COVID-19 Risk Reduction

Over the next six months, there is a real risk of a mini-outbreak of COVID-19 in your facility (risk = probability times severity of occurrence). We've seen outbreaks even in facilities that are taking strong action to reduce the risk any way they can. The costs can be astronomical, depending on your cost of downtime, liability exposure and cost of deep cleaning. If the cost of an outbreak in your 800-employee, 3-shift manufacturing facility is $20MM off the bat plus long-term concerns among your employees and stakeholders, and the risk is 20%, there is a huge value in halving that risk, which can be done by applying a few tools in parallel.

One tool that can reduce it is fever screening. For adults, fever is the first indication of COVID-19 in the majority of later-confirmed cases. According to a recent study of over 24,000 people with COVID-19, fever was present in 78% of individuals https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0234765. And according to CDC, fever is the single most common initial indication of an infection (https://www.cdc.gov/coronavirus/2019-ncov/hcp/clinical-guidance-management-patients.html and Guan WJ, Ni ZY, Hu Y, et al. Clinical Characteristics of Coronavirus Disease 2019 in China. N Engl J Med 2020;382:1708-20.). Because of asymptomatic spread, particularly prevalent in children, you can't catch everyone, but if you can detect fevers and your population is adults, fever detection can cut your risk significantly by reducing exposure to COVID-19 carriers. For influenza and other fever-associated diseases with no or less asymptomatic spread, you'll cut your risk much further.

However, fever screening doesn't exist today - over 400 companies are selling what they call fever detection, but what they sell doesn't do what it says on the box because they don't have anywhere near the accuracy required. It is common to see claims of 0.3C or 0.5F accuracy, but nearly all systems being offered today have real accuracy of 4F or worse - these will miss real fevers and will not reduce your risks. There are a small handful of expensive solutions that have the required accuracy, but these all require a mini-laboratory setup in your facility's entryway and must be staffed with a trained operator. The rest appear to be offering low-accuracy hacks to appear accurate and unfortunately, are unlikely to ever detect a real mild or moderate fever in the field.

We have a solution, the Fever Inspect, which is simple to setup and use - no trained personnel required. The Fever Inspect has been tested head-to-head against other systems and has the accuracy you need to reduce your risk.

How to Figure out Fever Sensitivity

We can figure out how many real fevers a system can catch. To do this, we need to know the real accuracy of the system and apply it to the fever scale below. However, the vast majority of fever detection systems are advertising accuracies that aren't possible with the technology they use (see the FDA guidance on thermography for fever detection). Unfortunately, you also can't trust oral temperatures alone, unless you have a large number of people with real fevers in that group, because the most common trick used to pretend a system is accurate is to push the output number closer to 98.6, which is what the average oral

temperature will read out as. You could build a box that outputs a 98.6 plus or minus some random number between -0.5 and 0.5 and no one will be able to tell the difference from oral temperatures of healthy people until you've measured several hundred people. Only with a blackbody calibrator can this type of trick be detected easily. A blackbody calibrator can also be used to get the accuracy of the system at determining surface temperatures, which is what we'll use for determining the proportion of fevers a system can catch.

The Fever Scale

Normal	98.6 plus or minus 1F
Mild	100.4F to 101.3F
Moderate	101.3F to 102.2F
Severe	102.2F and up

The Boring Details

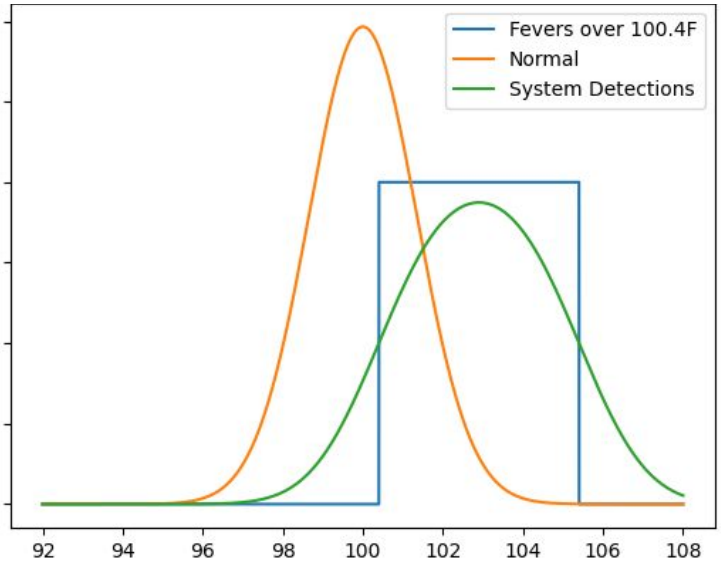
All systems will have a sensitivity and specificity that are not perfect and we're always forced to work with some assumptions. For the Fever Inspect, because we tested in a group of 32 people, we know our system has a real (human core body temperature) accuracy of 0.9F and a surface temperature accuracy of 0.5F. It may seem surprising that surface temperature accuracy is only half the story. This is because once real-world conditions are in place, all the other variables enter into the picture and push that accuracy higher (worse). We will use our system's accuracy at body temperature below. We simply don't have real accuracies for other systems until they undergo proper testing - what is reported in their marketing literature is so commonly unreliable their values cannot be trusted without some kind of testing such as what we have done.

Fever Inspect Performance

Taking the square of the sum of the system's accuracy of 0.9F and the 1F spread of human temperatures or 1.345F as the standard deviation we can expect in healthy people, we can calculate false positives using a one-sided online p-value calculator (e.g. https://www.statskingdom.com/p_value.html). Assuming a normal distribution, if the threshold is set at 100.4F, Fever Inspect would have a 9% false positive rate. In practice, we have not observed a false positive rate this high, although this could be due to using a population with smaller variability in core body temperature in our testing.

Remember this red-flag warning: if the system you're using never reports a false positive, it can only be doing this by fudging the output numbers so they appear closer to the expected normal temperatures, which is dangerous. Expect some level of false positives with even the best measurement systems in the world. A slightly higher threshold may be the safest approach, but we have found that simply repeating the scan is usually sufficient to weed out most false positives.

To determine detection rate, a different approach is needed, with fevers as a uniform distribution starting at the threshold, convolved with a normal distribution. This will cause those temperatures to blur out over a wider range, like in the plot below, and cause any measurement system to see the fever temperatures in the blue box as the smoothed out green line.



The detection rate is that portion that remains over the threshold the system is set to. For the detection rate for a higher fever such as 101.3F when using this same threshold of 100.4, we mirror the threshold to that amount below 100.4 and take the proportion remaining below. This gives us a detection rate of 88% for 100.4 fevers, 92% for 101.3F and 96% for 102.2F fevers. These are based on _real_ accuracy, not the wildly optimistic surface temperature accuracy. We expect the best thermal imaging-based systems in the world to get a little below 1F for the final application accuracy and 0.5F surface temperature accuracy. Surface temperature accuracy doesn't mean much if the total application accuracy is garbage. The application accuracy for the application of detecting fevers, as we discussed above, is what we want to know.

The Competition's Performance

The competition, based on comparison to oral temperatures, will SEEM like they could do even better because they report numbers much closer to the oral temperatures. However, if the pseudo-algorithm inside those systems is based on trickery that pushes the numbers closer to 98.6 (which appears to be the case), the oral temperatures won't tell us anything about the accuracy when faced with a real fever. Based on the other systems we have seen and our expertise in thermal imaging physics, we contend the best non-blackbody systems will detect zero mild and 5% of moderate and only 50% of severe fevers. That is if using the best uncooled camera that has a stated accuracy of 1.8F (real-world performance will be worse than this). We **expect their real-world performance to be worse**. We **expect all other non-blackbody systems to be even worse than that**.

It is possible to detect even mild fevers and to reduce your risk by reducing exposure to that portion of COVID-19 carriers who have a mild fever 1 or 2 days in advance of more serious symptoms showing up. However, the technology MUST be designed for the application and its performance tested in real-world conditions. Visit feverinspect.com and check out the Fever Inspect as a critical component in your set of tools for risk reduction.