

Tracking an Outbreak Global Response

THE INTERPRETER

Reopenings Begin a New Phase: 'Trial and Error' Played With Lives

By MAX FISHER

The world is entering a period of high-stakes experimentation, with cities and countries serving as open-air laboratories for how to most safely and effectively reopen amid the coronavirus.

Unable to wait indefinitely for science to answer every riddle about what makes infections spike in some circumstances and not others, governments are pushing ahead with policies built on a growing but imperfect understanding of the virus.

And with little consensus on how best to balance public health against social and economic needs, societies are feeling their way through trade-offs that would be gut-wrenching even with better information on any given policy's likely cost in lives and livelihoods.

"We're in the middle of a global trial-and-error period to try to find the best solution in a very difficult situation," said Tom Inglesbury, who directs the Center for Health Security at Johns Hopkins University.

The first wave of reopenings, predominantly in Asia and Europe, are providing a preview of what could become a continual process of experimentation and recalibration.

Each policy, like distancing students at Danish schools or temperature checks at Hong Kong restaurants, however based in scientific knowledge and calculated cost-benefit, is also a trial of what works, what's worthwhile and what people will accept.

Though experience bought in lives will convert some unknowns to knowns, many questions may remain unanswered for the duration of what is expected to be a one-to-two-year crisis.

That includes what may be the hardest but most urgent question of all: What is the value of a life saved?

Countries have little choice but to guess at stomach-turning ethical calculations. How many lives should be risked to save a thousand people from unemployment? To stop a generation of kids from falling behind in school? To salvage a sense of normalcy?

While Dr. Inglesbury stressed that "there are a lot of principles that are based on public health and common sense" to guide us, he also said, "There's no road map for this."

Navigating the Unknowns

Many countries policies are shaped, in part, by how they navigate the gaps in knowledge about the virus.

For example: Does being



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Lining up to register for financial assistance from the Thai government at the Ministry of Finance in Bangkok on Thursday.

outdoors drastically limit transmission?

Lithuania, on the belief that it does, is closing streets in the capital to allow restaurants and bars to open outdoor-only services.

Others are testing this hypothesis more tepidly. Bangkok is reopening parks but forbidding most activities that involve multiple people. Sydney is reopening beaches for swimming and surfing but not sunbathing or socializing.

Another mystery: How easily, and widely, do children transmit the virus?

Some countries are reopening schools, taking a calculated risk on indications that children might be relatively safe, while imposing restrictions in case they aren't.

Denmark is opening schools to younger children, who are tentatively thought to be less at risk, but hedging with restrictions on class size.

Germany, meanwhile, is inviting back older children who, the thinking goes, might pose a higher risk of transmission but will better comply with rules on masks and distancing.

There is another set of unknowns: those pertaining to people's behavior.

South Korea's government is gambling on citizens voluntarily observing a litany of guidelines on everyday interactions, like bowing instead of hugging at funerals.

In other areas, it is less trusting, using fines and digital monitoring to enforce mandatory quarantines for those thought to have even come into contact with an infected person.

California will allow some businesses to offer curbside pickup, in the hopes that enough workers and consumers will embrace this, and safely enough to halt the economy's free-fall without infections resurging.

Georgia, meanwhile, lifted restrictions on businesses only to find that customers were largely unwilling to come back.

These are: Keeping infections low, to prevent health services from getting overwhelmed; keeping deaths low, which entails deterring higher-risk infections; and controlling economic and social burdens.

RESEARCH AND DEVELOPMENT

Israel Directs High-Tech Prowess at Covid-19, With Numerous Promising Leads

By DAVID M. HALBFINGER

JERUSALEM — The Israeli Defense Ministry's research-and-development arm is best known for pioneering cutting-edge ways to kill people and blow things up, with stealth tanks and sniper drones among its more lethal recent projects.

But its latest mission is lifesaving. Since March, it has been spearheading a sprawling, high-speed effort to unleash some of the country's most advanced technologies against an enemy of another kind: Covid-19.

The national undertaking is for the first time linking up major hospitals and research institutes with Israel's vaunted high-tech sector and its military-industrial behemoths: Elbit Systems, Israel Aerospace Industries and Rafael Advanced Defense Systems, the companies behind Israel's arsenals of unmanned vehicles, missiles and souped-up fighter jets.

Red tape, institutional rivalries and cronyism can stand in the way of a unified, rapid response to a crisis. But Israel quickly set up a national task force and dozens of teams with hundreds of scientists, engineers, doctors, executives, government officials and military officers all working toward the same goals.

"In Israel, if there is a mission that has to be done, it's like a war," said Brig. Gen. Dani Gold, who is leading the charge. "Everybody drops what they're doing, tunes into the mission and works on the mission with a lot of energy and creativity."

General Gold, known as the father of the Iron Dome antimissile system, leads the Directorate of Defense Research and Development, Israel's version of the U.S. Defense Advanced Research Projects Agency, or Darpa.

Irith Pazner Garshowitz contributed reporting.



The control room at the coronavirus critical care department of the Sheba Medical Center in Ramat Gan, Israel, on Tuesday. Right, a Covid-19 detection device, developed by Tera Group. The breath test could handle 2,000 tests a day, and may be suitable for airports.

While Darpa gave the world the internet and GPS, its Israeli counterpart has not had a similar impact on civilian life. Its work on the coronavirus, officials say, could be a start.

Here are a few of its potentially game-changing projects.

Vocal Indicators

One company, Vocalis Health, which uses sensitive audio technology, artificial intelligence and machine learning to analyze voice and breathing, is trying to identify a vocal indicator for the coronavirus. Far-fetched as that may sound, the company has already linked vocal markers to the risk of mortality in patients with congestive heart failure and to pulmonary hypertension.

Working with Sheba Medical Center, Vocalis has been recording voice samples from Covid-19 patients in hopes of refining an app that could categorize patients' infections as mild, moderate or severe based on how they sound. "It's a whole new area that I think a few years from now will be very central in health care," said Dr. Eyal Zimlichman, the hospital's chief medical officer and

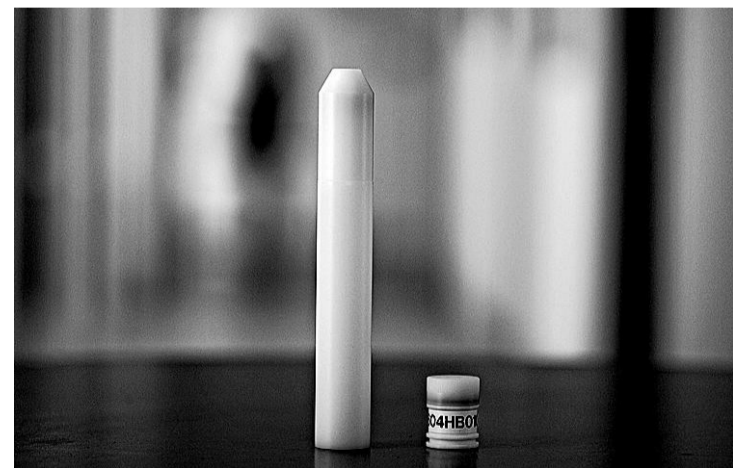
chief innovation officer.

Smell Tests

NanoScent, a company whose technology uses arrays of sensors to detect and digitize odors, says that the proliferation of virus cells among the microorganisms that inhabit the noses of Covid-19 patients what is believed to be a distinct smell. And it is training its artificial intelligence to detect that smell.

"It's not a definitive test," said Oren Gavrieli, NanoScent's chief executive and co-founder. "But you'd come, you'd blow into a special bag that we've designed, you'd have a 30-second test, you'd expose it to the sensing device, and you'd get a result: Either you're clear or you're suspected to have something."

Two other teams are developing breathalyzers using spectrum analyzers operating at super-high frequencies. TeraGroup's has patients blow into a cigar-size tube, said Oren Sadviv, the start-up's chief executive. Mr. Sadviv said the device could handle 2,000 tests a day, each for the price of a cup of coffee. He said it would be intended not to make a positive di-



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agnosis but to allow quick and cheap screenings at airports or marketplaces, flagging people who should get tested while letting others pass.

Prof. Gabby Sarusi of Ben-Gurion University, which is developing a similar device with Israel's Directorate of Defense Research and Development, said the coronavirus's size and electrical properties stick out when analyzed at high frequency and should be detectable as soon as several hours after someone is infected.

A Closer Look

Several of the most intriguing tools against the virus have been developed by AnyVision, a surveillance and facial recognition company that scans faces at military checkpoints. The company says its computer-vision and deep-learning technology can pick out someone on a watch list in a crowded stadium.

At Tel Aviv-Sourasky Medical Center, scientists are using AnyVision on a microscopic level, training it to detect Covid-19 cells by looking for the ways the virus diverts healthy cells from their usual functions. Prof. Dov Her-

sharper increase after some restrictions were lifted — raising the possibility of a return to lockdown, as some Chinese cities have already done.

Even failed experiments might offer hard-won lessons, in theory allowing each reopening to be safer than the last.

"Is there a resurgence of cases based on particular patterns of easing social distancing?" Dr. Inglesbury asked. "Do we discover that there are cases occurring in mass transit? Are the things that Hong Kong is doing with restaurants working?"

But there is a wrinkle: Cities and countries are tending to change several things at once, and that makes it hard to isolate specific lessons. A policy might appear to fail in some circumstances and succeed in others, slowing the world's ability to learn.

Gut-Wrenching Trade-Offs

Even if the world could quantify with certainty how a particular policy affects both the virus and social welfare, there is no formula for how to balance the two.

That has forced world leaders to confront a question that ethicists have wrestled with for years: How much should society be willing to sacrifice to save a life?

Put another way, how many people should lose their jobs to save one life, knowing that extended unemployment is associated with reduced life expectancy? How many people should be allowed to die if it lets a community keep the local factory running?

"One of the things that's new here is the trade-off between people's long-term futures," said Dr. Emanuel, the medical ethicist.

With no easy formulas or answers, he said, "Someone's got to make those trade-offs. I don't know what else to do."

For President Trump, more than any other leader so far, the upsides of reopening exceed even the most extreme risk — he is also among the only leaders to push for reopening as cases continue rising in many parts of the country. That, experts warn, could invite more economic damage than relief.

Other courses of action demand weighing human life against civil liberties, social inequality, even cultural value.

South Korea is taking steps toward restarting its baseball league, which is both a business and a source of enjoyment for millions. Hong Kong is allowing some access to libraries.

And Americans are already debating whether there is a point at which enforcement of social distancing — through monitoring, fines or outright coercion — carries unacceptable costs to individual liberty.

Reshaped Societies

What begins as economic or public health questions quickly become, with no other way to answer them, matters of philosophy and values.

How aggressive should schools be in reopening? New outbreaks might imperil adults who are older or have pre-existing conditions. But a year of lost school can set back a child for life.

Is the value of partially reopening a cultural site like Broadway measured in economic terms alone, or also in the happiness it brings to theatergoers, and its contribution to culture? Is that enough to put lives at risk?

Concessions in freedom and privacy — already being made in individualistic South Korea — could endure after the pandemic is over. The choices that are made could add up to societies reconfigured around the values that informed them.

As the consequences of those choices mount, the costs of fighting the pandemic will become clearer every week.

"It's going to be a very difficult balancing act," Dr. Inglesbury said.

Telemedicine

A number of projects are aimed at minimizing direct contact between health workers and patients.

Temu had already identified a market for personal robotic assistants, costing about \$2,000, that resemble an iPad on a parking-meter-high wheeled pedestal. Rafael and Elbit have now adapted them to operate in fleets, and to allow doctors to monitor patients or deliver their medicine without ever entering their rooms, said Yossi Wolf, who previously developed robots to help Israeli soldiers deal with Hamas tunnels or chemical weapons.

Separately, Israel Aerospace Industries has converted a radar and electrooptical sensor system, used to peer across Israel's borders, into a device that can take patients' vital signs without touching them, said Amira Sharon, a vice president at I.A.I.

Command and Control

At Soroka Medical Center in Beer-sheva, in the south, I.A.I. has also adapted the cockpit controls it builds for fighter jets and helicopters to store and analyze information about Covid-19 patients on ventilators, Ms. Sharon said. "It gives the medical staff a comprehensive picture, while minimizing contact, and can generate early-warning signs to see where patients are going," she said.

While Israel has fared relatively well against the virus so far, if a second wave overwhelms the health system, a command-and-control system being developed by the military is expected to link all the country's hospitals, allowing officials to shift people and equipment where they are needed most, said Col. Talya Gazit, a reservist who was reactivated to lead the effort.

"This will be the first time Israel can see the situation at once in all the hospitals in the country," Colonel Gazit said.