23 March 2020

To: Ravalli County Board of Commissioners
From: James R. Olsen

Subject: Responding to COVID-19 (SARS-CoV-2) in Ravalli County

Dear Commissioners,

I have been reading and looking at articles and literature for a bit over a week and wish to share what I have found. Some of this you may know, some will need correction.

The thrust of this input is to suggest an aggressive, proactive response that get Ravalli County ahead of the curve.

We now some history in this evolving problem to suggest countries that were quick, aggressive, and proactive have had the best outcomes. We are unfortunate in one way – the United States has been slow to act in compared with nations with the best outcome — and fortunate in another way in that we can see how various countries reacted and adopt the strategies that worked out the best.

Goals.

— Zero Fatalities.
and
— Mitigate impact on income-producing economic activity.

- **The Data Problem.** The nature of any infectious disease passing through a population with the reproduction rate of COVID-19 is an exponential curve due to a "doubling effect" initially. As larger numbers of people are exposed leaving fewer people to become new patients a peak is reached. That is the reality. This reality is hidden from us for a time since we don't see it until we 1) see people get symptoms, 2) we test for it.

  A response program can intervene. When it does, the doubling effect is can slowed in time which becomes what is known as flattening the curve and can mitigate the effect. And, ideally, an intervention program can stop people from being infected at all – which may or may not be practical.

  Perception is a delayed reflection of reality – this is inherent in the problem. What is reported in the news is what is perceived — and what people to respond to and act on. But what we are seeing is old information.

  A single test from a community-acquired COVID-19 is reported as positive; 86% of cases have mild or no symptoms, the incubation time is 1 to 14 days – an average of a week, the average time to pass it forward is 4 days. You see this one case, but it is likely that 50 to 300 other people have been exposed to the virus.

Perception is an imperfect reflection of reality — this is inherent in how you measure. Not everyone is tested; test can have faulty results. To make matters worse, the information on COVID-19 cases has been driven by the availability of test kits and the rules deciding to test a person. In Montana the first positive tests were reported a week after test kits were available — suggesting the timing had a much to do with the availability of test kits than its presence.

Later we will talk about how countries have reduced this delay and responded to inaccuracies – but in decision making it is important to keep the delay and inherent inaccuracies in mind. The other thing is the once you see a doubling trend you can expect it to continue. There will be the same delay in see the effect of any intervention program.

Reacting only to Perception can be dangerous. The so-called social distancing being practiced – really Limiting Interactions Outside your immediate Network (call it LION) slows things down. As seen in Italy, every week counts when confronting a disease that has a reproductive rate estimated as 2.

Errors in the information are inherent in the problem. It is easy to measure deaths; it is currently impossible to measure how many people actual have COVID-19 since a very large number have mild or no symptoms and do not get tested. In other words when we first saw fatality rates we were seeing an accurate number divided by a guess, which equals a guess.

Many of the percentages we see are hospitalizations, ICU, Respirator cases, and fatalities as a percent of people tested. This information is in error for two main reasons:

1) the people not tested are not included and
2) the criteria for testing a patient varies all over the place.

So, when we see the estimate of fatality going down over time from 3% plus to around 1% or lower, it is not because anything changed; it is because the estimate of untested populations is being included or more people were tested. In fact, the fatality rate may be the same as common flu in a population (0.1%)– of a factor of ten higher (1%).

To make matters more uncertain, the detection of the disease which waits for severe symptoms add a further time delay. Thus, the reality at this point is worse than the perception – how much worse – it depends.[1]

These numbers have, by necessity, a lot of uncertainty – the largest being not knowing how many people actually have the disease to the extent of reinfecting others. *But, that does not relieve us of making a best estimate of the numbers and how they will progress over time.*

What counts for managing the upcoming crises is the percentage of population. That means making assessments by weighing the percentages versus tested confirmed cases and looking at percentages versus population for countries using various strategies to control the disease.

[1] [Zuang, S, et. al. **"**Estimation of the reproductive number WHO, "Novel Coronavirus…"]

- **The Cluster Effect.** There is a trend when comparing different sets of data: the virus propagates much more readily in "closed" social interactions — the cruise ship, Diamond Princess, provided an isolated population of a demographic that was primarily elderly (but also fit enough for a cruise). The Ro reproduction number was 2.28 (how many people an infected person passes it on to) and the fatality rate was 1.0%. Everyone was exposed. Extrapolating this to the U.S. population, the death rate may well be lower because a age differences.[2]

  This is borne out by countries that tracked cases closely and mapped their relationships. In a graph of cases in Singapore a good number of cases were clustered among social groups. We know this because Singapore carefully tracked every case.[3]

  In practice the response has assumed this effect. The following MIGHT be true:
  - The virus is transmitted faster and more readily among clustered social groups – increasing the likelihood that someone with mild or no symptoms will pass it on within the group because of frequent contact. These groups include institutional living (from nursing home to prisons) and family groups. And, large groups that intermingle for hours.
  - The virus is transmitted more slowly between groups because of casual contact – with people with mild or no symptoms much less likely to pass it on.

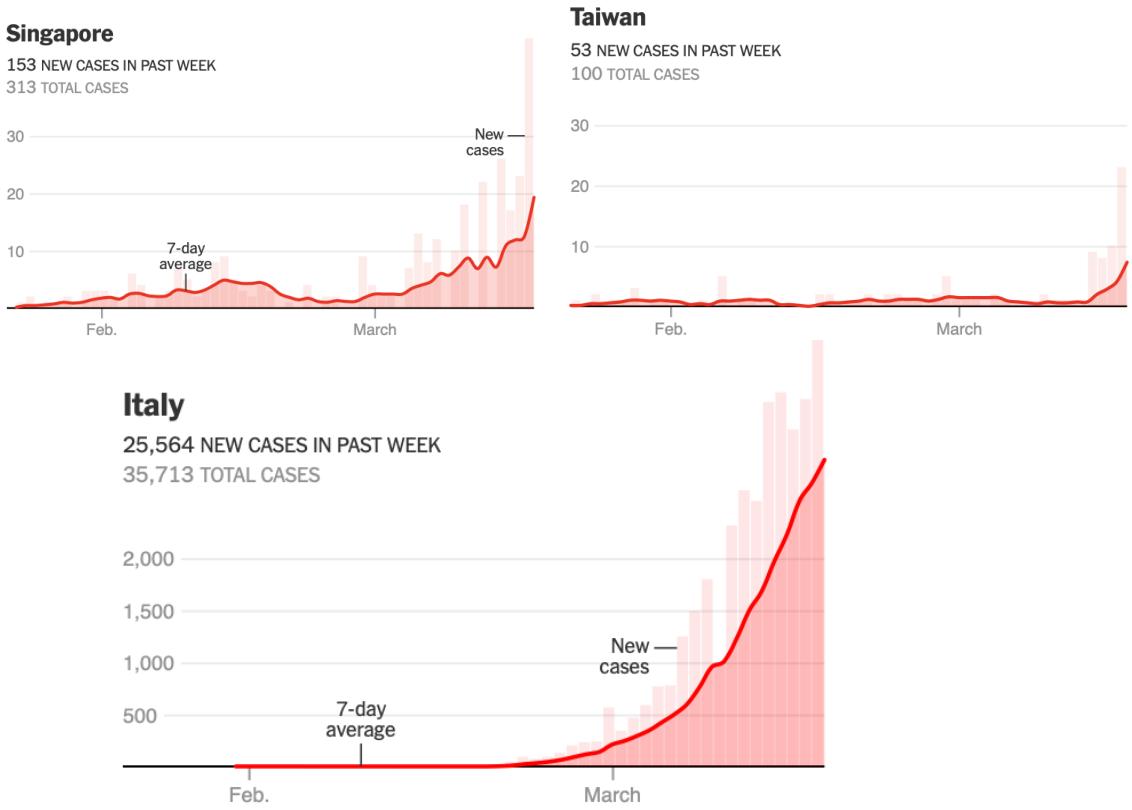
- ***Recommendation.*** **Provide quick, aggressive urgent care at the first sign of breathing difficulty and other new symptoms.** Many fatalities came on quick — from first symptom to death in a week.[4] This is the most critical need – to get critical cases in care within 24 hours:
  - Sufficient respirators, ICU beds, health care workers, and health care worker safety equipment (more in this later).
  - 24/7 Urgent care and triage located at key points along the valley (Darby, Hamilton, Stevi, Florence and maybe Corvallis and Victor.
  - The cautionary advice would be, *don't wait, go to Urgent Care* if you have 1) any new instance of breathing difficulty even if you don't have a fever, and 2) you have a fever. There is new information that suggest early symptoms may include digestion issues and loss of smell and taste.[5]

- **Population Strategy.**

  There appear to be two basic approaches that have been used by other countries:
  1) Total Lock Down/everyone shelter in place;
  2) Restrict business activity to reduce person-to-person social interaction - combined with other tactics.

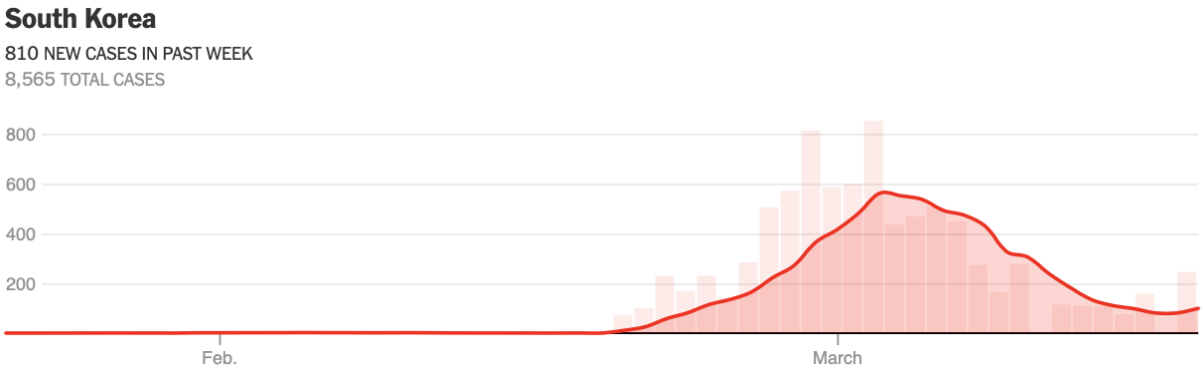
[2] [Zuang. "Estimation of the reproductive number…"; Ioannidis "A fiasco in the making?..."]
[3] [Channel News Asia, "Covid 19 Clusters…"]
[4] While the incubation time is 3 to 14 days and the disease can linger for weeks. [Lee, "How Does The COVID-19 Coronavirus Kill?"]
[5] [CNN, "Loss of…"]

- *Neither strategy has eliminated the disease to date*. The timing changes, "flatten the curve" but does not appear, so far, to change the eventual outcome. The countries that did the best at quickly shutting down incoming travel and/or quarantining incoming travelers have flattened the curve for a month or two – Singapore and Taiwan. (Graphs are a weekly count of new cases, the red line is a 7-day moving average) — though they now are experiencing an uptick.[6] It will, however, allow the community to get the testing kits and medical logistics in place.[7]



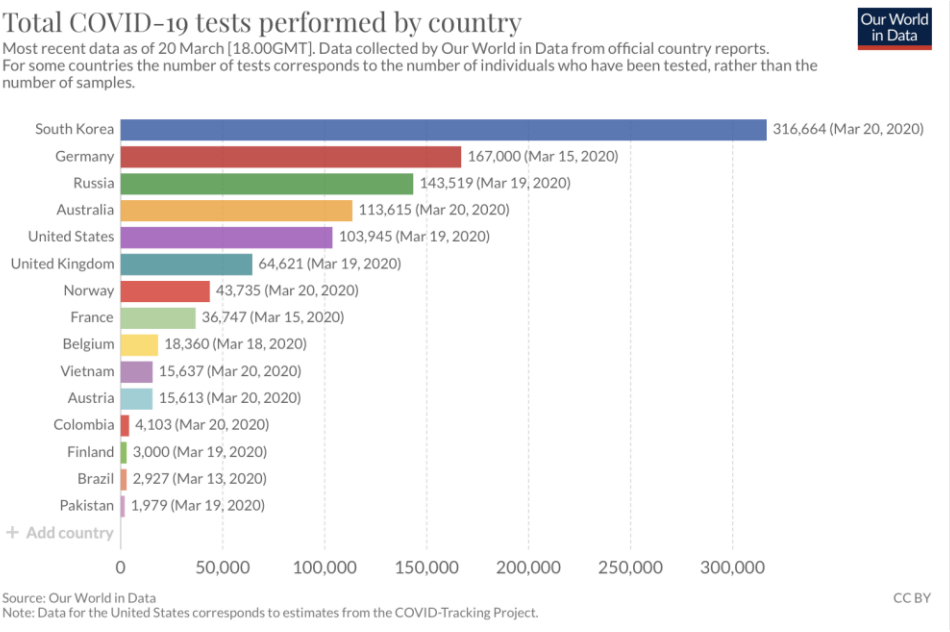
A strategy short of lockdown, combined with widespread testing, and strict quarantine has the best record today, the example being South Korea. Korea is the only country other than China showing they are on the "other side of the curve."[8] Notice though, it may be getting an uptick for a second wave – hopefully less severe than the first wave.

[6] Graphs: [Lia, "Which Country…"].
[7] [Branswell, "Why 'flattening the curve'…; Farraresi, "A coronavirus cautionary tale…"]
[8] Because China went from secrecy to openness and is now involved in international politics, I conclude the data is less reliable than that flowing from South Korea.



The South Korean Model. Empirically, it appears that the South Korean strategy has had the best outcome.

- Close large gatherings.
- No lockdown – depend on extensive public education for social distancing and sanitary behaviors.
- Strict quarantine for people testing positive.
- Extensive testing. Testing everyone entering the country including asymptomatic people. It is important to remember that all reports of COVID-19 cases is under counting the real number; the number of reported cases goes up as a higher percent of the population is tested – so that South Korea's case counts is probably the most accurate in the world.[9]
- Daily and truthful updates to the public.
- A cell phone app in helped people avoid outbreak areas.[10] The idea of using phone geolocation data to help identify hot spots.



[9] [Chart from Ortiz-Opina, Esteban. "How many tests for COVID-19…]. The test kits were made by a private South Korean in his own initiative after seeing what was unfolding in China. South Korean biotech executive Chun Jong-yoon. [Dunden, "South Korea took rapid…"].

[10] [Dujmovic, "Wildly popular coronavirus-tracker app.."]

A lockdown for any period of time is unsustainable – economically – and in my view psychologically and politically. In the not-so-long run, we need to return to economic activity. This should be a goal in the planning process with a specific criteria identified.

***Recommended* for Now.**

- Continue close large gatherings and indoor food and beverage service.
- Consider lifting indoor food and beverage service on a permitting basis – the business presenting their process.

When is the peak? There is a lot of uncertainty in terms of predicting the timeline for cases that will require hospitalization, ICU, and respirators.

The history of other countries that have gone before us indicate the peak is driven by how quickly the society acted to flatten the curve by reducing large gatherings and instilling sanitation and social adaptations. I my view, Ravalli County was already well in that direction before the Governor's order – for the past two or three weeks. We seem to lie somewhere between Korea and Singapore, 30 to 60 days assuming we continue further action.

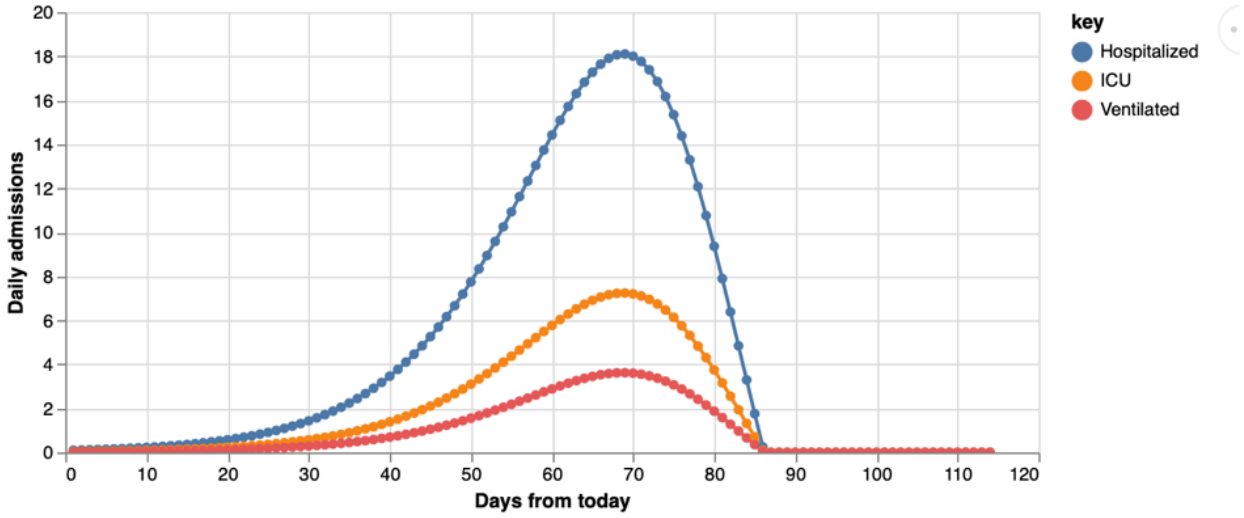
What are the percentages for hospitalizations, ICU, and respirator cases[11] and fatalities? If we focus on gathering and deploying the resources, the percentage in terms of population seems like better metric. There is a very rough model that allows one to plug in our data from the University of Pennsylvania.[12] An input of 35% reduction in social interactions in extends to period out to 70 days — remembering that his model is VERY rough and the reality will be different. But, it can set goals for the logistics — number of beds, providers, safety gear, ventilators.

[11] Estimates for fatalities has been steadily going down over time – not because of fatality numbers, but because of the uncertainty of the denominator – the number of cases. The estimates today range from on par with the flu to ten times that, 1%. [Baud, "Real estimates of mortality…"; Ioannidis, "A fiasco in the making? … making decisions without reliable data."; Rio, "New insights…"]

[12] [Predictive Healthcare Team, "Penn Medicine…"; Begley,. "Coronavirus model…"]

New Admissions

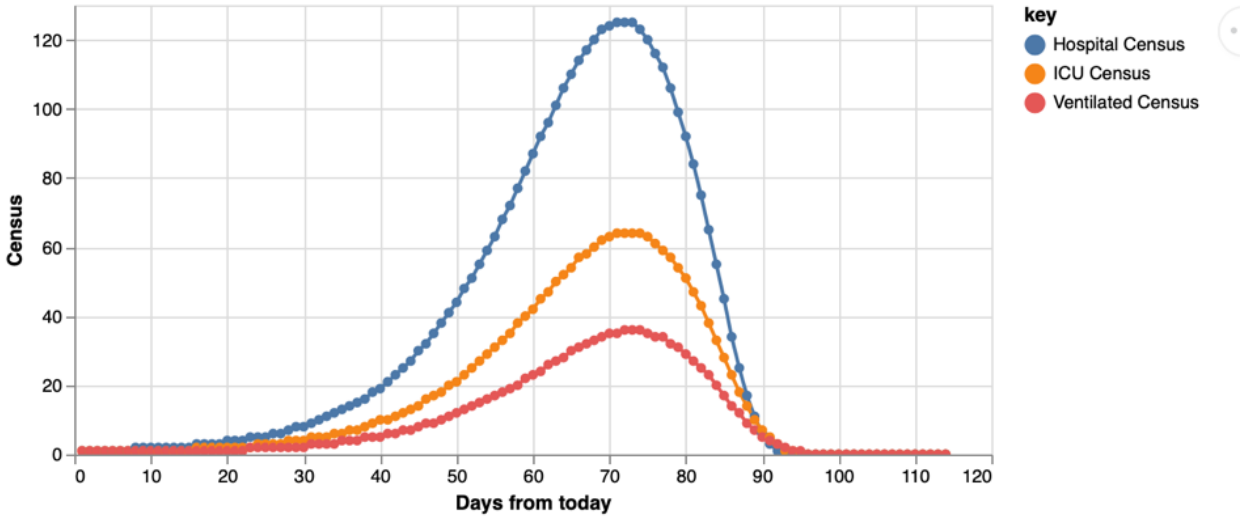
Projected number of **daily** COVID-19 admissions at Penn hospitals



Show Projected Admissions in tabular form

Admitted Patients (Census)

Projected **census** of COVID-19 patients, accounting for arrivals and discharges at Penn hospitals



Test Kits. There three kinds:

1) The virus RNA test that has been used test whether you *have it now*. This appears to use a "reagent" method – that is add a chemical to see if the desired result occurs. There have been reports for false-negatives; accuracy of the test seems uncertain. However, and this is important, countries that have used these tests extensively have had better outcomes.

- There are Antibody Tests now coming out. This indicates if you *have had it* by test the bodies response instead of for the virus itself.[13] This test has the potential in vastly improve the uncertainty of the number of people who actually get the virus – and make the percentages for hospitalization, ICU, respirator, and fatalities much more accurate. This combined with RNA testing would make management much easier and more targeted.
- Mass-Spectrum Testing. The basic idea is to bombard the sample with electrons to make them charge ions, then measure those. Each molecular compound has a unique "spectral pattern." So, if the virus has a unique protein, finding its signature will be a positive. There a several labs working on this[14] including one in Ravalli County, BVA inc.

  The FDA is speeding approval. Assuming that can happen, a way to get the BCA inc. into operation:

  a) Design a simple test. Collect samples from people (say 10) who are known to have the disease. Split the sample in two. One set is submitted blind-marked for the Spectrometer test. Collect samples from people (say 30) who have no symptoms and have no known contact with infected people. Split those in two. If the any asymptomatic tests show a positive or positive sample show for a negative - in the spectrometer test, send in their other sample for a standard test.
  b) Need a space to move the equipment in a suitable lab. This would need to be pressed hard – Ravalli County, Missoula, or Salmon would be close enough – maybe even further for the test with a known COVID-19 sample.
  c) As to making it a business and funding, two phases:
     a. *Proof of Concept* – that could be funded by the county or by an investor (to be amortized over the test fees).
     b. *Deployment and Operation*. In Operation it would be paid for with fees – provided by health insurers or the "all tests will be free" funds. This means a partnership with an institution that can collect the fees, paying the Testing Company from those funds – e.g. Marcus Daley.

     RCEDA could be recruited to help with the business end.

Getting What We Need - People, space, equipment, and supplies. If two milestones are put on the calendar, the specific task of getting can help in understanding what needs to be done to get them. What may be a mistake, is to assume the state or federal government will provide them, without a specific, solid commitments because every other county will be in the same boat at the

[13] [Bichell, "Who Has COVID-19? One Colorado County Is Offering Blood Tests To All Its Residents To Find Out."]
[14] [Paschall, "UVA researchers may have found faster way to detect COVID-19."]

same time. We can depend on them to a degree, but, if we are to go the extra distance to save the last life, the county should take charge of identifying and, if necessary, procuring what is needed.

- In general
    - Test kits (both RNA and Antibody kits)
    - Beds – the facility, the furnishings, the supplies, the human needs, comfort, and food.
    - ICU setups
    - Ventilator setups.
    - Staff
    - Staff safety gear.
    - 24/7 Urgent care facilities throughout the valley.
    - Test stations throughout the valley.

- Milestone examples
    - MARCH 30: 500 test kits.
    - APRIL 20: 5,000 test kits.
        - Convenient test stations in place..
        - 50 hospital beds, 20 ICU stations, 15 respirators.
    - MAY 1: 100 hospital beds, 60 ICU stations, 40 respirators.
    - MAY 15: 150 hospital beds, 80 ICU Stations, 60 respirators.

This is just an example, but it would be good to set numbers. The key is that if any of these exceed what we can be assured will be supplied from on high, we become motivated to be creative and look elsewhere – because that is the likely scenario.

To increase the effectives of experts, *manage the pyramid*. Leverage experts with assistants who do anything not requiring expertise. Train-up non-experts to do things such as triage and paperwork.

> ***Recommendation.*** Survey what we have and list what we need – do it quickly – not waiting for accuracy to the nth degree. Set milestones for getting them in place. Then organize work groups for each kind of item on the list and put them to work simultaneously – pushing them note any barriers – such as a process, rule, or even regulation that figure out how to get what they need if it could be waived. Give a near terms date for a plan the gets the job done.
>
> I suspect there is not enough staff in the county to do all of this simultaneously – that needs to be addressed with part time staff and volunteers who are up for the job.

Get Healthy. There are a number of things that the population can do to improve and preserve their immune system. While there are numerous alternative health ideas out there in addition to allopathic medicine there is an intersection where they meet – both the NIH and Naturopath agree. Supplements are recognized by the NIH are: Vitamin C, Selenium, Vitamin E, Zinc, avoiding B-6 and folic acid deficiency, D-3 (esp. respiratory disease).[15]

[15] {Yamshchikov, "Vitamin D…"; Beck, "Selenium and vitimine E…"]

Also, specific Chinese medicines have been used on COVID-19 patients with good effect.[16]

Sleep.

> ***Recommendation.*** Agree on the list. Create a flyer and web page – do repeated press – consider mailing it to every household.

Dynamic and evolving treatments. The world is working on treatments and vaccines. Treatments that are being studied and tested, most are crossovers from treatments of other diseases. They bear watching: Chloroquine, Kaletra (ritonavir plus lopinavir), Interferon, Remdisivir, Favipiravir, Actemra, and Kevzara. There is reasonable chance that with the next month or two, at least one of these will be shown to help in the treatment of COVID-19.

> ***Recommendation.*** As these get close to approval identify sources – and order if necessary.

The Most Vulnerable Need Special Treatment and Care. There is general agreement that institutions, such as nursing homes or any institution or living arrangement where dozens or more people live in close proximity – and the homeless – are likely to pass around the disease so that most are infected in short order.[17] For these:

- Priority and periodic testing, whether or not symptoms are present.
- Protocols to limit social interaction with the general population.

> ***Recommendation.*** Test or sample test these populations weekly. Have each institution present a plan for safe interaction with the community.

Homeless. There is growing evidence that this population is especially vulnerable AND Ravalli County has a significant housing security problem — as opposed to urban areas, in Ravalli County it is almost always involuntary and most people are working or have income, but not enough. The population is spread through camping grounds, informal shelters, and the like.

Several counties have put a moratorium on evictions and Ravalli County should do so as well.

> ***Recommendation.*** Order a halt to evictions. Create a panel to allow landlords to come forth and allow the hold be waived if the tenant is destroying the property or withholding rent they actually have.

Return to Economic Activity. The overall plan should include how to return to normal levels of economic activity – and have COVID-19 still present at some lower level. The most likely experience is waves. We are in the first one – the wave will build, peak, and fade — how big and when depending on our response. Then comes the next, presumably smaller one. As the first wave fades a transition plan to some steady-state response that is built into normal economic activity seems like the right thing to plan for.

[16] {Ren, "Traditional Chinese medicine for COVID-19"]
[17] [Zuang, "Estimate of Diamond Princes cruise ship."]

Public Interactions. The most powerful thing the county could do is to provide daily interactions with the public as to what is being done. Making the details, to a large extent, will replace the combination of malaise and apathy with a sense of motion.

Ideally the county page would be the trusted place that answers the important questions, not just about what the county is doing, but everything.

The Bill of Rights. There has been a tendency for state governments to repeat some variation of what others have done. While the regulation of business activities and the right to quarantine on an individual basis is accepted, the imposition on the First Amendment, as tempting as it might be – to restrict religious services and the right to assemble is protected by the U.S. and State constitutions.

Many organizations have shut down or limited services voluntarily. Curfews have been accepted since it has a limited effect daily on the right to assemble.

But, a government order that infringes on these rights for any but the shortest time is another matter – especially in Ravalli County.

Thoughts on managing in the face of uncertainty. I could see from the meeting on the 23rd that a lot of this seems to be in place. But, I thought it might be helpful to add some of my experiences.

Risk and Opportunity. The DoD defense acquisition world as well as large businesses have a formal process for this – which I would be glad to go over. But, what is important is to keep the general principles in mind — which is what most managers do anyway.

What is the risk that something will happen. For instance, what if the number of respirator cases in 25% more than we planned equipment for, or the we get notified that a number of COVID-19 tests were faulty. This list can be long – in this case listing the top 20 would be a good idea.

The responses can be AVOID – buy 25% more respirators or MITIGATE have a backup agreement to treat them in a location in Missoula.

Decision points. We know we will see some increasing demand for respirators and we can find out the lead time to buy them. We can decide to implement the AVOID action at a specified later date.

Invest to reduce or avoid a risk. Once I was planning a program for a GPS landing system that had to withstand purposeful jamming by opposing forces. The components needed to be integrated and tested in a testbed for six months. The military receivers were only new technology and would not be available until three months after the integration was supposed to start. It was suggested we simply wait and hope we could compress the integration schedule – but the cost was probably going to be an additional $3 million. I asked if commercial receivers could be used to begin the integration – sure but that would waste money because we would have

to discard them for the final system. How much do they cost: $250,000. Of course I said to go buy them – I replaced a likely $3 million overrun with $250,000 of cost.

Invest in Opportunity. It works the same way. If I have a possible solution that may not pan out that costs $100,000, and I can spend $10,000 to make sure it works before committing to the $100,000. It may be may be worthwhile to spend it.

Managing Uncertainty. Timing is everything. If a choice is uncertain and one needs to be made, there is always the choice – put the decision off to get better information. But, if today is the day when I have to do something or the delay will cost money — then no decision is a decision — to spend that money. Compare that cost or consequence with making the wrong decision.

Then if I go down the potentially wrong path — when will I know. Make sure to plan for another decision then.

Sometimes I may be faced with two or three alternative actions, not knowing which one will work. If time is of the essence and the cost of failure is high, I have been known to fund them all and do a "flyoff" at the end.

Spending money to learn more – Testing asymptomatic people is an example.

Managing a dynamic situation. There are several planning and scheduling techniques that are often used, which I could go through, However, for this situation you may already be using the most straight forward one with the Incident Management Team.

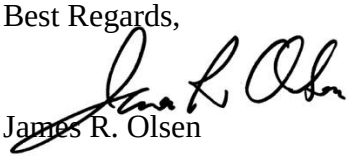
This was a common practice in my work when faced with a dynamic situation:

- The morning standup meeting, 20 minutes not 21. And I do mean stand up.
    - We would have call-ins on a speaker phone or video conference for distributed teams.
    - The meeting started precisely on time.
    - The meeting ended precisely 20 minutes later.
    - All information was shared – everybody heard everything
    - Me and a staff member would prepare a brief status report.
    - We used the Action Item method. So we would present a Action Items that were open – get a quick status from person assigned to it. Close it if we could. We kept them on a spreadsheet: Who, Title, What Event Is Required to Close it, Date Due, One or two word status (on time, late, etc).
    - Discussions were allowed and encouraged – for 30 seconds to 2 minutes – then we would take it off-line. If a decision could be made on the spot it was made. (controversial ones or ones that required more thought were put off until the next day).
    - New actions or status could be proposed by anyone.

The benefit of anything like this – engaging the entire team briefly every day – is to give a sense of urgency and progress, eliminate the problem of some person who needed to know something

hadn’t been told through some oversight, a sense of empowerment in which everyone had an input, a sense of command in that decisions were made on the spot when possible.

Best Regards,



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REFERENCES

Amanpour. Christine (producer and interviewer) and Dr. Peter Piot (Interviewee/Codiscoverer of Ebola). "Peter Piot: coronavirus is going to be everywhere," 19 Mar 2020/ VIDEO. *CNN*. https://www.cnn.com/videos/health/2020/03/19/amanpour-peter-piot-coronavirus-medicine.cnn/video/playlists/amanpour/ Accessed 3/19/2020.

Ai, Tao and Zhenlu Yang, et. al. "Correlation of Chest CT and RT-PCR Testing in Coronavirus Disease 2019 (COVID-19) in China: A Report of 1014 Cases," 26 Feb 2020. *Radiology.* Radiology Society of North America. DOI: https://pubs.rsna.org/doi/full/10.1148/radiol.2020200642

Baud, David et. al. "Real estimates of mortality following COVID-19 infection," 21 Mar 2020. *Infectious Diseases*. THE LANCET. DOI: https://doi.org/10.1016/S1473-3099(20)30195-X

Beck, MA. "Selenium and vitamin E status: impact on viral pathology." May 2007. *Journal of* Nutrition, Vol, 137, Issue 5, pages 1338-1340. Oxford. DOI: https://doi.org/10.1093/jn/137.5.1338

Begley, Sharon. "Coronavirus model shows individual hospitals what to expect in the coming weeks," 16 March 2020. *STATNEWS*. https://www.statnews.com/2020/03/16/coronavirus-model-shows-hospitals-what-to-expect/. Accessed 3/19/2020.

Bichell, Rea Ellen, "Who Has COVID-19? One Colorado County Is Offering Blood Tests To All Its Residents To Find Out." 21 Mar 2020. *All Things Considered*, Wyoming Public Media. https://www.wyomingpublicmedia.org/post/who-has-covid-19-one-colorado-county-offering-blood-tests-all-its-residents-find-out#stream/0. Accessed 3/22/2020.

Branswell, Helen. "Why 'flattening the curve' may be the world's best bet to slow the coronavirus." *STATNEWS*. 11 Mar 2020. https://www.statnews.com/2020/03/11/flattening-curve-coronavirus/. Accessed 3/21/2020.

Braun, Andés Sánchez. "Commitment, transparency pay off as South Korea limits COVID-19," 16 Mar 2020. *EURACTIV Network.* https://www.euractiv.com/section/coronavirus/news/commitment-transparency-pay-off-as-south-korea-limits-covid-19-spread/. Accessed 3/17/2020.

Brennan, Margaret (Interviewer) and Dr. Anthony Fauci (Interviewee) Director of the NIH, Institute of Allergy and Invectious Diseases (of which RML is a part). "Transcript: Dr. Anthony Fauci discusses coronavirus on 'Face the Nation,'" March 22, 2020. VIDEO, *Face the Nation*. CBS NEWS, https://www.cbsnews.com/news/transcript-dr-anthony-fauci-discusses-coronavirus-on-face-the-nation-march-22-2020/. Accessed 3/22/2020.

CDC (Centers for Disease Control and Prevention). "Severe Outcomes Among Patients with Coronavirus Disease 2019 (COVID-19) — United States, February 12–March 16, 2020." 18 Mar 2020. https://www.cdc.gov/mmwr/volumes/69/wr/mm6912e2.htm?s_cid=mm6912e2_w#T1_down. Accessed 3/22/2020.

Channel News Asia, "Covid-19 Clusters in Singapore." GRAPHIC. 21 Mar 2020. Channel News Asia. https://infographics.channelnewsasia.com/covid-19/coronavirus-singapore-clusters.html. Accessed 3/22/2020.

CNN. "Loss of smell or taste could be coronavirus symptoms." 23 Mar 2020. https://www.cnn.com/videos/health/2020/03/23/gupta-loss-of-smell-taste-coronavirus-newday-vpx.cnn

CSSE (Center for Systems Science and Engineering). "Coronavirus COVID-19 Global Cases." INTERACTIVE MAP, , Johns Hopkins University (JHU) https://www.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6. Accessed 3/22/2020.

Dujmovic, Jurica. "Wildly popular coronavirus-tracker app helps South Koreans steer clear of outbreak areas." 18 Mar 2020. Market Watch. https://www.marketwatch.com/story/wildly-popular-coronavirus-tracker-app-helps-south-koreans-steer-clear-of-outbreak-areas-2020-03-18. Accessed 3/22/2020.

Dunden, Alexis and Andrew Marks. "South Korea took rapid, intrusive measures against Covid-19 – and they worked," 20 Mar 2020. *The Guardian Newspaper.* https://www.theguardian.com/commentisfree/2020/mar/20/south-korea-rapid-intrusive-measures-covid-19. Accessed 3/22/2020.

Ferraresi, Mattia, "A coronavirus cautionary tale for Italy: Don't do what we did." 13 Mar 2020. *Boston Globe*. https://www.bostonglobe.com/2020/03/13/opinion/coronavirus-cautionary-tale-italy-dont-do-what-we-did/ Accessed 3/18/2020.

Ioannidis, John P.A. "A fiasco in the making? As the coronavirus pandemic takes hold, we are making decisions without reliable data." *STATNEWS*. 17 Mar 2020. https://www.statnews.com/2020/03/17/a-fiasco-in-the-making-as-the-coronavirus-pandemic-takes-hold-we-are-making-decisions-without-reliable-data/ Accessed 3/22/2020.

Lia, K. K. Rebecca and Keith Collins, "Which Country Has Flattened the Curve of the Coronavirus?" 19 Mar 2020. *The New York Times.* https://www.nytimes.com/interactive/2020/03/19/world/coronavirus-flatten-the-curve-countries.html. Accessed 3/19/2020.

Lee, Bruce Y. "How Does The COVID-19 Coronavirus Kill? What Happens When You Get Infected," 21 Mar 2020. *Forbes Magazine.* https://www.forbes.com/sites/brucelee/2020/03/21/how-does-the-covid-19-coronavirus-kill-what-happens-when-you-get-infected/#31f3e5916146. Accessed 3/22/2020.

NIH (National Institutes of Health. "New Coronavirus Stable for Hours on Surfaces, SARS-CoV-2 Stability Similar to Original SARS Virus," 17 Mar 2020. https://www.niaid.nih.gov/news-events/new-coronavirus-stable-hours-surfaces. Accessed 3/22/2020.

Ortiz-Opina, Esteban. "How many tests for COVID-19 are being performed around the world?" 20 Mar 2020. *Our World Data*, Oxford Martin School, University of Oxford. https://ourworldindata.org/covid-testing/ Accessed3/22/2020.

Paschall, CJ. "UVA researchers may have found faster way to detect COVID-19." 17 MAR 2020. NBC29. https://www.nbc29.com/2020/03/17/uva-researchers-may-have-found-faster-way-detect-covid-/. Accessed 3/23/2020.

Predictive Healthcare Team, Penn Medicine. "Penn Medicine - COVID-19 Hospital Impact Model for Epidemics." ONLINE MODEL. University of Pennsylvania. https://penn-chime.phl.io. Accessed 3/20/2020.

Ren, Jun-ling et. al. "Traditional Chinese medicine for COVID-19 treatment." 4 Mar 2020. *Pharmacological Research*, Vol 155, May 2020 104743. ScienceDirect, ELSEVIER. DOI: https://doi.org/10.1016/j.phrs.2020.104743; https://www.sciencedirect.com/science/article/pii/S1043661820307556?via%3Dihub.

Rio, Carlos Del and Preeti N. Marlani. "COVID-19—New Insights on a Rapidly Changing Epidemic," 28 Feb 2020. JAMA Health Forum, https://jamanetwork.com/journals/jama/fullarticle/2762510. DOI: 10/1001/jama.2020.3072. Accessed 3/22/2020.

vanDoremalen, Neeltje, et. al. "Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1," *The New England Journal of Medicine*. Correspondence. 17 Mar 2020. DOI: https://www.nejm.org/doi/10.1056/NEJMc2004973.

Vogel, Gretchen. "New blood tests for antibodies could show true scale of coronavirus pandemic," 19 Mar 2020. *Science Magazine*. https://www.sciencemag.org/news/2020/03/new-blood-tests-antibodies-could-show-true-scale-coronavirus-pandemic. Accessed 3/22/2020.

WHO (World Health Organization. "Management of ill travellers at Points of Entry – international airports, seaports and ground crossings – in the context of COVID -19 outbreak Interim guidance," Reference Number WHO/2019-nCoV/POEmgmt/2020.1. 16 Feb 2020. https://www.who.int/publications-detail/management-of-ill-travellers-at-points-of-entry-international-airports-seaports-and-ground-crossings-in-the-context-of-covid--19-outbreak. Accessed 3/22/2020.

WHO (World Health Organization. "Novel Coronavirus (COVID-19) Situation," 3/21/2020, https://experience.arcgis.com/experience/685d0ace521648f8a5beeeee1b9125cd. Accessed 3/22/2020.

Yamshchikov, Alexandra et. al. "VITAMIN D FOR TREATMENT AND PREVENTION Of INFECTIOUS DISEASES: A SYSTEMATIC REVIEW OF RANDOMIZED CONTROLLED TRIALS." 15 Apr 2010. HHS Author Manuscripts, NIHMS187181. doi: 10.4158/EP09101.ORR https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2855046/

Zuang, S, et. al. "Estimation of the reproductive number of novel coronavirus (COVID-19) and the probable outbreak size on the Diamond Princess cruise ship: A data-driven analysis." 22 Feb 2020. US National Library Of Medicine, NIH. https://www.ncbi.nlm.nih.gov/pubmed/32097725. Acessed 3/22/2020.