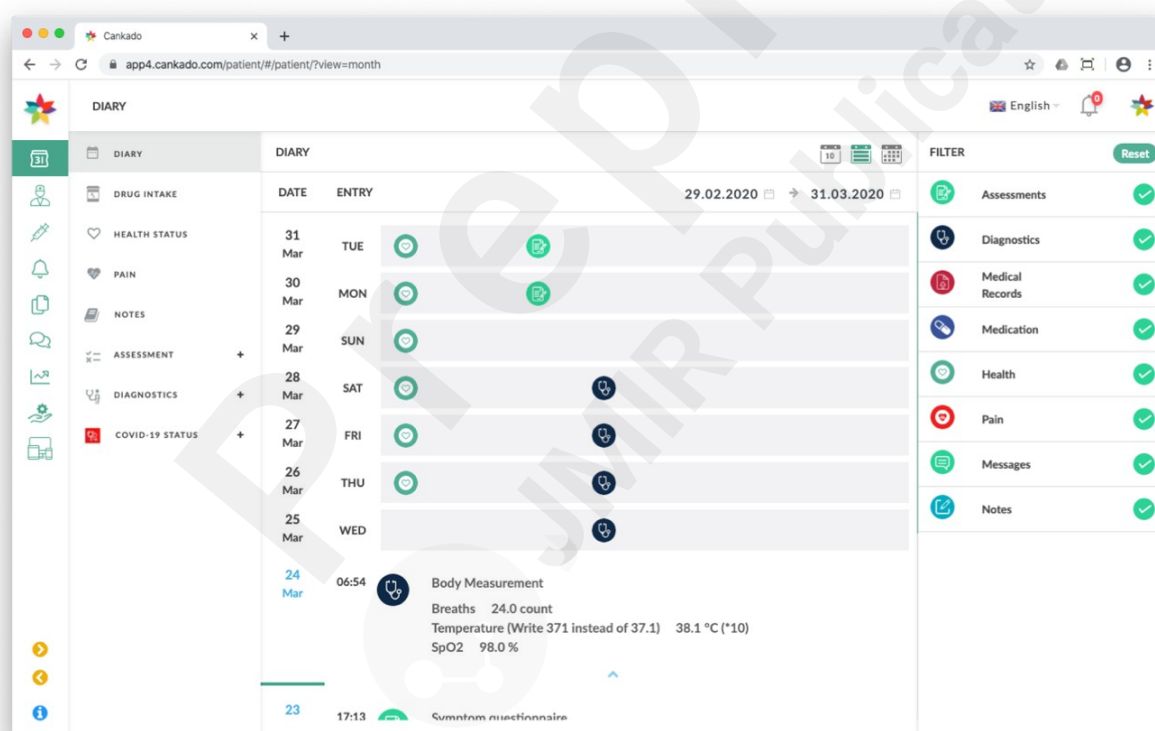
Figure 1: Screenshot examples from the patients' APP for login and data entry (B). Web view of the patient diary (B).
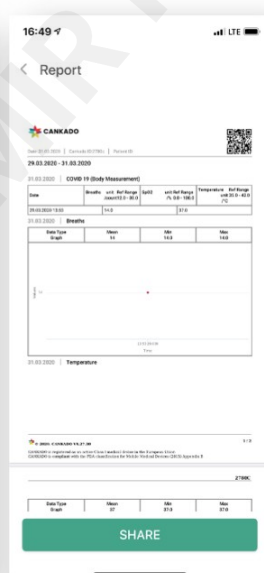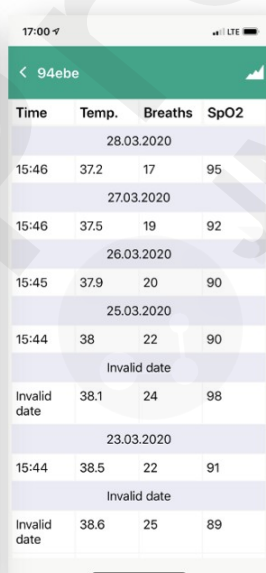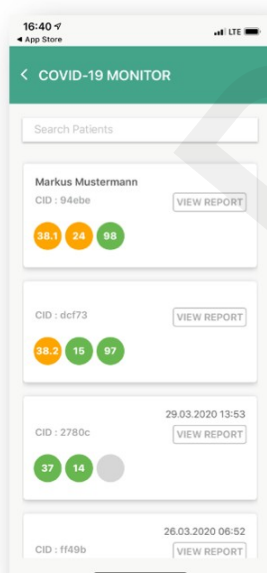
The Healthcare Professional Cockpit

If patients and healthcare professionals (HCP) are connected, the HCP's can see all their COVID-19 patients in a separate cockpit. The main intention is to get a fast and accessible overview of all

patients. The central window provides the patient list with the latest vital parameters, color code for severity, and arrows indicating changes compared to the day before. Two export features allow data transfer either from the patient list or from an individual patient history into a table format. The 'COVID-19 report' generates a single pdf-file with the whole COVID-19 related history of a patient, and the 'COVID-19 Patient Information' button creates a printout for easy patient linkage (figure 2).
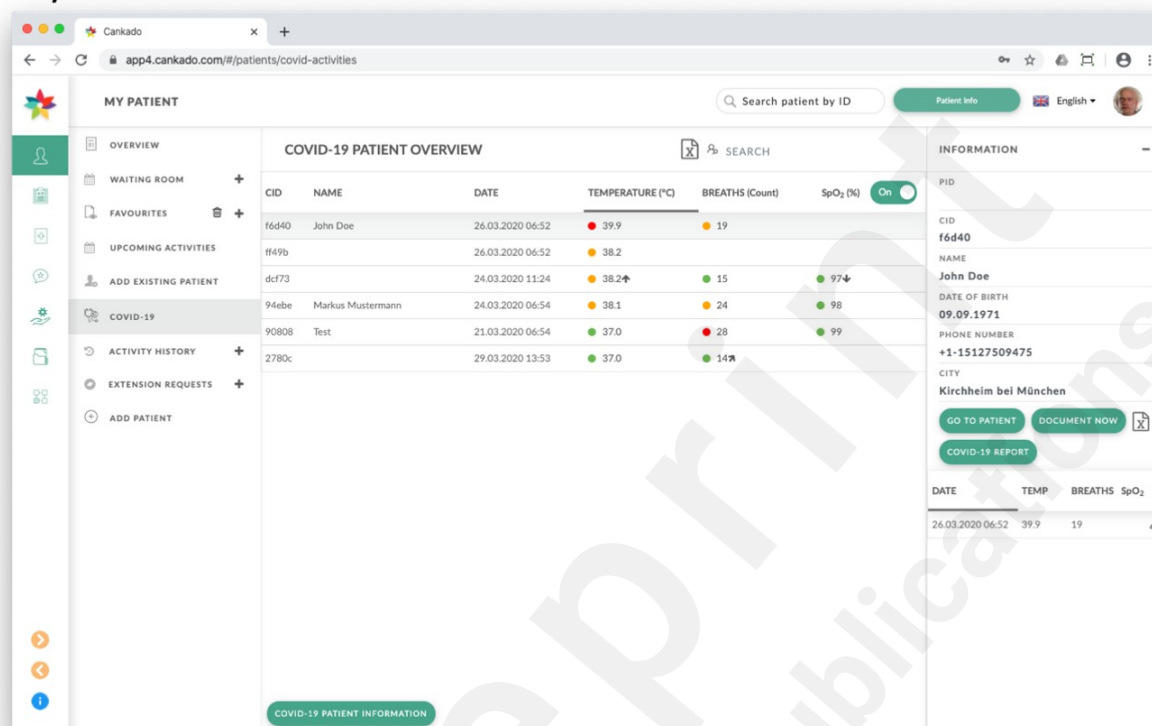
Figure 2: COVID-19 Cockpit view for healthcare professionals (A). Patient list, patient details, and pdf-report preview using the HCP Pro APP (B). Push notifications alert the healthcare professional if a patient's condition is deteriorating (C).

Contact-free Linkage

The system provides several ways to link or connect patients and doctors without having personal contact. The connecting process can be initiated by both the patient and the doctor.

Patients do have three alternatives to invite physicians. If the patient's APP is started, the patient can rotate the smartphone into the landscape orientation. Automatically the screen switches to an identifier page like a business card (figure 3a). This identifier contains a QR code for direct scanning and invitation code. The QR code can be scanned by the physician from the HCP Pro APP. This scanning procedure can also be performed through a closed glass door. The invitation code is intended for transmission by telephone. To do this, the doctor must select the function 'Add existing patient" in the web portal. For those patients who do not prefer to use the APP, an invitation letter can also be generated in the web-portal by selecting the 'invite physician' feature. This function creates a pdf-document that is intended for use by fax, email, or regular mail.

To connect the other way around, physicians can generate a patient information page by directly selecting 'COVID-19 Patient Information'. This printout contains the instructions for patients as well as a center-specific extension code (figure 3b). This extension code can be used for an unlimited number of patients. Patients who are using this code will directly get the COVID-19 extension (also if they did not select it before) and are automatically connected to the health center, which generated the printout.
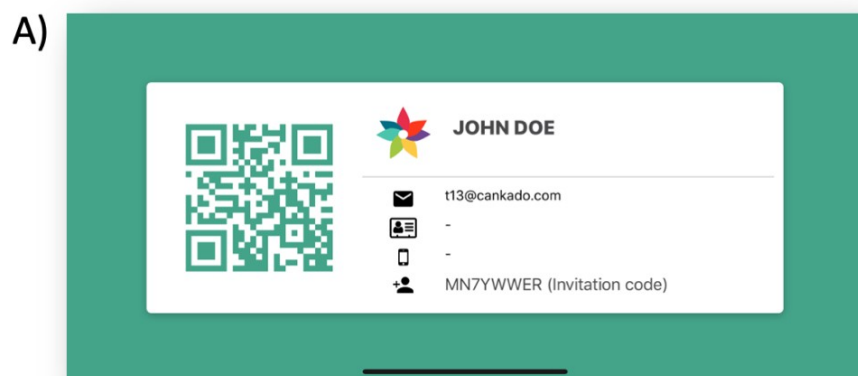
Figure 3: Invitation code using the patient APP for contact-free linking with a physician (A). Patient instruction for self-linking to a center (B).

Scenario 1: Patient screening and visit preparation

Once a patient is linked to a health center and has completed the assessments, all information can be printed at once using the "COVID-19 report" feature in the cockpit view. Within a single click, a pdf is generated, which contains all COVID-19 related information, including a graphical view of the vital parameters. For linking patient and HCP, all previously described methods can be used.

Scenario 2: Remote monitoring

Remote monitoring is intended for several use-cases. For example, patients can continue to be observed after discharge, or physicians who are under quarantine can take care of their patients remotely. For this purpose, the cockpit provides real-time access to all documented data. In case data are asked via a phone call, doctors also have the chance to enter the data immediately, or if some mistake happens on the patient's side, they can also edit the data.

Scenario 3: Use on a hospital ward

The provisional COVID-19 wards cannot often monitor patient data centrally. For these situations, the COVID-19 cockpit, in combination with the HCP Pro APP for physicians, can be used. If patient documents worsening vital parameters, connected doctors immediately get a push notification via the APP and can review the history (figure 2c). The web-view also supports real-time monitoring.

Discussion

The COVID-19 Caregiver Cockpit (C19CC) is a connected care solution-driven result of a joint international collaboration between physicians who are taking care of COVID-19 patients. C19CC includes several scenarios in routine care.

The most critical use cases are undoubtedly in the outpatient departments, which are overrun by patients. Here, the application helps to pre-screen patients in a contact-free manner and to get a fast overview of those patients who most urgently need help. Improving workflows and reducing workload in provisional COVID-19 wards constitute another vital application to help relieve some of the overburdened human resources while ensuring patient safety at the same time.

As of Feb 20, 2020, 20 % of all healthcare professionals in Italy, taking care of COVID-19 patients, have infected themselves [10]. Physicians who are infected or who had close contact with infected persons have to stay isolated under quarantine. However, these medical resources often remain unused during the quarantine period. Enabling these doctors to take care of patients remotely helps to keep them integrated with the delivery of medical care in a time when resources are scarce.

One very vulnerable group these days are patients with chronic diseases. Cancer patients, in particular, are at increased risk for severe events compared to non-cancer patients [11]. The same seems to apply to patients suffering from hypertension, diabetes mellitus, fatty liver/abnormal liver function, chronic gastritis/gastric ulcer, coronary heart disease, hyperlipidemia, cholelithiasis, arrhythmia, thyroid diseases, electrolyte imbalance, urolithiasis, stroke, chronic renal insufficiency, aorta sclerosis, secondary pulmonary tuberculosis, or COPD [12]. These patients should only go to the outpatient clinic if it is unavoidable in order to minimize their risk of infection. The described system can now support their care by real-time, electronic communication between a patient and the physician, including telehealth, remote patient monitoring, and secure communication between clinicians and their patients.

In conclusion, C19CC demonstrates how eHealth technology can quickly adapt to actual changing

needs in the healthcare environment and implement a system that can aid health care professionals in patient care and ensure patient safety at the same time. .C19CC is registered as an active medical device in the European Union and compliant with the FDA classification for Mobile Medical Devices (2015) Appendix B.

Acknowledgments

Many thanks to Baiju Rahman, Suresh Kumar, Sarath SR, Remo Rajan George, Tania KP, Sandipan Guha, Mohammed Ashfaq, Philip Mathews, and Devika Krishnan for implementing and validating all the ideas in such a short time by working day and night including weekends.

Conflicts of Interest

Schinköthe is the owner and managing director of the CANKADO companies. Gabri is the managing director of CANKADO Latin America.

Abbreviations

C19CC   COVID-19 Caregiver Cockpit
EHR   Electronic health record
HCP   Healthcare Professionals

Multimedia Appendix

https://youtu.be/opqWaZRnQtY

References

[1]   P. Gt Walker *et al.*, "The Global Impact of COVID-19 and Strategies for Mitigation and Suppression," 2020.

[2]   C. Wang *et al.*, "Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China," *Int. J. Environ. Res. Public Health*, vol. 17, no. 5, Mar. 2020, doi: 10.3390/ijerph17051729.

[3]   J. E. Hollander and B. G. Carr, "Virtually Perfect? Telemedicine for Covid-19," *N. Engl. J. Med.*, Mar. 2020, doi: 10.1056/nejmp2003539.

[4]   CANKADO, "Cankado - Digital Health | Improving Your Quality of Health," 2020. [Online]. Available: https://cankado.com/. [Accessed: 01-Apr-2020].

[5]   CANKADO, "CANKADO - Apps on Google Play," 2020. [Online]. Available: https://play.google.com/store/apps/details?id=com.cankado&hl=en. [Accessed: 01-Apr-2020].

[6]   CANKADO, "CANKADO im App Store," 2020. [Online]. Available: https://apps.apple.com/de/app/cankado/id1343701240. [Accessed: 01-Apr-2020].

[7]   CANKADO, "HCP Pro - Apps on Google Play," 2020. [Online]. Available: https://play.google.com/store/apps/details?id=com.cankado.hcpproapp&hl=en. [Accessed: 01-Apr-2020].

[8]   CANKADO, "HCP Pro im App Store," 2020. [Online]. Available: https://apps.apple.com/de/app/hcp-pro/id1475456311. [Accessed: 01-Apr-2020].

[9]   A. C. Dueck *et al.*, "Validity and reliability of the us national cancer institute's patient-reported outcomes version of the common terminology criteria for adverse events (PRO-CTCAE)," *JAMA Oncol.*, vol. 1, no. 8, pp. 1051–1059, Nov. 2015, doi:

10.1001/jamaoncol.2015.2639.

[10]   A. Remuzzi and G. Remuzzi, "COVID-19 and Italy: what next?," *The Lancet*. Lancet Publishing Group, 2020, doi: 10.1016/S0140-6736(20)30627-9.

[11]   W. Liang *et al.*, "Cancer patients in SARS-CoV-2 infection: a nationwide analysis in China," *The Lancet Oncology*, vol. 21, no. 3. Lancet Publishing Group, pp. 335–337, 01-Mar-2020, doi: 10.1016/S1470-2045(20)30096-6.

[12]   J. jin Zhang *et al.*, "Clinical characteristics of 140 patients infected with SARS-CoV-2 in Wuhan, China," *Allergy Eur. J. Allergy Clin. Immunol.*, 2020, doi: 10.1111/all.14238.

Supplementary Files

Figures