During critical moments, a matter of life, death and data

COVID Critical Care Consortium
teams with IBM to fight pandemic

by Leah Valentine
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"We don't know what to do!" These are six words that no intensive care physician ever wants to hear. But at the beginning of 2020, as reports about a new kind of coronavirus infection reached Prof. John Fraser, he heard these disturbing words with alarming frequency.

"We heard from colleagues that said this didn't seem like a plague," says Prof. Fraser, Professor and Director of the Critical Care Research Group at The University of Queensland (UQ) in Brisbane, Australia. "The lungs were acting differently. Patients were experiencing kidney failure and bizarre delirium. Friends and colleagues from across the Asia-Pacific region, exhausted from their rounds, called me every night and asked, 'What would you do in this situation?'"

At the time, Prof. Fraser had nothing to offer. He had never seen the disease before. The lack of clinical treatment information for COVID-19 infections—as the virus was now called—shook him to the core. "The sense of intellectual impotence really brought us together," says Prof. Fraser. "We had to do something now, before the vaccines and treatments came. How could we help our friends look after the most critically ill?"

Early on, as the COVID-19 pandemic spread from country to country, emergency room and ICU clinicians relied on disparate sources of treatment information. These included thick decks of spreadsheets, medical journals, a variety of online resources and, as always, on-the-fly consultations with colleagues on a variety of rapidly formed social media groups. But problems with existing and outdated clinical reference resources soon became evident.

In a fast-paced ICU environment, there often wasn't enough time for clinicians to drill down for the specific information required for each patient case. Because of the novelty of the disease, treatment databases were often incomplete, and many databases were set up for academics working on a research schedule, not clinicians constantly responding to "Stat!" on the ICU floor.

But then, a solution came to Prof. Fraser. "I realized there were weapons we could use because there were already 20,000 intensive care patient records out there," he says. "If we could bring this data together somehow, it would really help us."

At the beginning of 2020, the COVID Critical Care Consortium (COVID Critical) launched the Extra-Corporeal Membrane Oxygenation for 2019 novel Coronavirus Acute Respiratory Disease (ECMOCARD) research study. ECMOCARD studies the treatment and outcomes of COVID-19 patients in participating hospitals. The ECMOCARD database is the largest global repository of COVID-19 ICU patient information and has been endorsed by the World Health Organization and the US Centers for Disease Control and Prevention. Now, the database includes over 3500 eligible patient enrollments and is powering the statistical analyses for manuscripts which is led by colleagues at Queensland University of Technology (QUT).

Participating hospitals
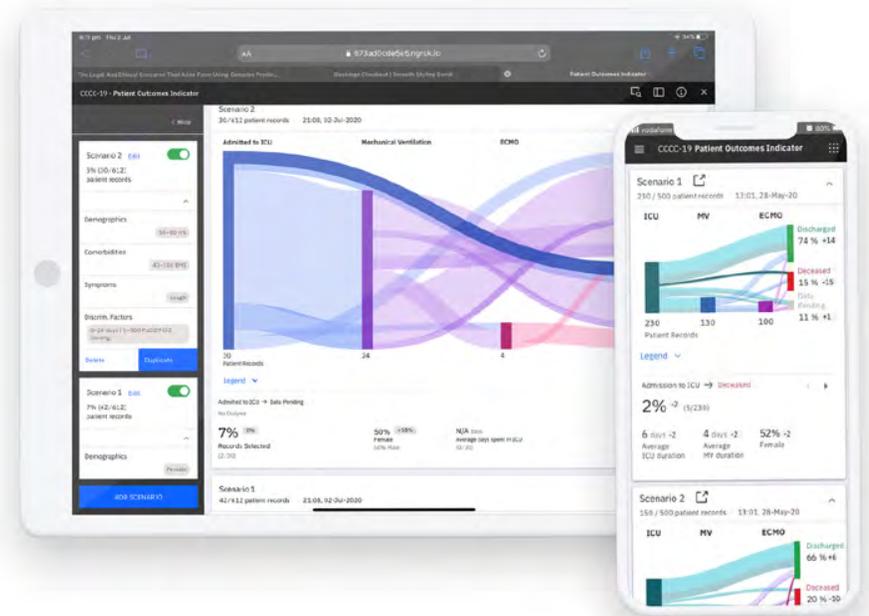and medical centers

370+

in 50+ countries

COVID-19 ICU
patient database

3,600+

de-identified cases

"It was like racing down the motorway at high speed with your sick mum in the backseat and the doctor driving blindfolded... because he or she had never seen this condition."

John Fraser, Professor and Director, Critical Care Research Group, The University of Queensland

Harnessing the power of data

When the COVID-19 pandemic struck the Asia-Pacific region, Prof. Fraser was conducting a research study looking for better ways to preserve donated hearts during transportation. He immediately pivoted to developing his idea for creating a COVID-19 treatment database designed for ICU clinicians. In March 2020, Prof. Fraser discussed the project with Australian news media. Shortly thereafter, the IBM team in Brisbane, Australia saw the story in the local newspaper and reached out to find out how IBM could assist Prof. Fraser's COVID Critical initiative.

In the beginning, Prof. Fraser and his team received more than 1,000 email inquiries a day from around the world. He also began a weekly series of video teleconferences attended by hundreds of global clinicians to determine what kind of treatment information tool would be most useful in an ICU setting.

As ICU wards around the world began to fill up with COVID-19 patients, data about patient treatments and outcomes grew accordingly. "But our understanding was not growing because we could not harness the power of all these separate and disparate data sources," says Prof. Fraser. "Looking at the regional and national silos where this information was stored, we asked, 'How can we get a better picture and better understanding?'"

Prof. Fraser saw the challenge as a puzzle to be solved. "If you have thousands of pieces of data spread across the world in different places, you can't see a picture," he says. "But if we bring those jigsaw pieces together, we can see a picture form."

Design and discovery

Two IBM iX® design researchers from Sydney, Australia initiated design discovery through an "Empathy Safari" to understand the scenario that unfolded before clinicians on these calls. The researchers played back their findings to the group to confirm that the full range of archetypes and regions were covered.

Initially, IBM was asked to enhance an existing "health research" prototype, developed by a team of academics within The University of Queensland's Faculty of Science. This dashboard used thousands of lines of code to curate the data, and while it laid crucial groundwork, this dashboard was better suited to researchers with more time to pore over and edit large amounts of data. For sleep-deprived ICU clinicians working 14 to 18 hours a day, back-to-back, a new kind of dashboard display was required. The data needed to surface quickly and be consumed at the bedside by clinicians encumbered by Personal Protective Equipment (PPE) that required 20 minutes to put on and take off.

Using IBM® Enterprise Design Thinking™ and agile methodologies, Prof. Fraser,
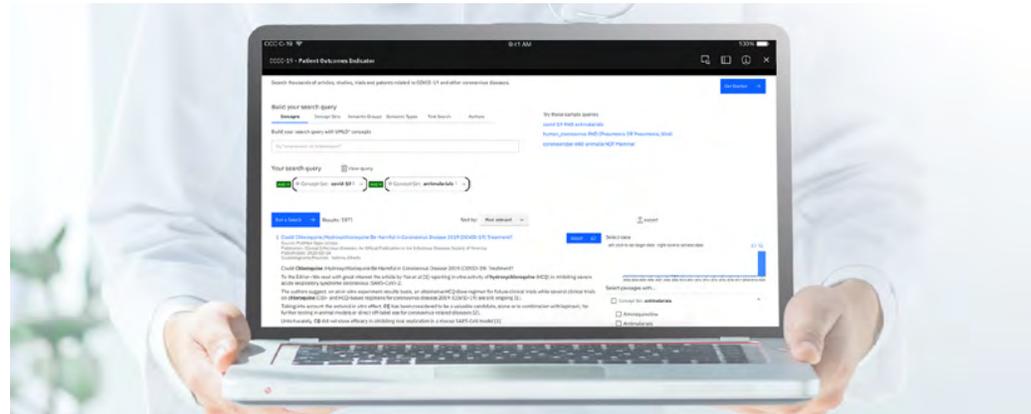
COVID Critical, and the IBM iX designers quickly started forming key insights from their research. The clinicians set forth the following "Hill Statement" that directed the building of the dashboard from inception to deployment:

"As an ICU clinician at the bedside, or at the noon meeting, I want to be able to enter de-identified patient data that is associated to the key milestones dates of an ICU patient flow, and compare that to the aggregate COVID-19 results from across the globe, by filtering against specifics such as countries that are similar to mine, age groups, severity of disease,

main therapies or comorbidities that are similar to my patient."

During the Empathy Safari phase of design discovery, IBM recommended an unbiased view of what the real-world experience was like for ICU clinicians and what information they needed at their fingertips. During dashboard design, COVID Critical took into account language barriers and clinician experiences related to differences between high, low- and middle-income countries. COVID Critical also coined the term: "We are building for data without borders. If we can't travel, why can't our data?"

A dashboard for multiple devices

"We decided that a dashboard that could be dynamic across multiple devices would be the easiest and fastest way to update information on a daily basis and guide clinicians on their own decision-making," says Prof. Fraser. "When we started design discovery, IBM asked, 'How can we best display this?' The IBM team became as equally passionate as the clinicians."

Five core design pillars provided the foundation for all design and development decisions going forward, including:

- "Glanceable Consumability" — Clinicians need to quickly see information that answers all key patient questions in a single pass.
- "Simplicity is Key" — Clinicians work in a complex, ever-changing environment with many unknowns. They don't need anything that adds uncertainty.
- "Trust in Data" — Clinicians need to be confident that they are not misled on life and death decisions made at key ICU patient milestones.
- "Protect Myself to Protect Others" — Clinicians need to disseminate and evaluate information about wearing PPE.
- "Contextualizable" — Clinicians need to place the data and make decisions within the context of patient needs. Patient data also needs to be placed in the context of aggregated data.

To get working dashboard prototypes into the hands of clinicians and support them in the new COVID-19 ICU environment, IBM iX designers and clinicians rapidly iterated dashboard designs reflecting the most current research.

Since January 2020, over 23,000 COVID-19 related papers have been published. With the number of published papers doubling every 20 days, this represents the largest proliferation of scientific literature in history, resulting in information overload and "channel fatigue". In addition, many reports become invalid and are retracted, making access to current information more important than ever.

Preferred data sources and channels for keeping up to date with the latest COVID-19 data include trusted scientific and medical publications, as well as daily management briefings. Social media was also used to communicate with trusted colleagues, including platforms such as Twitter and private chat groups within trusted networks such as WhatsApp and Viber.

With the clock ticking and a mysterious killer continuing to spread around the world, time is of the essence, but essential clinical data is finally plentiful and available.

Anatomy of an application

Within eight weeks, COVID Critical clinicians—in partnership with IBM designers and developers—began testing a new "connected clinician" app called the Patient Outcome Indicator Dashboard. This dashboard ingests data cleaned by the processing code written by the UQ data science team.

Compatible with most major web browsers and available on mobile phones, tablets and desktop computers, the real-time display dashboard provides a fast, highly visual user experience with five key elements:

- A starting dashboard display of datasets related to past COVID-19 patients
- A scenario builder for filtering desired patient parameters
- A scenario card that sums up the selected patient parameters
- Statistical displays of data streams related to the subset of patient records selected

- A method to compare patient scenarios to outcomes of current and previous COVID-19 patients to empower prognosis

IBM Consulting designed and developed the dashboard apps and IBM Cloud® served as a security-rich and scalable platform as a service (PaaS) development platform. During tool development IBM Security™ provided tools to encrypt and secure sensitive data.

In addition, IBM business units provided their time and expertise on a pro-bono basis and continue to work with COVID Critical to continue improving solutions.

Breathing easier with treatment insights

Today, ICU clinicians around the world are using the COVID Critical app as they treat COVID-19 patients, informed by data contributed by COVID Critical member hospitals. "It allows us to compare our

ICU patients to patients from around the world, so we can track and understand what could happen to individual patients," says Dr. Asad Usman with the Department of Anesthesia and Critical Care at the University of Pennsylvania.

The initial focus of the clinical app is on treatment data related to mechanical ventilation and dialysis. As more data is collected and analyzed, the app will be expanded to record and share clinical features related to pulmonary, cardiological, neurological and kidney function.

Although the clinical app's primary focus is to empower clinicians in moments that matter, information gained from the patient database also provides impact statistics related to hospital bed resourcing

and forecasting. For example, the cost of mechanical ventilation for a COVID-19 patient has been estimated at USD 20,000 per day, with a total in-hospital treatment cost ranging from USD 42,000 to USD 500,000.

On average, COVID-19 patients spend 24 days in the ICU. Analysis of data also revealed another concerning statistic: when COVID Critical started in early 2020, ICU mortality rates stood at 80%—another reason for the urgency of COVID Critical efforts.

"Doctors and nurses are data-driven creatures," says Prof. Fraser. "We like to know what to do next because the stakes are incredibly high. We need the data to help your mum and dad as much as possible."

Tech beyond borders for healthy collaboration

With the addition of each new hospital to COVID Critical and the input of each new deidentified patient record to the COVID-19 database, the founding vision behind COVID Critical comes into tighter focus. "We were creating not doctors without borders, but technology without borders," says Prof. Fraser.

By putting the apps into the hands of clinicians in over 50 countries—and growing—around the world, low- and middle-income countries can benefit from research developed in high-income countries. In addition, all participating countries can share global treatment insights on a constantly changing pathogen that respects no borders.

When the ECMOCARD research study concludes, even more COVID-19 treatment lessons-learned will be shared widely across clinical and research settings.

In the future, the technology behind the app holds significant promise for other

clinical research topics, as well as other medical technologies, including wearable devices and pocket technologies designed for monitoring and updating. And with more data collection comes the potential to evolve the use of AI to accelerate the generation of curated knowledge and sharing of insights.

Beyond the collaboration across continents and between public and private sectors, COVID Critical and IBM have also removed barriers between professional silos. "Traditionally, collaboration between the two industries, medicine and computer engineering, has been like oil and water," says Dr. Usman. "Together, intensive care physicians, UQ mathematicians, data scientists and IBM experts spearheaded the rapid design and development of an application that empowers physicians and disseminates insights in the key moments that matter."

"COVID Critical, working with IBM, has created a level playing field that everyone
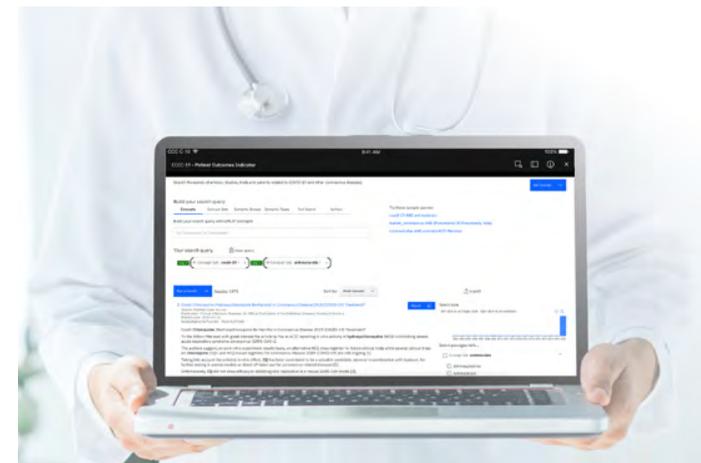
in different countries can access in the same way," says Prof. Fraser. "If used properly, data and technology will help prevent infection, treat the patients and help us go back to work, go back to play, go back to travel, and go back to education. Technology and data used smart is the way forward."

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About the COVID Critical Care Consortium

Based at The University of Queensland in Brisbane, Australia, the COVID Critical Care Consortium (COVID Critical) (external link) started in January 2020 to provide insights about treating critically ill patients infected by the SARS-CoV-2 virus. More than 370 hospitals have joined COVID Critical, which also supports the Extra-Corporeal Membrane Oxygenation for 2019 novel Coronavirus Acute Respiratory Disease (ECMOCARD) study.

Solution components

- IBM Cloud®
- IBM Consulting
- IBM Security™