



**Sandia
National
Laboratories**

Doing Pandemic R&D as if There's No Mañana

Charting a course to zig and zag our way out of the pandemonium we're in

Vipin P. Gupta, Kenneth R. Miller

April 23, 2020

AUTHORS AND DISCLAIMERS

Vipin P. Gupta (aka VPG-8824) is a Distinguished Member of Technical Staff and part of two nascent anti-viral cells at Sandia National Laboratories in Albuquerque, NM. To his sheltered-in-place, 80-year-old tiger mother's delight, he's finally putting his Applied Physics Doctorate from Imperial College London to use on something that's a bit closer to being a physician.

Kenneth R. Miller (1939-2019) was an artist in Sandia's Advanced Concepts Group. He (aka KRM-16000) was (and still is) a quiet listener who expressed futuristic ideas in the form of drawn pictures. His 82-year-old wife is sheltered-in-place in Albuquerque, NM, where their two daughters call her every day.



Issued by Sandia National Laboratories, operated for the United States Department of Energy by National Technology & Engineering Solutions of Sandia, LLC.

NOTICE: This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government, nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, make any warranty, express or implied, or assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represent that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government, any agency thereof, or any of their contractors or subcontractors. The views and opinions expressed herein do not necessarily state or reflect those of the United States Government, any agency thereof, or any of their contractors.

“Everything that kills me makes me feel alive”
One Republic, “Counting Stars”

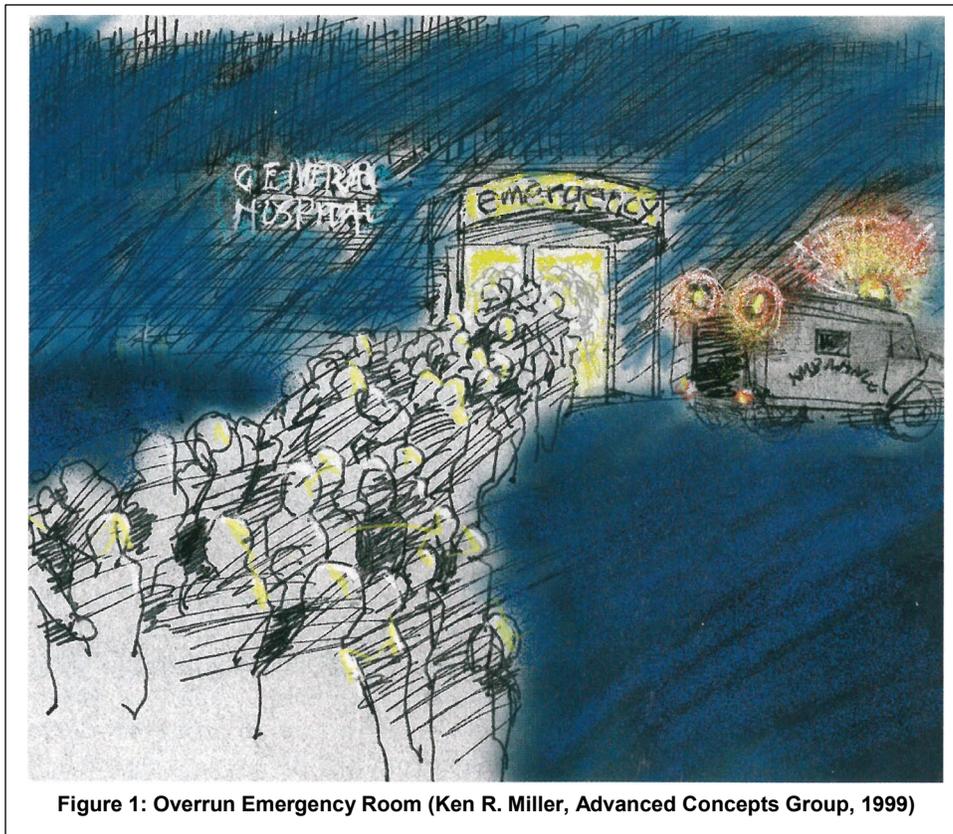


Figure 1: Overrun Emergency Room (Ken R. Miller, Advanced Concepts Group, 1999)

Since the beginnings of Sandia National Laboratories, Sandians have made the unthinkable not only thinkable, but also plannable and doable. Over time, we've tempered ourselves, studying and devising ways to deter, defend against, and blunt threats of mass death, destruction, and disruption. Now we, and all within our social circles, are living one of the nightmares that only a small fraction of our fellow Sandians have pondered, tackled, and anticipated—a virus that bypasses militaries, zips through borders, hitches to domestic travelers and commuters, makes its hosts unknowing dangers to others, overwhelms hospitals and clinics (see Figure 1), hobbles governments, and takes away the lives and livelihoods of compromised and marginalized people everywhere.

Taken by surprise, Sandians have dispersed and re-congregated into three interconnected camps. Those who determinedly and defiantly carry on with the work they've been doing since before the pandemic hit. Those who are doggedly mustering and redirecting their abilities, experience, education, and energies to get us to the other side of this crisis (without ending up on the Other Side in the process). And those who are in fight-or-flight mode because this virus is pushing them to their personal limits, directly threatening them and/or the lives, jobs, and businesses that matter to them.

From these three camps (which some of us migrate between on a daily, hourly, or even minute-by-minute basis), we make our individual and collective attempts to hold it together, do our work, and live another day. While there is much about this that is beyond our control, we are anything but helpless. Each of us has specialized powers and influence that can be brought to bear on the big and small parts of this gnarly problem. It all starts with a personal and collective understanding of the situation we're in.

Setting aside—but *definitely* not forgetting—what sparked this crisis in the first place, the country and world are in a fast moving pandemic with much pandemonium because of seven core problems:

1. **People don't know what to do to protect themselves and those within their social circle.** Individuals don't know how much, how often, and what they can wear (masks? gloves?), eat (garlic? pho?), suck (zinc lozenges? Vitamin C?), swish (antiseptic mouthwash?), gargle (salt water?), rinse (neti pot?), swallow (antimalarial pills? anti-viral pills?), inject (plasma? vaccines?), breathe (yoga? pure oxygen?), and/or do (tongue cleaning? voice resting?) to ward off this coronavirus and thwart it from becoming a severe-to-life-threatening respiratory infection.
2. **People and organizations don't know how to avoid touching or inhaling a phantom menace that they cannot see.** Individuals and organizations can't see the microscopic coronavirus that are alive and infectious, floating in a droplet, clinging to a cheek, attaching to a hand, sitting on a tabletop, resting on a doorknob, or sticking to an elevator button.
3. **Because contagious individuals can spread this virus without even knowing it, people and organizations assume that there are dangerous people all around.** Individuals and organizations lack the ability to determine quickly, conveniently, and reliably who within their physical contact circles are unknowingly spreading the coronavirus to others.
4. **People with early symptoms are petrified because they don't know what kind of illness they have.** Individuals with mild cold or flu-like symptoms don't have the ability to quickly, conveniently, and reliably determine if they have actually been infected with this coronavirus.¹
5. **Medical practitioners don't have a straightforward cure for severe-to-critical COVID-19 patients.** Doctors, nurses, and caregivers don't have a quick and effective treatment regimen (with no harmful side effects) that doesn't require multiple days or weeks in a hospital bed or Intensive Care Unit.
6. **Quarantined people with COVID-19 don't know exactly when they can leave and interact with others again.** Individuals and organizations don't have the ability to determine when those who are recovering from mild-to-severe COVID-19 stop being contagious.
7. **Individuals and organizations don't know who is immune to COVID-19.** Individuals and organizations lack the ability to determine quickly, conveniently, and reliably who within their physical contact circle has antibodies to the coronavirus strain(s) that cause COVID-19 and what kind of protection those antibodies provide against future infection (see Figure 2).

¹ The various test kits that are being used all over the world are not as simple, as reliable, and as understandable as other types of test kits (e.g., pregnancy test kits) that can be bought online or at a drug store.

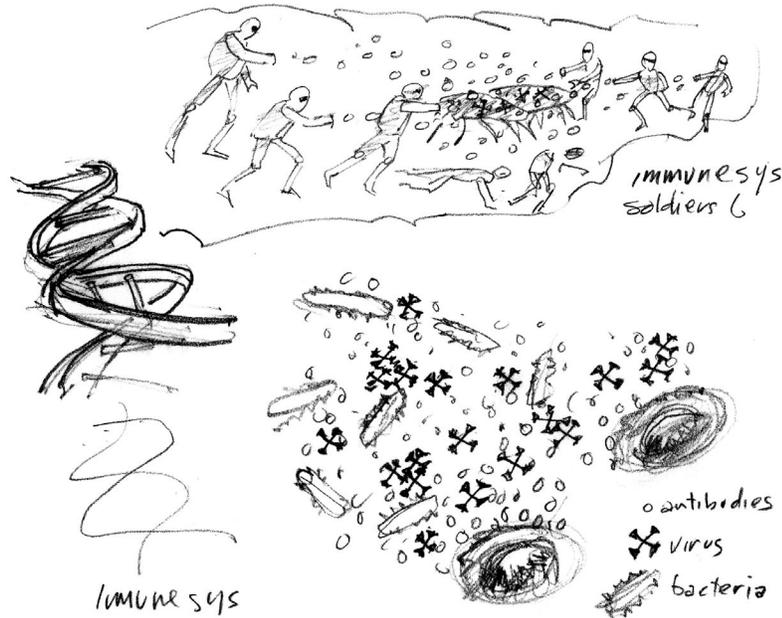


Figure 2: Concept sketch of the Immune becoming visibly known, counted on pandemic dashboards, mobilized to protect the vulnerable, and organized to jumpstart all of society's shutdown organizations. (Ken R. Miller, Advanced Concepts Group, circa 2000).

Because we don't have practical solutions for these seven core problems, we've had to rely on basic and desperate measures that all of us have become too familiar with: frequent handwashing, social distancing, cancellation of mass gatherings, air travel restrictions, sheltering-in-place, and business closures. In effect, governments have put local and global economies into a medically induced coma in order to extinguish this out-of-place virus. It's a very risky proposition that has compelled many to ask, beg, plead, and even pray for better ways to cure ourselves of that which is afflicting us.

We can postulate that some people somewhere in the world are going to solve all seven of these core pandemic problems. Five of these problems (#2-4, #6-7) fall in the arena of diagnostics,² testing, and tracking, one (#1) fits under personal and home care (where the beds are), and remarkably one and only one (#5) needs to be solved exclusively by medical practitioners.

That the bulk of this emergency is technical and organizational rather than medical ought to make this finite problem list less daunting than what most prognosticators initially expressed. Even better, this list is one less than it was around Y2K because twelve Sandians ("The Decon Dozen") spent the last two decades inventing, perfecting, and commercializing a figurative and literal solution to what used to be the eighth core problem with pandemics—the inability to decontaminate a physical area *and* know with verifiable confidence that contagious pathogens are not present.³ Consequently, since before the beginnings of this outbreak, individuals and organizations worldwide have been purchasing this decontaminant en masse from several commercial suppliers and using Sandia's non-

² It is too bad and so sad that Theranos ended up as a fiasco rather than an ahead-of-its-time savior for the epic that we're now in. The biomedical engineers and technicians who were part of that spectacular setback have the world stage set for their comeback, breakthrough, and redemption.

³ Bieker et al., "Rapid Inactivation of SARS-like Coronaviruses," Sandia National Laboratories, SAND 2004-1120. <https://prod-ng.sandia.gov/techlib-noauth/access-control.cgi/2004/041120.pdf>

toxic, non-corrosive chemistry to kill and wipe away all trace of this new virus in hospital rooms, on ships, in subway cars, in offices and factories, and in emergency vehicles.

With the chance to make as significant a contribution again, we are starting to see the formation, multiplication, and spread of anti-viral cells inside our lab campus as well as throughout Sandia's national network of facilities. Some of the evidence that this is happening includes:

- The posting activity on the COVID-19 wiki where rookie, veteran, and non-technical Sandians are cross-fertilizing and actively exchanging good, bad, and ugly ideas without fear of embarrassment or ostracism.
- The COVID-19 Laboratory Directed Research and Development (LDRD) Call set up by our CRO (aka SJS-1000) which has funded 20 projects within the first twenty days of the proposal call.
- The special leadership assignment of our Chem-Bio Director (aka AKS-8000) by our Lab Director (aka LD-1) regarding Sandia's activities related to the COVID-19 Pandemic.
- The identification, classification, and future recruitment of ~300 active and retired Sandians with proven track records of invention *and* technology adoption outside Sandia.
- The brainstorming throughout the Labs on how advanced manufacturing and rapid prototyping could be used to produce autonomous, non-invasive ventilators, sunlight could be used to disinfect facemasks, robots could be used to reduce viral exposure and social isolation, and materials that could be made to put anti-viral protective coatings on doorknobs, gloves, and countertops.
- The consideration of easier, faster, and more effective ways to fund, group, track, and do applied R&D.
- The continuation of crucial Sandia national security work (e.g., cybersecurity, weapons systems, supply chain integrity), protecting our R&D flanks as more are affected by and take on the pandemic.
- And finally, the resurrection of ideas and timeless wisdom in lab and personal archives from deceased Sandians, the fastest growing demographic group of Sandians before this pandemic even started.

From all of these Sandia groups and activities, there are frustrated heroes waiting to be discovered.⁴ Let's learn all we can from this errant virus, find these novel people wherever they are in our lab, country, or world, and help them make their silver bullet and duct tape solutions go anti-viral. In the end, that may be the only way we're going to dispel our mass fears, rebuild our upended lives, and reflect on exactly what we were so worried about before this crisis began.⁵

⁴ These words come directly from Jamshid Gharajedaghi's book, *Systems Thinking: Managing Chaos and Complexity* (1999), p. 283. Reportedly 80 years old and sheltering-in-place in Berkeley, CA, this brilliant Iranian-American came to Sandia twenty years ago and taught us how to overcome crises like the one we're in.

⁵ We also need to reflect on the to-be-determined (some disappeared and some dead) someones in now infamous locales within the Sinic Republic who sampled, captured, handled, and/or killed the animal hosts of SARS-CoV-2, colliding and splattering it all over the human race.