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Photographs by Boaz Perlstein

A BLUEPRINT FOR THE HOSPITAL OF THE FUTURE

Revolutionary new directions in remote health care design

In the spring of 2020, to handle a surge of COVID-19 patients, Israel's Sheba Medical Center created 97 new ICU beds in its underground parking lot practically overnight. The space was divided into "clean" and "contaminated" zones. Some staff worked in person in the latter, dressed in full protective gear, while others worked remotely from a control room in the nearby clean zone. Using multiple fixed cameras, interactive audio-video technologies and robots fitted with tablet computers to display their faces, these operators helped tend to the needs of patients and families and managed staff in the contaminated zone.

Confronting an unprecedented pandemic, the hospital was exploring a new way of operating an intensive care unit: remote care for patients who were physically inside its building. The goals were to limit staff exposure to pathogens, to reduce errors caused by working in bulky protective equipment and, perhaps most important, to see how well remote in-patient medicine could work on the ground.

Nirit Pilosof, an architect, researcher and former Azrieli Graduate Studies Fellow who had spent her career designing and studying health care facilities, had just weeks earlier begun postdoctoral research at Cambridge Digital Innovation (CDI), Hughes Hall and Cambridge Judge Business School at the University of Cambridge. She joined an interdisciplinary team at CDI that was investigating the "Smart Hospital of the Future."

Her original plan had been to travel back and forth between the U.K. and Israel to research digital transformation in health care settings. But when lockdowns closed borders, she remained in Israel and took a front-row seat to perhaps the greatest acceleration of digital health care in our time.

Over six months, Pilosof observed Sheba's COVID units and interviewed doctors, nurses, engineers, technology experts and the architectural design team. "They developed a whole new model of care," she says.

It wasn't perfect. The partial views provided by cameras, for instance, were never as good as seeing the whole scene while one was present in the space. No amount of smiling on a camera could replace a human touch. And there was not enough privacy for patients. But the exercise illuminated a future in which, with tweaks, remote care in its various iterations could become a major organizing feature of health care design.

We tend to think of architects designing inert structures, not dynamic systems. But buildings influence their users. Design produces outcomes. And perhaps nowhere is this more evident than in hospitals.

A landmark paper in 1984, written by Roger Ulrich and published in the journal *Science*, found that patients who saw greenery through their hospital windows needed less pain relief and fewer post-operative days in care than patients who could only see a brick wall. That paper helped spawn a field known as "evidence-based design."

Evidence-based design explores, among other things, connections between architecture and health. It recognizes that the built environment has an impact on how a facility performs and how its users fare within it. Everything from ward layout to lighting and acoustics will have consequences related to clinical outcomes, staff performance and the well-being of patients. Some will be life-and-death. And, just as in medicine itself, medical architecture should "do no harm," says Pilosof. In fact, she argues, medical buildings should be designed, as much as possible, to support the healing process.

Architect Nirit Pilosof, who was the design project manager for the Tel Aviv Sourasky Medical Center's Sammy Ofer Heart Center (top), had a front-row view of the Sheba Medical Center's rapid transformation and its COVID-19 control room (bottom) when the pandemic began. She is now exploring ways to rethink health care design in the new digital era.
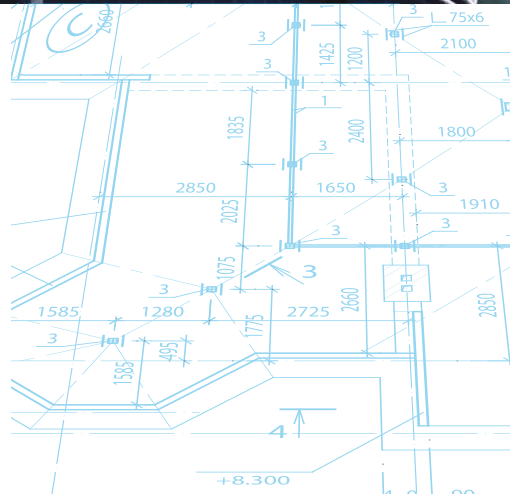
PHOTOGRAPH COURTESY OF SHEBA MEDICAL CENTER

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There are two central lessons from the study of Sheba's COVID units, according to Pilosof. One is that there is great potential for so-called smart hospitals. "The hospital can really change if we start looking at how we can redesign it by using remote technologies," she says. The other is that there are still big ethical questions to be addressed. "How do we redesign health care services," she asks, "without compromising patient privacy and human dignity?"

Although the COVID part of her research is now complete, Pilosof continues to collaborate with Cambridge and Sheba on a project called "Hybrid models of care: Integrating physical care with virtual care." She and her colleagues believe that hospitals will evolve from centralized monoliths that do everything inside their walls into more dispersed health care ecosystems. A transformation that's currently underway at the Sheba Medical Center, led by its ARC (Accelerate, Redesign, Collaborate) Center for Digital Innovation, provides a perfect real-time example to study. The hospital — one of the best in the world — recently launched "Sheba Beyond" to become Israel's first virtual hospital. Through this arm, the facility offers different kinds of care, including ambulatory services, rehabilitation and remote home hospitalization.

"We realize that in the future, physical hospitals will be used only for acute care," says Pilosof, who became head of research in Sheba's Innovation and Transformation Division this past September. "Remote technologies hold the potential to change the layout of medical units completely."

Many in-hospital patient rooms will have to be transformed into intensive care rooms, for instance, which is more complicated than it may sound as they require different types of staffing and infrastructure. At the same time, many other types of patients will be monitored remotely — some within the physical building, but some elsewhere, including in their own homes. According to one vision, patients will be monitored identically, regardless of where they are located, using a tablet to access their medical data. In Sheba's home hospitalization trial, specialists monitor patients at home using virtual technologies. (Only patients who have someone at home to help out are eligible.) If the patient's condition worsens, they can come straight back to the same unit, bypassing the emergency department. "The team already knows them and their medical history," says Pilosof. "The way they look at it is that the unit has both physical beds and virtual beds." Medical professionals are happy to have access to continuous data, rather than relying on self-reports, and patients are often comforted by the fact that they are being monitored closely.

Pilosof is currently assessing how well the project is working by conducting qualitative interviews with all of the relevant stakeholders. She has already found that interactions between medical professionals and patients' families are being altered — in most cases, for the better. In a hospital, during rounds, doctors and their entourage typically move from room to room, and patients' families are often excluded. In Israel, most rooms are semi-private and family members are asked to wait outside to protect the privacy of the other patient. When done remotely, however, families are invited in. "When the patient is at home, they actually ask the family to join the meeting, because they need the family to be involved in the care," says Pilosof. "This has really shifted the relationship between the patient and the family and the medical staff." Families are now part of the team, she says, and almost part of the staff.

The research also indicates a need for control centres, says Pilosof, just like in the COVID units. "We're talking about designing control

centres that will manage all the patient data, whether they're at home or in the hospital, with operational and spatial data spread across the health care system." The trick will be integrating the different datasets represented by "digital twins" to optimize operations and support informed clinical decisions.

"Multidisciplinarity is absolutely critical in this research," says Michael Barrett, an information systems and innovation studies professor at the Cambridge Judge Business School who is leading the research at Cambridge and has worked closely with Pilosof. "We are bringing together scholars who are experts in digital technologies, digital innovation and service innovation, but then also thinking about the spatial dimension." This type of research has traditionally been weak on thinking spatially, he says, but working with Pilosof has helped to address that gap.

Pilosof has a special interest in designing for the unknowable future. "We are in an era of transformation," she says. "Everyone is trying to predict what will happen, but we don't really know where it will lead." Unfortunately, medical facilities, she says, are too often tailor-made to fit specific programs and the operational approach of the existing medical director. Sometimes, though, that medical director leaves before construction is even complete. Or, as the pandemic underscored all too clearly, demands can suddenly change. Planning for change, she says, is probably the biggest challenge in health care design today.
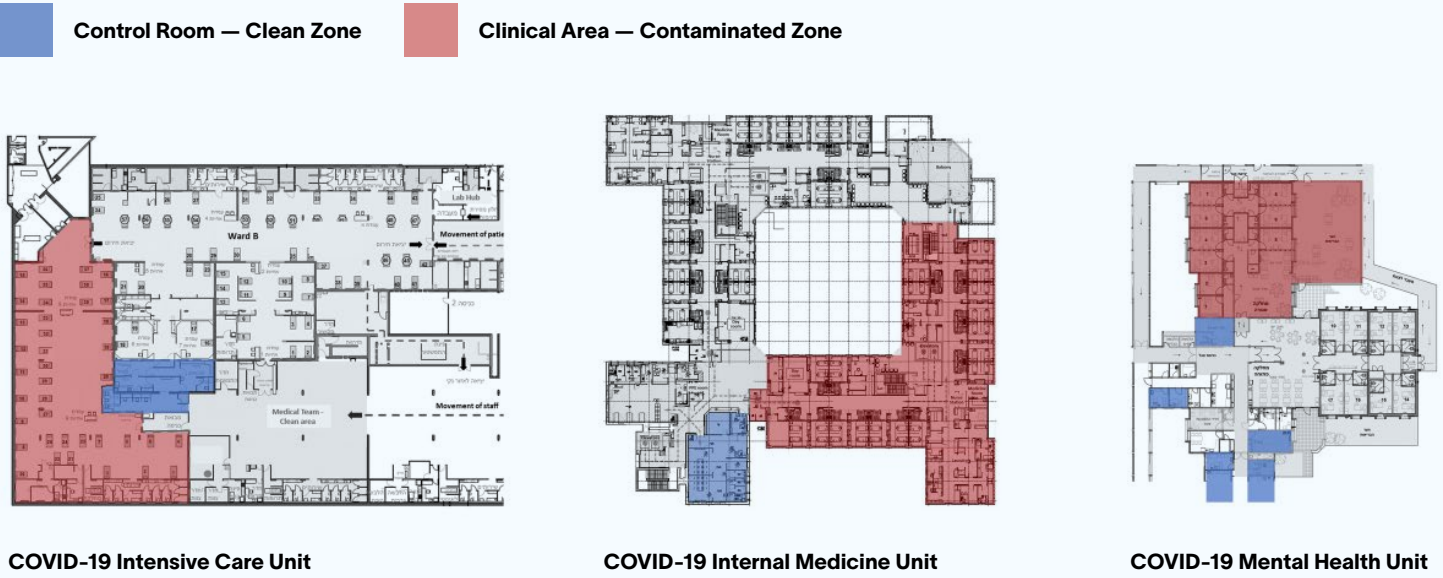
"You have to design a building today when you actually don't know what the future needs will be," says Pilosof. Medicine and technology are advancing rapidly, yet it can take seven years — or longer — from a facility's blueprints being completed to the ribbon cutting. "By the time the building is built," she says, "it's already obsolete."

The key is to design with flexibility in mind, says Pilosof — something she knows from experience. From 2005 to 2009, while working at Ranni Ziss Architects, she was the design project manager for the Sammy Ofer Heart Center, a cardiac care facility at the Tel Aviv Sourasky Medical Center (Ichilov). Only three floors were needed for it, but the hospital wanted to make the most of its donation, so it commissioned 11 floors. "We actually built an empty shell," she says. But it was an empty shell with enormous potential: she and her colleagues knew something would fill in the space, even if they didn't yet know what, and they didn't want the design to be a limiting factor. During her PhD studies in the Faculty of Architecture and Town Planning at Technion–Israel Institute of Technology in Haifa, where she was an Azrieli Graduate Studies Fellow from 2016 to 2019, she demonstrated that this was an efficient approach.

Pilosof's interest in planning for change had been sparked earlier, while she was working toward her master's degree at McGill University in Montreal. She had studied the evolution of the McMaster Health Sciences Centre, a utopian building of the 1970s in Hamilton, southwest of Toronto — "an infinitely flexible space," she says, "designed never to be finished." But 30 years on, she discovered in her research, it had not continued growing as predicted, but had instead become a "static monument." The architectural approach was efficient, but management and funding issues overruled the initial vision. This showed that despite the best intentions of architects, Pilosof says, so much remains outside of their control.

Since starting her collaboration with Cambridge, Pilosof has moved further into management studies. Today, in addition to her work at Sheba, she is also a faculty member at Tel Aviv University's Coller School of Management, where she is co-teaching a course on evidence-based design for medical directors in the Health Systems Management MBA program. "Meeting all those future decision makers in high positions and teaching them about health care design — that's really an opportunity to make a change," she says. She hopes to develop a program in which she can bring architecture students into the same room as medical and management students to help them imagine the future together. ▲●■

IN-PATIENT TELEMEDICINE IN COVID-19 MEDICAL UNITS AT SHEBA MEDICAL CENTER

■ Control Room — Clean Zone   ■ Clinical Area — Contaminated Zone

COVID-19 Intensive Care Unit

COVID-19 Internal Medicine Unit

COVID-19 Mental Health Unit

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