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MEDICAL DISPATCH

AMID THE CORONAVIRUS CRISIS, A REGIMENT FOR REENTRY

Health-care workers have been on the job throughout the pandemic. What can they teach us about the safest way to lift a lockdown?

By Atul Gawande

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In places around the world, lockdowns are lifting to various degrees—often prematurely. Experts have identified a few indicators that must be met to begin opening nonessential businesses safely: rates of new cases should be low and falling for at least two weeks; hospitals should be able to treat all

coronavirus patients in need; and there should be a capacity to test everyone with symptoms. But then what? What are the rules for reentry? Is there any place that has figured out a way to open and have employees work safely, with one another and with their customers?

Well, yes: in health care. The Boston area has been a COVID-19 hotspot. Yet the staff members of my hospital system here, Mass General Brigham, have been at work throughout the pandemic. We have seventy-five thousand employees—more people than in seventy-five per cent of U.S. counties. In April, two-thirds of us were working on site. Yet we've had few workplace transmissions. Not zero: we've been on a learning curve, to be sure, and we have no way to stop our health-care workers from getting infected in the community. But, in the face of enormous risks, American hospitals have learned how to avoid becoming sites of spread. When the time is right to lighten up on the lockdown and bring people back to work, there are wider lessons to be learned from places that never locked down in the first place.

The New Yorker's coronavirus news coverage and analysis are free for all readers.

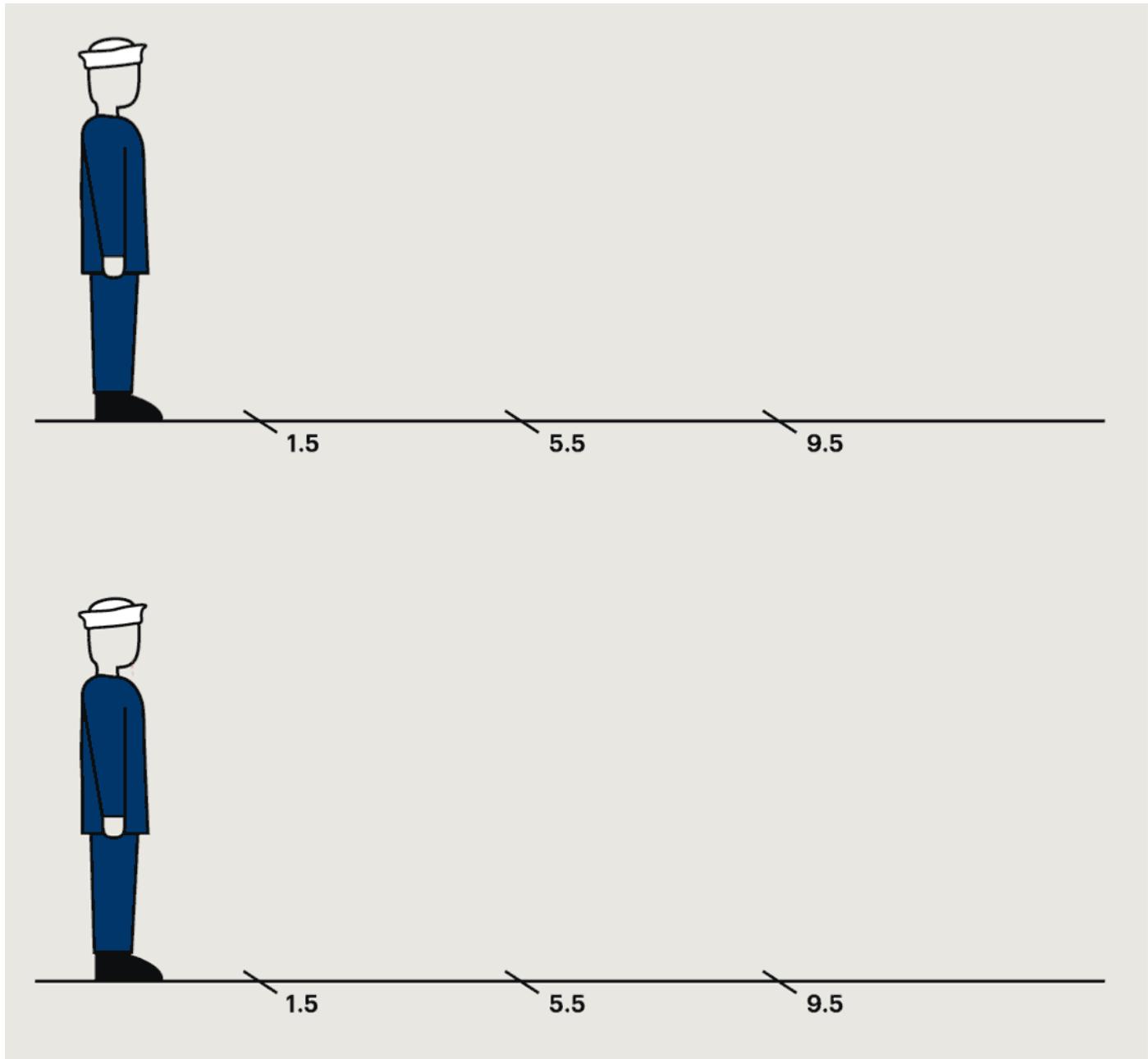
These lessons point toward an approach that we might think of as a combination therapy—like a drug cocktail. Its elements are all familiar: hygiene measures, screening, distancing, and masks. Each has flaws. Skip one, and the treatment won't work. But, when taken together, and taken seriously, they shut down the virus. We need to understand these elements properly—what their strengths and limitations are—if we're going to make them work outside health care.

Start with hygiene. People have learned that cleaning your hands is essential to stopping the transfer of infectious droplets from surfaces to your nose, mouth, and eyes. But frequency makes a bigger difference than many realize. A study conducted at a military boot camp found that a top-down program of hand washing five times a day cut medical visits for respiratory infections by forty-five per cent. Research on the 2002 SARS coronavirus outbreak found that washing hands more than ten times a day reduced people's infection rate by even more. Disinfecting surfaces helps, too, and frequency probably matters, although I haven't found good research on this. The key, it seems, is washing or sanitizing your hands every time you go into and out of a group environment, and every couple of hours while you're in it, plus disinfecting high-touch surfaces at least daily.

That is not enough, however, because environmental transmission may account for as little as six percent of COVID-19 infections. SARS-CoV-2, the virus that causes COVID-19, spreads primarily through respiratory droplets emitted by infected people when they cough, sneeze, talk, or simply exhale; the droplets are then breathed in by others. (Loud talking has even been shown to generate measurably more droplets than quieter talking.) This is why physical distancing is so important. We have all now learned the six-foot rule for preventing transmission of contagion-containing droplets. In my hospital system, observers gently remind us to stand the prescribed distance apart on escalators and in the elevator line; we allow no more than four people on elevators that used to carry more than twenty (a nightmare at shift changes). We've turned as many internal meetings, patient visits, and team huddles as possible into video meetings, even if someone is right across the hall. When we can't avoid face-to-face encounters, we've put up Plexiglas barriers and spaced our chairs and work stations farther apart.

The six-foot rule isn't some kind of infectious-disease law, however. There's no stop sign at six feet that respiratory droplets obey. Public-health guidelines, in fact, originally set the at-risk distance at three feet or less, based on theoretical models going back to the nineteen-thirties, simulation studies, and experience in previous outbreaks, such as a 1981 outbreak of infectious meningitis in a Texas elementary-school classroom. That outbreak began in a cluster of five girls seated together on one side of the room. One infected the other four. Investigators later took measurements: the distance from one girl's seat to another was about two and a half feet. Close contact at lunchtime spread the *Meningococcus* bacteria to other children, who transmitted the disease in their classrooms. In all, thirty-one children became ill or were carriers, and the spread was mainly in two classrooms where the chair-to-chair distance was three feet or less.

Even then, it was already apparent that respiratory illnesses frequently travel farther. Past guidelines from the C.D.C. also cited a 1948 military study in which almost fifty young men with confirmed *Streptococcus* infection—strep throat—were asked to cough, sneeze (with the help of a sneezing powder), and talk. Petri dishes and air samplers were placed at various distances to capture bacteria. All three activities dispersed contagion. Sneezing was the worst.



A study conducted at a naval base in the nineteen-forties found that germs were most commonly collected within a foot and a half of the sneezing subject, but in some cases they could travel much farther.

In the most common pattern, bacteria grew only on petri dishes placed on the floor a foot and a half from the sneezer. In ten per cent of cases, bacteria were captured only by the air samplers. In twenty per cent, no streptococci were recovered anywhere. But one recruit spewed large quantities of bacteria into petri dishes and air samplers almost ten feet away. "This subject," the report noted, "was really an

unusually good atomizer.” They’d caught him at a time of particular infectivity. A few days later, he wasn’t nearly as infectious anymore.

It has now become well recognized that, under the right conditions of temperature, humidity, and air circulation, forceful coughing or sneezing can propel a cloudburst of respiratory droplets more than twenty feet. Yet it wasn’t until the SARS epidemic in 2002, after several cases documenting more distant spread, that authorities doubled the at-risk distance from three to six feet. In one case, a man with SARS on a three-hour flight from Hong Kong to Beijing infected twenty-two people, five of whom died. The twenty-three passengers in the same row or the three rows in front of the index patient bore the highest risk: eight fell ill. So did the flight attendant for the patient’s section. Extending the recommended distance made sense. But six feet was simply a choice guided by practicality. People seven rows away—around eighteen feet—developed SARS, too.

We’ve seen similar events in the current pandemic. Take, for instance, the now infamous Skagit Valley Chorale practice, on March 10th, at a church in Washington State. It was pre-lockdown, but there’d been enough coronavirus news to lead the group to suspend the usual hugs and handshakes and to sit farther apart than usual. According to choir members who were present, no one seemed ill at the start of the rehearsal. No one coughed. The singing was as powerful as ever. And that may have been the problem. There was an index patient who had been experiencing cold-like symptoms for three days, which worsened after the rehearsal and led to a diagnosis of COVID-19. According to an investigation by the Skagit County Public Health department, fifty-two of the sixty other choir members in attendance subsequently fell ill. Thirty-two choir members tested positive for COVID-19. Two died.

COVID-19 isn’t actually crazy infectious. Measles is crazy infectious: for instance, in a 2008 outbreak in San Diego that began in a school where thirty per cent of students were unvaccinated, each infected child spread the virus to, on average, eighteen others—meaning that the disease has a “reproductive ratio,” or R₀, of eighteen. By comparison, a person with COVID-19 will infect, on average, only two to three others out of all the people he or she encounters while going about ordinary life. Exposure time matters: we don’t know exactly how long is too long, but less than fifteen minutes spent in the company of an infected person makes spread unlikely. (For instance, among four hundred and forty-five people who were within six feet of a COVID-19 case for ten minutes or more, only two tested positive, both of whom had confirmed cases in their households.) But an R₀ of two or three is more

than enough to cause a pandemic. Given an average incubation period of five days, a single unchecked case can lead, over two months, to more than twenty thousand infections and a hundred deaths. The six-foot rule goes a long way toward shutting down this risk. But there are clearly circumstances where that is not sufficient. At the right point in the illness, under the right environmental and social conditions, one person can produce a disaster. In ninety minutes of choir practice, in a crowded church on a March day, with a woman at the height of infectivity, the R₀ was in the dozens.

Hence the practices begun in Asia, and adopted by my health system, to institute daily screening of all employees, patients, and visitors for symptoms of COVID-19. Anytime I want to enter a hospital building, I have to go to a Web site that I've bookmarked on my phone, log in with my employee identification, and confirm that I have not developed a single sign of the disease—a new fever, cough, sore throat, shortness of breath, loss of taste or smell, or even just nasal congestion or a runny nose. (Administrators could also have added a formal temperature check with an infrared touchless thermometer, but, although ninety per cent of symptomatic COVID-19 patients eventually develop fevers, early on, fever is present less than half the time. So it's the mild symptoms that are most important to screen for.) A green pass on my phone indicates no symptoms and grants me access to the hospital. Otherwise, I can't work. In that case, the Web site directs me to call our occupational-health clinic and arrange for possible testing.

Testing when people have symptoms is important; with a positive result, a case can be quickly identified, and close contacts at work and at home can be notified. And, with a negative result, people can quickly get back to work and keep the hospital going. (Owing to false-negative test results, you are still required to wait until your fever has been resolved, and your symptoms have improved, for seventy-two hours.) Tests for people with symptoms are becoming increasingly available; this is no longer a problem for our hospital. Without these tests, people with symptoms have to self-quarantine for much longer—for at least seven days from the start of their symptoms and until they've been fever-free and with improving symptoms for seventy-two hours.

This self-screening is obviously far from foolproof. Anyone could lie. Nonetheless, in the first week of rollout, more than five hundred colleagues indicated through the Web site that they had symptoms. Through the first week of May, symptoms, often mild, prompted more than eleven thousand staff members to stay home and receive testing. Fourteen hundred of them tested positive for SARS-CoV-2

measurable reasons: they send the right message. Embarrassingly, people in health care have often

seen calling in sick as a sign of weakness. Screening has changed that. Toughing it out is now a shameful act of disloyalty.

Even the most scrupulous check-ins, however, can do only so much in this pandemic, because the SARS-CoV-2 virus can make people infectious *before* they develop symptoms of illness. Studies now consistently indicate that infectivity starts before symptoms do, that it peaks right around the day that they start, and that it declines substantially by five days or so. This is the pattern we see in influenza. But it's the opposite of the pattern we saw with the coronavirus that caused China's SARS outbreak eighteen years ago. That virus had a low risk of transmission until after five days from the onset of symptoms, which made it easier to identify and isolate cases before others got infected. No large-scale lockdown was necessary. It seems that there are also plenty of people who are infected by the virus that causes COVID-19 who never become symptomatic, especially children. So far, studies of transmission networks have not revealed such silent carriers to be a major source of spread. Nonetheless, patients who do not yet show symptoms, or have just begun to, are turning out to be important vectors of disease.

That's why we combined distancing with masks. They provide "source control"—blocking the spread of respiratory droplets from a person with active, but perhaps unrecognized, infection. Since March 25th, my hospital system has required all employees to wear disposable surgical masks. In early April, we began providing masks to all patients on-site. Patients pose a more controlled risk: they don't come and go every day. As cases have become widespread in the community, however, staff have been at increased risk of picking up the virus at home and then spreading it to patients and colleagues.

So how effective are surgical masks? A study published in *Nature* last month shows that, if worn properly and with the right fit, surgical masks are effective at blocking ninety-nine per cent of the respiratory droplets expelled by people with coronaviruses or influenza viruses. The material of a double-layered cotton mask—the kind many people have been making at home—can block droplet emissions as well. And the SARS-CoV-2 virus does not last long on cloth; viral counts drop ninety-nine per cent in three hours. Cloth masks aren't as breathable as surgical masks, though, and that's

important.

Surgical masks are made of a melt-blown polypropylene fibre fabric, which, under magnification, looks like cotton candy. Most of the filtration this material provides isn't from direct blockage but from an electrostatic charge applied to the fibre using a machine called, aptly enough, a corona charger. The static electricity captures viral particles the same way that a blanket in the dryer catches socks. This allows the material to breathe more freely. Cloth masks feel warm and smothering by comparison, and people tend to loosen them, wear them below their noses, or take them off more frequently. The fit of improvised masks is also more variable and typically much worse. A comparison study found that surgical masks did three times better than homemade masks at blocking outward transmission of respiratory viruses.

Don't ditch your T-shirt mask, though. A recent, extensive review of the research from an international consortium of scientists suggests that if at least sixty per cent of the population wore masks that were just sixty-per-cent effective in blocking viral transmission—which a well-fitting, two-layer cotton mask is—the epidemic could be stopped. The more effective the mask, the bigger the impact.

Cloth and surgical masks do not fit tightly. You can breathe air coming in around the sides. They are designed to safeguard others, not the wearer. The basic logic is: I protect you; you protect me. Benefit to the wearer may be limited, but it's likely not insignificant: laboratory research has found that surgical masks reduce inhalation of respiratory-droplet-size particles by about three-quarters. Two-layer cotton masks filter about half as much, on average, though a good fit can improve that considerably. Masks also prevent wearers from touching their noses and mouths. In a study of the SARS epidemic in Hong Kong, people who wore masks in public frequently were half as likely to become infected by the SARS coronavirus as those who didn't.

There are masks specifically designed not only to protect others but also protect the wearer from infection: N95 respirators. These are masks that are designed to fit tightly around the nose and mouth, so that the air you breathe comes entirely through the mask, not around it. They use a filter material with a higher electrostatic charge that blocks at least ninety-five per cent of airborne particles

as small as 0.3 microns. I protect you and I protect me. If we had an unlimited supply of N95s, all

health-care workers would wear them—indeed, lots of people would. But supplies are scarce even in

hospitals, so we reserve N95s for respiratory therapists, intensive-care staff on COVID-19 units, and other clinicians whose work exposes them to high levels of airborne SARS-CoV-2.

Even N95s aren't foolproof. The seal around the face is often imperfect. Your eyes remain a portal of entry for SARS-CoV-2, too. And breathing through an N95 all day is uncomfortable. Talking and being heard while wearing one is a challenge. So people usually prefer to use them for limited periods of time. There's a more comfortable but more sinister N95—the N95 with a valve. The valve makes exhalation easier by getting rid of outward filtration: I protect me; I expose you. These masks are designed for people working in industrial settings where the protection is against dust or asbestos, not viruses. Some cities have, rightly, banned the use of those masks during the pandemic.

Evidence of the benefits of mandatory masks is now overwhelming. Our hospital system would not be able to stop viral spread without them. But will supplies keep up? Factories are increasing production of both surgical masks and N95s as rapidly as possible, but they don't come close to meeting health-care workers' needs, let alone supplying the general public, and they won't for months to come. It should therefore be no surprise that foreign factories have prioritized meeting their own countries' needs, often under government edict, and the world is fighting over what's left.

In order to stretch our supplies, our hospital now limits workers to just a mask a day. We've also found ways to decontaminate masks for reuse. That hasn't been easy: if a disinfectant gets a mask wet, the electrostatic charge is lost. A major breakthrough was the development of a hydrogen-peroxide decontamination system by Battelle, a nonprofit research institute in Columbus, Ohio. Battelle's machine creates hydrogen-peroxide vapor that, testing shows, maintains mask filtration, potentially for up to twenty cycles. The costs run to more than three dollars a mask—too much for regular surgical masks, but acceptable for N95s. And the system can decontaminate eighty thousand N95s a day, enough for high-risk health-care workers in hospitals across our entire region. The cleaning system consists of six air-tight twenty-foot shipping containers. One of them now sits in a parking lot in a Boston suburb.

Domestic production of masks in the U.S. has been delayed by inadequate federal support and

coördination, but it is nonetheless ramping up. For instance, Joanna Newton, a pediatric hematologist and oncologist, spearheaded a collaboration among a group of institutions—including ExxonMobil, NASA, and Georgia Tech’s Global Center for Medical Innovation—to reduce the bottlenecks in the supply chain and create reusable N95 masks. She explained to me that although American production of medical masks has largely shifted abroad, the melt-blown-fibre fabric is produced domestically for lots of other things: diapers, air-conditioning filters, disinfectant wipes, vacuum-cleaner bags, acoustic insulation in automobiles. Her coalition has persuaded several idled manufacturers to help churn out mask fabric. That has required costly investments in retooling and training, but they’re now producing enough material for a hundred and twenty million face masks per month.

My hospital system’s four-part combination strategy has been in place for a month and a half, and we have increasingly strong evidence that it works. Michael Klompas, my hospital’s leader for infection prevention, tracks all new COVID-19 diagnoses among admitted patients. (We’ve averaged more than a thousand suspected and confirmed COVID-19 patients a day for most of the past month.) The patients he worries about most are those who are diagnosed more than four days after admission for unrelated complaints, and who haven’t had any cases in their households, suggesting that they could have been infected *in* the hospital. “I can count those patients on one hand,” he said. Every health-care worker who gets infected is extensively interviewed. Many have an unknown source. But when there is an identified source, it is overwhelmingly in the community, usually the family, he said. “We certainly have a subset of cases that we can attribute to a patient or a co-worker. Those cases are diminishing.”

In tracking our health-care workers who have tested positive, Klompas has looked for correlations with high-risk hospital assignments, and he’s found none. What seems to matter isn’t where you work in the hospital—say, in the COVID-19 unit—but where you live. Workers who test positive are more likely to have a home Zip Code in known hot spots—such as Chelsea, a town across the river from Boston, where intergenerational housing is common and where random testing has found a thirty-per-cent infection rate.

The four pillars of our strategy—hygiene, distancing, screening, and masks—will not return us to normal life, but, when signs indicate that the virus is under control, they could get people out of their homes and moving again. As I think about how my workplace’s regimen could be transferred to life

outside the hospital, however, I have come to realize that there is a fifth element to success: culture. It's one thing to know what we should be doing; it's another to do it, rigorously and thoroughly.

My eighty-three-year-old mother lives in a senior-living community called Lasell Village, not far from my home. It has two hundred and fifty residents, nearly two hundred staff members, and three levels of care, from independent living to twenty-four-hour skilled nursing. Initially, the leadership implemented three of the four measures of the plan used at my hospital: hygiene, distancing, and screening. They put up hand-sanitizer dispensers and secured enough disinfectant to wipe down every door handle and high-touch surface multiple times per day. They banned family visitors (like me) and asked residents to stay in their apartments or in outdoor walking spaces. The dining room was closed, and meals were delivered to residents' doors. Temperature and symptom checks were instituted at the entrance for all, which resulted in many personnel going into self-quarantine.

But it was not enough. An outbreak occurred in a housing unit for disabled residents. Four of the eight residents there became infected, possibly by a staff member who subsequently tested positive for COVID-19. All four died. The week that my health system mandated masks, Lasell Village began requiring its staff to wear them, too, although because of a shortage of surgical masks, most employees got only one per week, plus a backup cloth mask. A few days later, residents and local nonprofits had sewed enough cloth masks to distribute one to every resident as well.

"I wake up every night worrying," Anne Doyle, the president of Lasell Village, told me. "The tiniest little decisions have consequences"—such as how to triage the dwindling supply of hand sanitizer. But the worry that keeps Doyle up most nights isn't logistics, she told me, though they are an unending struggle. It's culture—how people live and work together every day.

In hospitals, we have had to learn how to bring the stringent antiseptic standards of the operating room into the professional culture of other parts of our institutions. This requires absorbing the detailed practices that keep us from transmitting germs in a given setting—like the rule at the operating table that, once you're scrubbed in, you never let your hands fall below your waist. Even more, this requires developing norms about how to address lapses in rules, so you can comfortably call one another out when you see a standard slipping and still enjoy working together. This isn't simple; I've seen surgical colleagues in the hallway pop their masks down below their noses to talk, which

They never would have done across an operating table, but I am hesitant to call out the language.

Culture is the fifth, and arguably the most difficult, pillar of a new combination therapy to stop the coronavirus. People tend to focus on two desires: safety and freedom; keep me safe and leave me alone. What Doyle says she needs her people—both staff and residents—to embrace is the desire to keep others safe, not just themselves. She needs them to say, “I’m worried about my sore throat, and I am going to stay home.” Or “I am O.K. with being reminded to pull my mask up.” That is the culture of the operating room. It’s about wanting, among other things, never to be the one to make someone else sick.

At Lasell Village, Doyle is doing what she can to create cultural change under pressure. She has made sure that all her staff has enough paid sick time. “Most people have a ton of sick days. For those who don’t, we make it clear that we’ll top up whatever they have in order for them to adhere to precautions around the coronavirus,” she said. She’s worked to foster an atmosphere in which everyone will take a runny nose seriously. Residents, however, often have outside aides. When it became clear to Doyle that these aides weren’t necessarily getting adequate support, she had her team track them down, and made sure they had masks and training. In March, feeling flu-like symptoms, Doyle set an example by putting herself into self-quarantine. Her symptoms worsened, and it was a full three weeks until she was able to be tested and to return to work.

Every day, there’s a new problem to solve, and she asks employees and residents alike to figure out how to rise to the challenge. “When you have a community that cares about each other, then people are interested in adhering [to the guidelines] for other people,” Doyle told me. All the effort appears to be making a difference. The frequency of cases among residents fell substantially after the initial outbreak. Lasell Village went from five cases per week down to two and then one.

The combination therapy isn’t easy. It requires an attention to detail that simply staying in lockdown does not. But, during the crisis, people everywhere have shown an astonishing capacity to learn from others’ successes and failures and to rapidly change in response. There is still much more to learn, such as whether we can safely work at less than six feet apart if everyone has masks on (the way nurses and patients do with one another) and for how long. But answers will come only through commitment to abiding by new norms and measuring results, not through wishful thinking.

As political leaders push to reopen businesses and schools, they are beginning to talk about the tools that have kept health-care workers safe. The science says that these tools can work. But it's worrying

how little officials are discussing what it takes to deliver them as a whole package and monitor their effectiveness. On April 24th, as the first states began relaxing restrictions, the *Times* ran a picture of a barber in a suburb of Tulsa, Oklahoma, mask askew, nose poking out, clipping the hair of an unmasked customer. The week before, the county had experienced ninety-one new coronavirus cases and five deaths, an increase from the prior week. The government had no formal plan for surveillance testing to look for early signs of failure. Many leaders didn't even seem interested. President Trump has sought to compel meatpacking plants to stay open, even though thousands of workers have been infected by COVID-19. He has encouraged protesters to flout public-health guidelines, and seems to consider it embarrassing to set the example of wearing a mask—even as the virus became the country's top cause of weekly deaths in mid-April and then penetrated the White House. This is about as far as you can get from instilling the culture of the operating room.

Still, regardless of what model politicians set, more and more people are figuring out how to do what has worked in health care, embracing new norms just as we accepted social distancing. We see proof of a changing culture every time we step out and find a neighbor in a mask. Or when we spend time to make our own fit better. Or when we're asked whether we have any concerning symptoms today. Or when we check to see whether the number of COVID-19 cases in our community has dropped low enough to warrant reentry. If we stick to our combination of precautions—while remaining alert to their limitations—it will.

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Atul Gawande, a surgeon and public-health researcher, became a staff writer at The New Yorker in 1998.

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