RESPONDING TO COVID-19

Almanac

November 6, 2020 update
Context and purpose

The novel coronavirus has infected millions of people globally and is taking a severe toll on individuals, families, and economies as productivity drops and stock markets reflect increased global uncertainty.

This document provides some baseline facts and guidance for business leaders as to critical questions to address in the immediate and near-term to ensure the continuity of their business and the safety, health, and wellbeing of their workforce and customers.

What is it?

COVID-19 is the name for the illness caused by the novel coronavirus that originated in Wuhan, China in December 2019.

It is from the same family of viruses that cause some common colds, as well as Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS).

It is considered similar to other respiratory infections such as influenzas; symptoms range from fever, cough, shortness of breath to more severe cases of pneumonia and organ failure.
# OLIVER WYMAN’S CORONAVIRUS ALMANAC

This Almanac contains the latest perspectives on key areas related to the COVID-19 pandemic

<table>
<thead>
<tr>
<th>Section</th>
<th>Key Topics</th>
<th>Summary</th>
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</table>
| **01** Epidemiologic perspectives | • Epidemiological background  
| Pages: 8-22 | • Up-to-date statistics by geography | • Coronavirus, declared a pandemic in March 2020, has infected millions globally  
| | | • The virus displays unique and deadlier characteristics than other known diseases  
| | | • The pace and maturity of infection is highly variable by region, largely hinging on speed and strength of government response |
| **02** First peak suppression and on-going management | • Current state of suppression by geography  
| Pages: 23-30 | • Requirements for reopening and on-going management | • Many countries have effectively suppressed the first peak through a range of measures, but reopening and recovery is just beginning  
| | | • Key considerations for reopening and management of the virus – public health, economy, and school reopening |
| **03** Reopening and on-going management of schools | • Current statistics from reopened schools  
| Pages: 31-48 | • Best practices being implemented | • School opening is not driving case growth and infection rates for both students and staff remain low  
| | | • European countries that are going back into lockdown are by-and-large keeping schools open |
| **04** Global reopening & management | • Global lessons learned  
| Pages: 49-59 | • Tracking of future risk across the globe | • As countries re-open, we are crystalizing best practices and assessing regions with greatest risk of further disruption |
| **05** US reopening & management | • US opening approach and initial learnings  
| Pages: 60-69 | • Risk of future disruptions | • Best practices and common themes have emerged from the US reopening  
| | | • The United States is seeing rapid case growth across the country, jeopardizing existing levels of economic openness, though some states appear to be leveling off for a variety of reasons |
| **06** Testing & diagnostics | • Current landscape of available tests  
| Pages: 70-84 | • Emerging tech profiles & development news | • The current testing landscape is extremely fragmented, with hundreds of available tests and multiple different methodologies with different sample types and collection/analysis procedures  
| | | • Some emerging tech promises to address a need for low-cost testing at scale |
| **07** Oliver Wyman Pandemic Navigator | • Overview  
| Pages: 85-99 | • Example capabilities  
| | | • Web-based version to explore | • Oliver Wyman has developed a unique time-dependent SIR model to forecast the spread of the virus at the state and county level called the Pandemic Navigator Core Model  
| | | | • Along with a number of methodologies and tools, Pandemic Navigator provides business leaders and policymakers with the data needed to make informed decisions through the crisis  
| | | | • A sample of the Pandemic Navigator is freely available online |
| **08** An end to the cycle: therapeutics, vaccines and cumulative immunity | • Therapeutics in development  
| Pages: 100-113 | • Vaccine development timeline and current state  
| | | • Key considerations and unknowns | • Effective therapies and an eventual vaccine will be critical to bring economies and communities fully “back to normal” - further testing and development is to come  
| | | | • Constantly evolving understanding of the disease and limited understanding of the immune response it propagates uncertainty around how and when the pandemic will resolve |
| **09** Macroeconomic outlook | • Most recent forecasts of US and global GDP and US unemployment | • Latest GDP forecasts predict a severe shock to the US economy, mirrored by unemployment levels  
| Pages: 114-125 | | • Return to pre-COVID levels is anticipated early 2022 |
### Key Developments This Week (1 of 4)

**What we learned this week**

**Epidemiologic perspectives**
- **Improved survival rate**: Researchers at NYU analyzed the outcomes of more than 5,000 patients hospitalized from March to August and concluded death rates had dropped significantly in August compared to March, even when controlling for differences in the patients’ age, sex, race, and comorbidities.

- **Silent epidemic**: US Health experts say the current increase is being driven in large part by people who don’t have any symptoms, with asymptomatic cases responsible for 50% of case growth.

- **Children and school closures**: Children account for fewer than 5% of all cases of reported coronavirus in the 27 countries of the European Union and Britain, according to a study by the European CDC. The agency found that school closures would be “unlikely to provide significant additional protection of children’s health.”

**Global developments**
- **European resurgence**: Europe surpassed 10 million confirmed coronavirus cases, doubling in just 32 days, and 268,000 Covid-19 deaths on Sunday. Cases per capita on the continent are growing at 3x the rate of the United States.

- **New lockdowns & restrictions**: Countries have increased the stringency of their responses across the globe in response to Autumn resurgences.
  - Britain announced Saturday expansive new restrictions that effectively establish a national lockdown, joining France, Germany, Belgium, and Ireland in shutting down large parts of their societies to try to keep their hospitals from being overwhelmed amid vast second-wave surges of coronavirus infections.
  - New measures took effect Tuesday in Austria, Greece, and Sweden following a partial shutdown imposed in Germany Monday and tighter rules in Italy, France, Kosovo and Croatia.

- **New re-openings**:
  - Melbourne ended its 111-day lockdown after recording no new COVID-19 cases for the first time since June.
  - Israel has also begun to reopen schools, salons, and synagogues after bringing case growth down to below target levels.

**Why it matters**

- Improved survival is likely due to evolved treatment protocols, fewer at-capacity hospital systems, and emerging therapeutics.

- Without proper testing infrastructure, asymptomatic carriers will continue driving further uncontrolled case spread.

- Evidence is mounting that it is possible to keep schools open through an outbreak as risk to children is inherently lower and classrooms do not appear to be sites of super-spreader events. As a result, many European countries are keeping schools open as they re-enter lockdown.

- Countries across the globe are seeing second or third surges of the virus, including previously successful countries like Czechia and Germany.

- Healthcare infrastructure is becoming strained: hospital systems across Europe are at a critical point, with Belgium postponing all nonessential procedures and Croatia asking former doctors to come out of retirement.

- Dozens of mostly peaceful protests against another wave of lockdowns are appearing across the continent as despair, exhaustion, and fear abounds, signaling the appetite for further lockdowns low.
### Key Developments This Week (2 of 4)

<table>
<thead>
<tr>
<th>What we learned this week</th>
<th>Why it matters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reopening (US)</strong></td>
<td></td>
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<tr>
<td><strong>Case growth:</strong> For the first time, the United States exceeded 120,000 new cases on November 5. More than 20 states have experienced weekly case records and 40 states are seeing growing infection rates, with South Dakota seeing the fastest growth rate of 61% compared to two weeks ago.</td>
<td>As the country battles with its worst surge yet, further case growth is likely as the country heads into colder weather and the holiday season.</td>
</tr>
<tr>
<td><strong>Testing &amp; tracing:</strong> Testing capacity has stagnated in the past few weeks, and turnaround time for results can still be upwards of 5 days in strained areas. Many states are still showing concerning positivity rates &gt;10% (IA, SD, WY, ID, KS, UT, MT)</td>
<td></td>
</tr>
<tr>
<td><strong>Hospital capacity:</strong> 50,000 people are now hospitalized across the country and these counts have been increasing in 47 states over the last month. Strained capacity has now shifted to current outbreak regions: Nebraska’s largest hospital has now limited elective surgeries and IA and MI have warned that their bed capacity may soon be overwhelmed.</td>
<td>As hospital capacity becomes strained, new rounds of restrictions may be required, including in rural regions that have less hospital bed capacity per capita.</td>
</tr>
<tr>
<td><strong>Closures:</strong> Chicago has banned indoor dining for at least 2-3 weeks. El Paso is on lockdown, which includes schools, as the city reaches hospital capacity. <strong>Bright spot:</strong> San Francisco has now brought infection rates down to its lowest levels since the pandemic began and is now allowing restaurants, theaters, and museums to open at 25% capacity.</td>
<td></td>
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<tr>
<td><strong>Impact of reopening schools:</strong> K-12 schools have now been open for 2-3 months with no observed impact to overall community spread. Higher education continues to be a challenge in parts of the country: case spikes have recently occurred at Penn State, Kansas State, University of Kansas, and University of Michigan, with local health officials ordering Michigan students to shelter in place for 2 weeks.</td>
<td></td>
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<td><strong>Spread across state lines:</strong> New York has ended its state quarantine list requiring out of state travelers to quarantine for 14 days upon arrival and now requires travelers to get tested prior to arrival and again 3 days after entering the state.</td>
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<tr>
<td>Vaccines</td>
<td>Vaccine trials:</td>
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<tr>
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<td>• The FDA has given AstraZeneca and Johnson &amp; Johnson permission to resume their phase 3 trials, which were previously paused due to serious adverse events</td>
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<td></td>
<td>• Moderna has completed enrollment of its clinical with 30,000 participants receiving their first of 2 shots. The company expects to have early data within the month that may help shed light on efficacy</td>
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<td>• Pfizer’s vaccine trial is nearing enrollment completion: 42,000 of its planned 44,000 patients have been enrolled, with 36,000 receiving their second of 2 doses</td>
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<td></td>
<td>• China has four products in stage 3 trials, more than any other nation</td>
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<tr>
<td></td>
<td>Vaccine contracts</td>
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<tr>
<td></td>
<td>• Moderna has received more than $1bn for its potential Covid-19 vaccine. The vaccine is priced at ~$25 a dose and the US government has ordered 100m doses</td>
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<td></td>
<td>• A new study has shown that wealthy countries have already acquired the rights to billions of doses of future vaccines, potentially leaving poorer countries without enough supply for years to come</td>
</tr>
<tr>
<td>Why it matters</td>
<td>Firms are still working to produce an effective vaccine. While delays are to be expected, the chances are decreasing for a vaccine approval by year-end, although front-runners are still optimistic. US HHS Secretary Alex Azar said that a vaccine may be available for vulnerable Americans by January and by the end of January, would have enough to vaccinate all seniors and frontline healthcare workers</td>
</tr>
<tr>
<td>Why it matters</td>
<td>Wealth inequality may significantly delay vaccine deployment in developing countries</td>
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<tr>
<td><strong>Broad impact</strong></td>
<td>US economic recovery: after its worst quarter in history, the US GDP increased at a 33.1% annualized pace in the third quarter</td>
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<td>EU economic recovery: GDP increased by 12.1% compared to the prior quarter, the highest increase on record. However, Wall Street expects mid-single digit growth over the next 5 quarters</td>
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<tr>
<td>Why it matters</td>
<td>COVID threatens to widen a growing inequality gap in the United States, as higher income individuals and businesses face little economic threat, while lower income individuals may see lasting impacts, including a rise in homelessness. Ongoing challenges to pass a US relief bill exacerbate the issue</td>
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</table>
# KEY DEVELOPMENTS THIS WEEK (4 OF 4)

<table>
<thead>
<tr>
<th>What we learned this week</th>
<th>Why it matters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Therapeutics</strong></td>
<td></td>
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<tr>
<td>• <strong>Remdesivir</strong></td>
<td>Overall, the results of Remdesivir’s efficacy in treating COVID-19 are mixed. More studies are needed to confirm its efficacy</td>
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<tr>
<td>– The FDA granted full approval to remdesivir for treating hospitalized COVID-19 patients, the first drug approved to treat the virus</td>
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<td>– Approval comes a week after an international study led by the WHO found no benefit for patients treated with the drug</td>
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<tr>
<td>• <strong>Monoclonal Antibodies</strong></td>
<td>While antibody treatment does appear promising, even if the FDA decides to approve emergency use authorization, current supply is nowhere near estimated demand</td>
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<tr>
<td>– Regeneron released new data, days before the FDA is expected to decide on their emergency use authorization requests, confirming the efficacy of its COVID-19 antibody cocktail</td>
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<td>– REGN-COV2 reduced COVID-19 related medical visits in patients by &gt;50%</td>
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<td>– Supply constraints will only allow the company to deliver 50,000 doses by year end, despite the need for 12,000 doses per day</td>
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<tr>
<td><strong>Diagnostics</strong></td>
<td>With so many asymptomatic cases and PCR capacity constraints, quick and readily available alternative testing will become vital to controlling the Pandemic</td>
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<tr>
<td>• <strong>Promising diagnostics in development:</strong></td>
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<tr>
<td>– Singapore startup has developed a COVID-19 breathalyzer test that clinical trials show provide results in 60 seconds with 90% accuracy</td>
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<td>– MIT researchers have used AI to detect a COVID-19 infection by analyzing the sound patterns in audio recordings of coughs with a 100% accuracy in identifying asymptotic cases and 83.2% accuracy in identifying negative cases</td>
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</tbody>
</table>
01

EPIDEMIOLOGIC PERSPECTIVES
COVID-19 SPREAD GLOBALLY

Over 48.3 million cases...

...and over 1.2 million deaths...

First reported in Wuhan, China, on December 31, 2019

Declared a global pandemic by the World Health Organization on March 11, 2020

...across nearly all 200 countries and territories

1. Countries included: All Countries in “European Region” Sub-region in WHO Situation Report; 2. Turkmenistan does not report coronavirus data, resulting in a blank result on the above map

Source: Map from CDC (link), Numbers from John Hopkins University & Medicine (link)
COVID-19 TRENDS AND SPREAD OF THE DISEASE

Since our last update, cases continue to decrease in APAC and LATAM, while Europe and the United States experience new case resurgences.

Cumulative Confirmed Cases of COVID-19

New Cases Per Day of COVID-19
7 Day Moving Average

Source: John Hopkins University & Medicine Coronavirus Resource Centre

1. Includes countries categorized under “European region” based off of latest WHO Situation Reports
HOW DOES COVID-19 COMPARE TO OTHER DISEASE OUTBREAKS? (1 OF 2)

COVID-19 is currently more deadly and contagious than the Flu, but the science on transmission and mortality continues to evolve.

Case Fatality Rate\(^1\)

Log scale

<table>
<thead>
<tr>
<th>Disease</th>
<th>Infected</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bird Flu</td>
<td></td>
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<tr>
<td>MERS</td>
<td></td>
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<tr>
<td>Ebola</td>
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<td>1918 Spanish Flu</td>
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<tr>
<td>SARS</td>
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<tr>
<td>1918 Spanish Flu</td>
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<tr>
<td>SARS</td>
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<tr>
<td>COVID-19</td>
<td></td>
<td></td>
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<tr>
<td>H1N1 Swine Flu</td>
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<tr>
<td>Measles</td>
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</tbody>
</table>

Legend and key statistics

- **SARS**: 8,096 infected | 774 deaths
- **MERS**: 2,494 infected | 858 deaths
- **1918 Spanish Flu**: ~500 MM infected | ~50 MM deaths
- **COVID-19**: ~47MM infected | ~1.2 MM deaths
- **H1N1 Swine Flu**: 700 MM–1.4 BN infected | 284 K deaths\(^2\)

Case Fatality Rate & Transmission Range

- **More Deadly**
- **More contagious**

Average number of people infected by each sick person (R0)

- **Denotes Coronaviruses**

1. New York Times (link) for fatality and R-naught comparisons, CDC timelines for case numbers (selected link: CDC SARS timeline); 2. Updated CDC estimates (link); 3. The R0 for the coronavirus was estimated by the WHO to be between 1.4–2.5 (end of January estimate) (link), other organizations have estimated an R0 ranging between 2–3 or higher (link); 4. CDC Paper (link); 5. Calculated as Number of Deaths/Total Confirmed Cases as reported by John Hopkins University. 6. Emerging Infectious Diseases (link) 7. Science (link)

Information as of 11/02/20
**HOW DOES COVID-19 COMPARE TO OTHER DISEASE OUTBREAKS? (2 OF 2)**

The infectious cycle of COVID-19 is unlike that of any other outbreak we have seen before.

### Incubation timeline (days)

<table>
<thead>
<tr>
<th>Incubation Period (days)</th>
<th>Illustrative</th>
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</thead>
<tbody>
<tr>
<td><strong>0</strong></td>
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<tr>
<td><strong>1</strong></td>
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<tr>
<td><strong>2</strong></td>
<td></td>
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<td><strong>3</strong></td>
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<td><strong>4</strong></td>
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<td><strong>5</strong></td>
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<td><strong>12</strong></td>
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<td><strong>13</strong></td>
<td></td>
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<tr>
<td><strong>14</strong></td>
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</tr>
</tbody>
</table>

#### Why does this matter?

The combination of a longer incubation period with asymptomatic transmission means that there is a longer window of time during which infected individuals are unaware that they are contagious.

#### Why is quarantine 14 days?

- While the median incubation period is 5.5 days, symptoms have been documented to occur over a longer time frame; 14 days should capture 99% of all cases.
- Ideally, asymptomatic individuals should be tested during quarantine to ensure they have not been infected.

### Infectious cycle:

- There is broad acceptance that COVID-19 can be (and often is) transmitted prior to onset of symptoms (asymptomatic transmission).
- Several epidemiological studies estimate that the infectious period begins 2-3 days prior to onset of symptoms, peaks 0.7 days before symptom onset and then declines within 7 days.
- Viral loads have been shown to build during the asymptomatic period, with viral shedding very high in the first week of disease, followed by decline in the next week.
- A new study showed that viral loads are significantly higher in patients with milder symptoms, while another found that asymptomatic individuals shed for a much longer duration than asymptomatic patients supporting the idea that transmission is heavily driven by individuals with mild or no symptoms.
- While viral genetic material can linger in the body for 2-4 weeks, live virus cannot be cultured after day 11 of illness.

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CASE FATALITY RATE (CFR) BY COUNTRY
While the global CFR is a useful metric to understand COVID-19, country-specific CFRs range by orders of magnitude.

What is driving the variation?

- **Position along the trajectory of the outbreak:** For many countries (e.g., South America, US), there are substantial amounts of unresolved, active cases, leading to variable CFR.
- **Breadth of testing:** Broader testing leads to a larger confirmed base of patients, decreasing CFR.
- **Distribution of key risk factors within the population:** Age, gender and pre-existing conditions have a significant influence on mortality (see next page); countries with higher CFRs have a population skewed towards these risk factors (e.g., Italy has the second oldest population on earth).
- **Health system threshold:** Every country has a health system capacity, that when exceeded, will result in the inability to provide sufficient support to all patients thereby resulting in a higher CFR.

Note that case fatality rates may still be unstable in countries currently in the midst of outbreaks.

1. Calculated as Number of Deaths/Total Confirmed Cases as reported by Johns Hopkins University

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CASE FATALITY RATE (CFR) BY AGE
For all geographies fatality rates increase significantly with age

Case fatality rate by age
As % of confirmed cases

Notes: * South Korea does not provide data for ages 80+, same percentage has been listed for 80–89 and 90+ **Japan and Italy data includes a small proportion of cases without a specified age, these were not included; 5. South Africa Data as of 6/22/20

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**CASE FATALITY RATE (CFR) BY COMORBIDITY**
Significantly higher death rates occur among those with underlying conditions

### Prevalence of comorbid condition in NY COVID-19 fatalities

<table>
<thead>
<tr>
<th>Condition</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>53.3%</td>
</tr>
<tr>
<td>Diabetes</td>
<td>35.1%</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>20.8%</td>
</tr>
<tr>
<td>Dementia</td>
<td>13.6%</td>
</tr>
<tr>
<td>CAD</td>
<td>11.8%</td>
</tr>
<tr>
<td>Renal Disease</td>
<td>10.5%</td>
</tr>
<tr>
<td>COPD</td>
<td>9.5%</td>
</tr>
<tr>
<td>Atrial Fibrillation</td>
<td>7.9%</td>
</tr>
<tr>
<td>Cancer</td>
<td>7.7%</td>
</tr>
<tr>
<td>Stroke</td>
<td>6.6%</td>
</tr>
</tbody>
</table>

90% of New York COVID-19 fatalities involved at least one comorbidity

### Comorbidity reports across the globe

- Initial data from China reported significantly elevated CFRs for patients with **cardiovascular disease, diabetes, chronic respiratory disease, hypertension and cancer**

- Most common comorbidities identified in Italian COVID-19 fatalities were **hypertension, diabetes, ischemic heart disease, renal failure, atrial fibrillation, COPD and cancer**

- A study in Spain identified **cardiovascular disease and respiratory problems** as the most common comorbidities in severely ill and fatal cases

- Emerging data from the US and France suggest that **obesity** is an additional risk factor for severe disease resulting from COVID-19

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1. New York State Department of Health as of 8/26/2020 (link)
2. JAMA (link)
3. JAMA. (link)
4. El Pais (link)
5. Medscape (link)
GROWING BODY OF EVIDENCE DEMONSTRATES THAT COVID-19 IS HAVING A MORE SIGNIFICANT IMPACT ON MINORITY AND DISADVANTAGED COMMUNITIES

Evidence¹

- **African Americans** were disproportionately impacted in the majority of US states reporting racial information:

<table>
<thead>
<tr>
<th>Example Region</th>
<th>% of Cases</th>
<th>% of Deaths</th>
<th>% Total Pop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wisconsin</td>
<td>22%</td>
<td>25%</td>
<td>6%</td>
</tr>
<tr>
<td>Kansas</td>
<td>12%</td>
<td>28%</td>
<td>6%</td>
</tr>
<tr>
<td>Michigan</td>
<td>37%</td>
<td>42%</td>
<td>14%</td>
</tr>
</tbody>
</table>

- Some states also demonstrate disproportionate impact to **Hispanic and Asian** communities:

<table>
<thead>
<tr>
<th>Example Region</th>
<th>% of Cases</th>
<th>% of Deaths</th>
<th>% Total Pop</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA (Hispanic)</td>
<td>30%</td>
<td>8%</td>
<td>7%</td>
</tr>
<tr>
<td>KS (Asian)</td>
<td>3%</td>
<td>8%</td>
<td>2%</td>
</tr>
</tbody>
</table>

- Though data is limited, **American Indian, Alaska Native (AIAN) and native Hawaii or other Pacific Islander (NHOPI)** groups have also been impacted significantly. (Note: Navajo Nation now has the highest per capita infection rate in the country):

<table>
<thead>
<tr>
<th>Example Region</th>
<th>% of Cases</th>
<th>% of Deaths</th>
<th>% Total Pop</th>
</tr>
</thead>
<tbody>
<tr>
<td>AZ (AIAN)</td>
<td>21%</td>
<td>21%</td>
<td>4%</td>
</tr>
<tr>
<td>NM (AIAN)</td>
<td>59%</td>
<td>--</td>
<td>9%</td>
</tr>
</tbody>
</table>

- The homeless and incarcerated have also been impacted significantly though there is limited quantified data available

**Contributing factors**

- **Chronic conditions**: Underlying medical conditions such as diabetes and heart disease create greater risk for infection, severe illness and death. These conditions are found in higher prevalence in African Americans, Hispanics and Native Americans in the US (e.g., 40% of African Americans have hypertension vs. 29% of total pop³)

- **Socio-economic factors**: Lower income communities are at greater risk of contracting COVID-19 due to close living conditions, increased need to go outside the home for food and work and greater reliance on public transportation (e.g., Data from the U.S. Bureau of Labor Statistics show that <20% of African American workers and ~16% of Hispanic ones are able to telecommute)

- **Lack of information**: In minority communities, information is often disseminated by members who are currently socially distanced (e.g., barbers, pastors) and evidence-based information on the disease and its impact on the community may be limited

- **Racial bias in treatment**: Review of lab billing information suggested African Americans with coronavirus symptoms were less likely to be tested⁴

- **Unique challenges for Navajo Nation**: Despite having one of the strictest stay at home orders in the country, the Navajo Nation has been hit particularly hard. Significant contributors may include multiple generations living in one household or infrequent hand washing (30-40% lack running water)⁵

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**OVERALL, SUMMER US HOTSPOTS ESCAPED MUCH OF THE MORTALITY IMPACT ASSOCIATED WITH EARLY PANDEMIC HOTSPOTS**

New daily deaths and confirmed cases per 1m, 7-day moving average

During the early pandemic, hard hit states experienced a wave of deaths roughly similar in shape to their case curve, delayed by ~2-3 weeks ①

Despite relatively similar per capita case numbers, the summer hotspots diverged from early hotspots, only experiencing a mild bump in their death rates ②

While the risk from COVID is still high, mortality risk has decreased due to a number of factors (e.g., younger patients, better therapeutics, stronger testing)

1. New hospitalization data not available in Texas

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IN THE US, HOSPITALIZATIONS PER CONFIRMED CASE HAVE DECREASED AS THE PANDEMIC HAS PROGRESSED

Confirmed cases vs hospitalizations

Hospitalized patients 5 days prior to date per daily new case (7MA)

Potential reasons for decrease in rate of hospitalizations per case

• Increased testing infrastructure has allowed the US to detect more asymptomatic and non-serious cases
  – The US testing positivity rate has decreased from ~20% in April to ~7% in November
  – The US has increased its testing per million by >10x from ~350 in April to ~3,675 in November
• As the Pandemic has progressed, the proportion of COVID-19 cases from younger individuals (who are less likely to require hospitalization than older cases) has increased

1. Per CDC, there are 5 days from symptom onset to pneumonia. To compare the cohort of hospitalized patients with the same cohort who tested positive, daily case counts should be measured against the hospitalizations that occurred 5 days after; 2. JHU; 3. NYT

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THE RATE OF DEATHS PER HOSPITALIZATION HAS ALSO DECREASED FROM ~15% IN MID-APRIL AND HAS HELD STEADY SINCE MAY AT ~2%

Possible reasons for decrease in death rate

- Some deaths did not occur in hospitals in the early parts of the first outbreak as people did not realize they had the virus or were turned away from hospitals, subsequently dying in their homes or nursing homes.
- There was greater need for triage and ventilator rationing in the early stages of the Pandemic when hospital/ICU capacity was reached.
- New treatments for COVID-19 including antivirals (remdesivir) and steroids (dexamethasone) have been shown to improve survival rates.
- Sophisticated and optimized protocols have been developed that improve outcomes, such as lower usage of ventilators, and improved body positioning for oxygenation.

1. The shift in hospitalized patients is to compare the cohort of deaths with the cohort of likely hospitalizations: per CDC, there are 5 days from symptom onset to pneumonia (likely hospitalization) and 13 days from pneumonia onset to death; 2. Source: The Lancet; 3. Source: The Lancet;

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### IMMUNE RESPONSE TO COVID-19: AN EVOLVING UNDERSTANDING

| **What does the immune response to COVID-19 entail?** | • SARS-CoV-2 initially elicits an innate immune response that is similar to that of a typical virus including release of key cytokines and recruitment of Natural Killer cells as well as other key protective cells  
  • Like other coronaviruses, SARS-CoV-2 appears to be able to suppress several portions of this innate immune response; this is particularly evident in patients with severe disease  
  • Subsequently, the adaptive immune (T and B-cell mediated) response is also activated and SARS-CoV-2 specific antibodies (IgG and IgM) can be detected in serum 7-14 days after the onset of symptoms |
| --- | --- |
| **Does it work the same way in everyone?** | • While there is much still unknown here, there is clear evidence that the immune response differs significantly between individuals  
  • There is emerging evidence that some individuals have cross-reactive antibodies and pre-existing cross-reactive T-cell memory from exposure to other coronaviruses⁹,¹⁰  
  • In individuals with severe disease, a highly dysregulated immune response ensues that includes a cytokine storm, extreme inflammation, and depleted protective cells (Natural Killer and T-cell); it is believed that mortality is partially driven by this response  
  • In addition, a range of initial (1 month) titers (levels) of antibodies has been documented in recovered patients with similar clinical presentation⁴  
  • Finally, there appears to be a difference in the T-cell response as well; some individuals who lack an antibody response show strong, specific T-cell immunity⁹ |
| **Does infection with (and recovery from) confer immunity?** | • This is one of the key unknowns in our understanding of COVID-19 disease and available evidence is mixed  
  • There have been several reports of reinfection, but these are rare and the biology is not yet understood⁵,¹¹  
  • There have been several studies in animals that suggest that protection is conferred after initial infection⁵ |
| **How long does protection last?** | • This is another key unknown, critical for the development of a vaccine and for potential herd immunity  
  • Comparisons to SARS and MERS initially suggested a likely window of 1-3 years of protection⁸  
  • A longitudinal study of seasonal coronaviruses revealed substantial reduction of antibodies 6 months post infection and frequent re-infection 12 months after initial infection⁷  
  • Another recent study has suggested a waning immune response after 3 months, but this may actually represent the slow and steady decline expected of B cells (that would still allow for protection)⁸  
  • Evidence is mounting that T-cell immunity may last longer and offer stronger protection against COVID-19⁹ |
| **What are the other key remaining unknowns?** | • What is the long-term baseline titer (or range of titer) of antibody going to be?  
  • How much antibody do you need to be protected from reinfection and disease? |

---

## AT A GLANCE: SUMMARY FACTS

### Contagion
- **Key facts**
  - Initial estimates suggested COVID-19 R0 is between 2 and 3 (with edge of range estimates closer to 1.4 and 3.6), which means each person infects 2–3 others; R0 for the seasonal flu is around 1.3.
  - New emerging estimates suggest R0 may be closer to 5.7 (edge of range 3.8–8.9)
  - Early evidence suggests COVID-19’s transmission is highly variable, with most infections resulting in no subsequent infections and a few resulting in many, which should color response.

<table>
<thead>
<tr>
<th>Current human immunity</th>
<th>Key unknowns</th>
</tr>
</thead>
<tbody>
<tr>
<td>- No herd immunity exists yet as the virus is novel in humans</td>
<td></td>
</tr>
<tr>
<td>- There is emerging evidence that some individuals have cross-reactive antibodies from exposure to other coronaviruses. It remains to be seen if these are protective</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Infectious cycle</th>
<th>Key unknowns</th>
</tr>
</thead>
<tbody>
<tr>
<td>- COVID-19 can be spread asymptptomatically</td>
<td></td>
</tr>
<tr>
<td>- The incubation period is a median of 5.5 days (up to 14 days) vs 3-day period for common flu</td>
<td></td>
</tr>
<tr>
<td>- Several epidemiological studies estimate that the infectious period begins 2-3 days prior to onset of symptoms, peaks 0.7 days before symptom onset and then declines within 7 days</td>
<td></td>
</tr>
<tr>
<td>- While viral genetic material can linger in the body for 2-4 weeks, live virus cannot be cultured after day 11 of illness</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fatality</th>
<th>Key unknowns</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Case fatality rates (CFR) are trending at 2.6% globally vs. 0.1% for flu</td>
<td></td>
</tr>
<tr>
<td>- Infected fatality rate (IFR) is estimated at 0.68% (0.53-0.82%) though the data shows a significant degree of heterogeneity</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Portion of cases asymptomatic but contagious</th>
<th>Key unknowns</th>
</tr>
</thead>
<tbody>
<tr>
<td>- In retrospective studies of those people tested and confirmed positive for COVID-19, experts estimate 18–30% are asymptomatic, with another 10–20% with mild enough symptoms to not suspect COVID-19</td>
<td></td>
</tr>
<tr>
<td>- Early indicators from point in time comprehensive testing of small populations (e.g., Vo, Italy; Iceland) suggest as many as 50% of cases could be asymptomatic</td>
<td></td>
</tr>
<tr>
<td>- In cohorts of younger individuals (e.g., pregnant woman, sailors on USS Theodore) the proportion of asymptomatics exceeded 60%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Portion of cases reaching “critical”/“severe” infection</th>
<th>Key unknowns</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Data from the US CDC suggested that approximately 14% of confirmed US cases required hospitalization; 1/6th of those needed ICU beds</td>
<td></td>
</tr>
<tr>
<td>- Among states that report hospitalizations, recent data suggests ~9-10% of cases now require hospitalization</td>
<td></td>
</tr>
</tbody>
</table>

---

1. The R0 for the coronavirus was estimated by the WHO to be between 1.4-2.5 (end of January estimate) (link), other organizations have estimated an R0 ranging between 2–3 or higher (link); 2. CDC Paper (link); 3. Emerging Infectious Diseases (link); 4. Science (link); 5. JAMA. “Presumed Asymptomatic Carrier Transmission of COVID-19” 6. CDC 7. Annals of Internal Medicine (link); 8. Academy of Medicine Singapore (link); 9. JHU. 10. medRxiv (link); 11. Nature (link), Eurosurveillance Paper (link); 12. ZMESCience report (link); 13. Business Insider (link); 14. NEJM (link); 15. China CDC, JAMA (link); 16. Note: However, hospitalization status was only known for ~50% of all cases in CDC study 17. Science Immunology (link)

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FIRST PEAK SUPPRESSION AND ON-GOING MANAGEMENT
HOW DO SUPPRESSION MEASURES LOWER THE BURDEN OF THE PANDEMIC?

Leaving the disease unconstrained is not an option; aggressive suppression measures can ease the impact of the disease on health systems.

Illustrative COVID-19 transmission with and without suppression measures

Timing and width of first peaks may vary between countries.

- Fewer total cases of COVID-19
- Fewer total COVID-related deaths
- Preservation of the healthcare system resulting in lower COVID-related CFR and maintenance of mortality from unrelated conditions (e.g. heart attacks, strokes)
- Time for infected, isolated and quarantined healthcare workers to get better and back to work
- Time to improve testing and tracing capabilities, manufacture supplies (e.g. PPE, vents) and to understand the virus better

1. Assuming case-based isolation only

<table>
<thead>
<tr>
<th>Theme</th>
<th>Best Practice</th>
<th>Challenging Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mass testing and tracing is the cornerstone of an effective response</td>
<td>By maintaining extremely widespread testing and contact tracing, <strong>South Korea</strong> was able to effectively levy targeted suppression measures and control outbreaks within specific populations</td>
<td>Despite very strong testing overall, <strong>Singapore</strong> did not effectively test or trace their migrant worker population, leading to unseen community spread and extremely high cases per capita, especially compared to other Asian nations</td>
</tr>
<tr>
<td>2. Digital contact tracing infrastructure is useful as a supplement to manual tracing, but efficacy varies by geo</td>
<td><strong>South Korea</strong> was able to effectively enhance its contact tracing capabilities with credit card data, phone location logs, and surveillance footage</td>
<td>Voluntary adoption of apps in Western countries like <strong>Norway</strong> is substantially lower than necessary (~17% as of May 7th); by May 16, the app had failed to identify any new cases; efficacy is limited anywhere that depends on voluntary adoption</td>
</tr>
<tr>
<td>3. Strict individual quarantine measures may limit need for broader lockdowns, if testing and tracing are successful</td>
<td>In the early days of the outbreak, both <strong>Taiwan</strong> and <strong>Singapore</strong> were able to effectively stop domestic transmission by strictly enforcing quarantine for incoming travellers, sick individuals, and suspected sick/close contacts</td>
<td><strong>Sweden</strong> has resisted both strict individual quarantine and broad societal lockdowns, and despite relatively strong public compliance with social distancing guidance, has suffered in key metrics compared to its Nordic neighbors</td>
</tr>
</tbody>
</table>
LESSONS LEARNED – KEY GLOBAL THEMES ON SUPPRESSION (2/2)

<table>
<thead>
<tr>
<th>Theme</th>
<th>Best Practice</th>
<th>Challenging Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Transparent, trusted leadership with clear and consistent top-down messaging leads to effective responses</td>
<td>While local authorities in <strong>Germany</strong> have autonomy to set local regulations and reopening plans, the federal government has set clear, consistent baselines that must be adhered to, ensuring a consistent philosophy but flexible approach to suppression and reopening</td>
<td><strong>Spain</strong>’s highly decentralized system of government resulted in difficulty coordinating a common response among its autonomous regions</td>
</tr>
<tr>
<td>5. Success is also highly influenced by a mix of underlying factors unique to each country, including previous epidemic experience, population dynamics, and cultural factors</td>
<td>Asian countries such as <strong>Taiwan</strong>, <strong>South Korea</strong>, <strong>Hong Kong</strong>, or <strong>Japan</strong> have generally fared well. Due to SARS and MERS, residents were already used to PPE and hygiene protocols, and governments were able to rapidly deploy and adjust existing preparedness plans and public health infrastructure</td>
<td><strong>Italy</strong> has struggled with a high death rate, in part due to an older population with comorbidities. Elsewhere, cultures like <strong>Spain</strong>’s, which involve communal meals and substantial time spent in restaurants, cafes, and bars, naturally increased the risk of community spread</td>
</tr>
<tr>
<td>6. Robust public healthcare systems will limit negative impact</td>
<td>Despite high cases per capita, <strong>Germany</strong>’s robust public health system and excess capacity lead to a relatively low fatality rate</td>
<td><strong>Spain</strong>’s underfunded, decentralized hospital system was ill-equipped to share information or resources, and limitations on PPE, hospital beds, and ICU beds lead to one of the world’s highest fatality rates</td>
</tr>
<tr>
<td>7. Protecting the elderly and vulnerable populations is imperative for lowering deaths</td>
<td><strong>Singapore</strong> moved 2,600 nursing home employees into hotels to better stop spread to seniors, and has so far been rewarded with one of the lowest fatality rates in the world</td>
<td>Existing guidelines were ineffective or detrimental in providing care to seniors in <strong>Sweden</strong>, leading to a high death rate stemming primarily from nursing homes</td>
</tr>
</tbody>
</table>
## WHAT DOES IT TAKE TO REOPEN ONCE THE FIRST PEAK IS SUPPRESSED?

<table>
<thead>
<tr>
<th>Capability</th>
<th>Where are we?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1: Health system capacity</strong>&lt;br&gt;The personnel, PPE, beds, and other equipment to sustainably manage normal healthcare needs and a potential new surge</td>
<td>Most countries and US states have sufficient capacity though a few hot spots remain at the margin</td>
</tr>
<tr>
<td><strong>2: Testing</strong>&lt;br&gt;Sufficient rapid testing to screen essential workers, conduct random testing, effectively contract trace and ID new flareups</td>
<td>US as a whole and many European countries are making progress on building necessary capacity, some European and Asian Countries (Germany, Norway, S. Korea) and specific US States (CA) have adequate supply</td>
</tr>
<tr>
<td><strong>3: Contact tracing</strong>&lt;br&gt;Identification, testing, and isolation of infected individuals’ contacts</td>
<td>Most countries lack adequate capacity; rapid staff up and creation of technological tools are beginning to fill the gap</td>
</tr>
<tr>
<td><strong>4: Central surveillance</strong>&lt;br&gt;Processes and infrastructure for aggregating and analyzing data to drive decision-making around suppression strategies</td>
<td>Asian countries have led the way, and existing surveillance systems are being adapted elsewhere but face data and lag time issues</td>
</tr>
<tr>
<td><strong>5: Social distancing</strong>&lt;br&gt;Cultural and infrastructural changes to daily life and work</td>
<td>Businesses and individuals are just beginning to grasp the extent of the new normal</td>
</tr>
</tbody>
</table>

1. CDC has issued guidance on these topics that should be referenced by local authorities

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WE CANNOT AFFORD TO REMAIN SHUT DOWN, BUT IT’S NOT WITHOUT RISK TO RE-OPEN FULLY. WE EXPECT >12 MORE MONTHS OF SOCIAL DISTANCING “CYCLES”

Initial Outbreak

~2 Months

Severity will vary based on suppression tactics and population dynamics

Mitigation/Economy

• Closure of non-essential businesses
• Community-wide stay-at-home mandates
• Widespread remote work
• Border closures and travel restrictions

Long Haul of Suppression

12+ Months

Cycles of relax/tighten as social distancing remains the only “brake”

Ramp up testing to watch for resurgence of virus and gauge progress to herd immunity

Containment

Therapeutic breakthroughs (treatment, vaccine) and consistently applied public health tools at scale (testing, tracing, selective quarantine, surveillance) enable return to normalcy

• Economic and social activity largely returns to normal
• At risk individuals will still take precautions as disease will still be circulating
• Prevalent use of vaccines, perhaps annually

Gradually re-open less risky businesses with employee testing, social distancing

• Keep riskier businesses closed for longer periods of time (bars, gyms, concerts) to mitigate spread
• Truly rethink operations for riskier businesses to fully incorporate health surveillance and social distancing wherever possible
• Remote work and mask-wearing still the norm
• No large gatherings
• Quarantine for confirmed cases, close associates, and travelers
• Stay-at-home order for elderly, ill, and/or immunosuppressed
DURING THE LONG HAUL WE NEED TO FIND THE OPTIMAL R(t) BALANCE – KEEP AS MUCH OF THE ECONOMY OPEN AS POSSIBLE WITHOUT RISK OF SERIOUS OUTBREAK

Rapid Case Growth

Limited suppression measures until public health strain is too high, followed by broad, reactive suppression measures in response

- Rapid progress towards herd immunity during “open” periods
- Economic instability driven by need to reclose broadly when case counts rise too high
- Population less willing to “reclose”, leading to lower compliance and less effective suppression

Managing Rt

Proactively tighten & ease suppression to maintain balance & keep Rt just below risk threshold; proper testing important to accurately calculate Rt

- Economy is as open as possible without threatening health infrastructure
- Maximal herd immunity without overwhelming health system
- Limited need for reactive, destabilizing suppression measures

Cautious suppression

Targeted suppression measures levied well before growth approaches risk threshold

- Limited public health risk
- Lower case count enables targeted suppression
- Longer road to herd immunity
- Higher likelihood of extended unemployment/economic disruption

© Oliver Wyman 1. Assumes protective immunity is conferred and lasts long enough for herd immunity to be impactful
MANAGING TO A TARGET RUN RATE REQUIRES CAREFUL MONITORING OF METRICS AND GRADUAL MODIFICATIONS TO PREVENT JARRING STOPS AND STARTS

Next 12+ Months

Risk Threshold

Case Growth per Day

Optimal daily case rate

Ease restrictions
- Look for steady, sustained reduction in cases
- Easing should be gradual (e.g., raising capacity limits or increasing operating hours)
- Ease restrictions piecemeal, and wait to observe effect before further actions

Operate with continuous caution
- Mask mandates and social distancing should still be in place
- Continue easing restrictions until an systemic uptick is observed

Impose restrictions
- Watch out for steady, sustained rise in cases
- Restrictions should be put in place well before approaching risk threshold due to lag in effect
- Restrictions should be gradual (e.g., gathering size or capacity limits)

Operate at the peak
- May stop imposing restrictions when seeing slowing or declining case growth
- Should operate under peak restrictions until multiple weeks evidencing case declines
RE-OPENING AND ON-GOING MANAGEMENT OF SCHOOLS
REOPENING SCHOOLS HAS BEEN TOP OF MIND FOR U.S. AND GLOBAL POLICYMAKERS

Key considerations include:

1. **What is the estimated risk from reopening?**
   Health risk to parents, staff, and students from reopening

2. **What is the scope of reopening?**
   Balancing risk and economic importance of reopening schools vs. businesses

3. **How do we reopen safely?**
   Best practices for reopening schools and how reopening is playing out across the U.S.

4. **What are the key considerations for colleges (vs. k-12)?**
   How college reopening differs in approach and impact than k-12 reopening
RISK IS MATERIALLY LOWER FOR YOUNGER PEOPLE, POTENTIALLY ALLOWING FOR GREATER CIRCULATION AND PARTICIPATION IN ECONOMIC ACTIVITY... (1/4)

While infection is prevalent in those under the age of 60, the risk for hospitalization and death is severely diminished in younger age groups.

Asymptomatic patients tend to be younger

Age distribution of patients, by symptoms

Wuhan, 2020

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Asymptomatic</th>
<th>Symptomatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-17</td>
<td>321</td>
<td></td>
</tr>
<tr>
<td>18-44</td>
<td>2,187</td>
<td></td>
</tr>
<tr>
<td>45-64</td>
<td>3,553</td>
<td></td>
</tr>
<tr>
<td>65-74</td>
<td>3,562</td>
<td></td>
</tr>
<tr>
<td>75+</td>
<td>4,301</td>
<td></td>
</tr>
</tbody>
</table>

Case rates by age

New York City, 2020

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Cases per 100k</th>
<th>Hospitalizations per 100k</th>
<th>Deaths per 100k</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-17</td>
<td>30</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>18-44</td>
<td>241</td>
<td>859</td>
<td>184</td>
</tr>
<tr>
<td>45-64</td>
<td>3,553</td>
<td>1,666</td>
<td>603</td>
</tr>
<tr>
<td>65-74</td>
<td>3,562</td>
<td>1,503</td>
<td></td>
</tr>
<tr>
<td>75+</td>
<td>4,301</td>
<td>2,647</td>
<td></td>
</tr>
</tbody>
</table>

1. Risk of reopening

© Oliver Wyman 1. Jama; 2. NEJM
...BUT YOUNGER AMERICANS ARE DRIVING THE SPREAD AND TRANSMITTING THE VIRUS TO OLDER POPULATIONS (2/4)

Younger Americans continue to drive case growth...
- 60% of new cases come from Americans younger than 50
- This trend also exists at a regional level, with Wisconsin cases driven by patients younger than 30
- Infected cases younger than 60 are ~3x more likely to infect others than older cases, though it is unclear if this is the result of biological factors, behavioral, or both

... and case increases in younger cohorts tend to precipitate increases in older ones
- As seen above, outbreaks in younger individuals occur ~4-15 days ahead of outbreaks in older individuals
- Anecdotal evidence suggests that outbreak in younger Americans may happen earlier in a given region due to higher incidence of risky behaviour

A smart reopening strategy may allow the less at risk to return to school and work in order to drive economic recovery while carefully protecting the more vulnerable (e.g., elderly, those with comorbidities, residents and workers of long-term care facilities)
THOUGH CHILDREN HAVE MADE UP AN INCREASING PROPORTION OF NEW CASES, THAT TREND IS NOT ASSOCIATED WITH SCHOOL REOPENINGS... (3/4)

New weekly cases
Among US children

Though cases have increased over time, children are still significantly underrepresented in COVID metrics (~24% of total US population vs. ~15% of COVID cases & ~3% hospitalizations)

COVID cases and hospitalizations were growing faster among children than the rest of the population before school reopening, but that trend has largely stabilized since schools began reopening in mid-August
More children are getting sick and being hospitalized than early on in the pandemic, but that has not translated to higher risk of negative outcomes to the children themselves. Thus, **primary risk from reopening schools is from increased opportunity for transmission to family members and outside contacts**, as well as risk of illness to teachers and other staff.
# Reopening Schools May Require High Risk Businesses to Stay Closed or Significantly Change Operations to Reduce Broader Community Spread

## Risk of Reopening

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less risky</td>
<td>Can easily accommodate and enforce distancing, PPE, hygiene protocols, and capacity limits; preferably outdoors</td>
<td>Car dealerships, takeout, medical appointments, outdoor recreation (e.g., golf, fishing, tennis)</td>
</tr>
<tr>
<td>More risky</td>
<td>Can reasonably implement safety protocols, but contact above recommended levels is likely; indoor activities that facilitate transmission</td>
<td>In-store retail, dine-in restaurants, office space (i.e., corporate buildings), public transit, appointment-based personal services (e.g., nail salon, barbershop)</td>
</tr>
<tr>
<td>Most risky</td>
<td>Can not reasonably enforce safety protocols; indoors with limited circulation; mass gatherings or events not conducive to distancing; spaces conducive to yelling/singing</td>
<td>Movie theaters, bars, concerts or sporting events, religious services, gyms/fitness studios</td>
</tr>
</tbody>
</table>

## Reopening Risky Businesses Should Take Place Under Specific Circumstances and with Abundant Safety Measures

- **Reopening should likely wait until cases are extremely low**
  - New daily cases were <20 when **Norway**, **Finland**, and **Hong Kong** reopened bars; Finland and Norway have remained open since.
  - **New Zealand** waited until it had multiple consecutive weeks of no new cases to reopen large gatherings and sporting events.
  - Concerts are still banned in a variety of successful countries, including **Germany** and the **Netherlands**.

- **The “new normal” requires new standards and operating procedures**
  - Sports in **Norway** have reopened with strict measures determined by current infections, allowing for continuous operation.
  - Movie theaters throughout Europe and Asia have begun reopening, albeit with limited capacity, plastic dividers to separate staff/patrons, and limited concessions.
  - **Germany** instituted a singing ban for reopened churches.

- **Authorities should be prepared to reclose if necessary**
  - It is likely too early to fully determine the impact of reopening high risk businesses; reclosing may be necessary in light of rising cases.
  - **South Korea** quickly shut down bars and nightlife when an outbreak was traced to a series of clubs; they remain shut.
  - **China** broadly shut down high risk businesses after an outbreak in Beijing; they remain shut.

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IN A TRADE-OFF BETWEEN REOPENING SCHOOLS AND LONGER CLOSURES FOR RISKY INDUSTRIES, THE ECONOMIC BENEFIT IS GREATER FROM SCHOOL REOPENING

Selective business closures may result in an economic net benefit if the parental labor force can return to work

- **Reopening schools is critical for our economy**
  - Over 1/3rd of all families in the US have children under the age of 18 and at least one working parent
  - As seen in the table at right, working parents (including single parents) represent a substantial proportion of the American labor force, and over 1/3rd of essential workers
  - As seen in the chart at right, a nationwide shutdown for only one month could reduce economic productivity by over $50B

- Thus, the **United States should consider longer shutdowns of high risk businesses** in order to adequately control community transmission and enable school reopening
  - The top three industries deemed highest risk by the Texas Medical Association have gross contributions to GDP far smaller than the potential impact from school shutdowns
  - Assuming community spread is controlled through economic shutdowns to the point that schools can reopen nationally, **there is a substantial net benefit**
  - Though industry shutdowns have effects beyond the shutdown period revenue impacts, school shutdowns are still an order of magnitude more disruptive

---

### Labor contribution from parents, 2019

<table>
<thead>
<tr>
<th></th>
<th>Total Individuals</th>
<th>Estimated % of US Labor</th>
<th>Estimated annual earnings</th>
</tr>
</thead>
<tbody>
<tr>
<td>All parents w/ children &lt;18</td>
<td>64.5 MM</td>
<td>38%</td>
<td>$2.9T</td>
</tr>
<tr>
<td>Single parents w/ children &lt;18</td>
<td>9.8 MM</td>
<td>6%</td>
<td>$291B</td>
</tr>
</tbody>
</table>

### Economic impact of business closures

**United States, $BN**

**Risk industries**

- **Bars**
- **Live music**
- **Live sports attendance**

**Schools**

<table>
<thead>
<tr>
<th>Estimated gross revenues by time period, 2019</th>
<th>4 weeks</th>
<th>6 weeks</th>
<th>12 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bars</td>
<td>$5.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Live music</td>
<td></td>
<td>$76.7</td>
<td></td>
</tr>
<tr>
<td>Live sports attendance</td>
<td>$10.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Estimated productivity loss from school closures by duration</th>
<th>4 weeks</th>
<th>6 weeks</th>
<th>12 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>$51.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$76.7</td>
<td></td>
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</tbody>
</table>

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1. BLS; 2. US Census; 3. Risky determined by the Texas Medical Association; 4. National Restaurant Association; 5. Statista; 6. Statista; 7. NYU; Model methodology involves estimating households most likely to miss work due to childcare needs and utilizing existing earnings and industry data to value the effect of their absence on the economy; 8. CEPR; 9. Estimated impact utilize annual gross revenues by industry and assuming gross revenue generation is constant across time periods within a year;
MANY WESTERN EUROPEAN COUNTRIES ARE RE-ENTERING ANOTHER WAVE OF LOCKDOWNS, BUT KEEPING SCHOOLS OPEN

Countries with announced second lockdown orders, but keeping school open

Overall, keeping schools open does not appear to be driving further case expansion

• Medical experts have stated that with proper precautions, the rate of COVID-19 transmission in school settings is low, especially with younger students
  – In Canada, schools have remained open despite cases overall increasing. The rate of Covid-19 infections has increased in people under 20, but most of these cases have been contracted outside of school settings and large outbreaks in schools remain rare
  – In Finland, the reopening of schools in May did not cause an increase in COVID-19 infection rates among students, according to Finnish authorities as well as no major outbreaks within schools
  – In Spain, an analysis of regions during their second wave of infections in late Summer did not find any spikes in COVID-19 cases due to school reopenings

• Precautions are key as Israel resumed in-person instruction this summer without social distancing and mask requirements, leading to a case surge

1. NYT; 2. Washington Post; 3. Xinhuanet; 4. NPR
3. Reopening safely

EXPERIENCE AROUND THE WORLD INDICATES THE DEGREE OF RISK INCREASES WHEN THERE IS HIGH COVID-19 SPREAD IN THE COMMUNITY

Reopening schools in areas with low community spread

• In South Korea and Australia, schools reopened when community spread was low

• An analysis of 11,000 school-aged children in Seoul found no sudden increase in pediatric cases after school reopening

• Similarly, an analysis of school reopenings in New South Wales found that only 25 out of 7,700 schools reported an initial COVID-19 infection

• The success of school reopenings in both countries can be attributed to the strong public health response that involved high levels of testing and effective contact tracing

Reopening schools in areas with high community spread

• In Jerusalem, schools reopened when community spread was high

• 10 days after reopening, a major COVID-19 outbreak occurred in a single high school that resulted in the infection of 153 students and 25 staff members

• 87 additional infections occurred outside the school due to contact with infected students

• One potential factor in the mass outbreak was an extreme heat wave (above 40 °C), during which the school exempted students from wearing masks indoors and continuously operated indoor air-conditioning

Sources: 1. Nature (link); 2. medRxiv (link); 3. The Lancet Child and Adolescent Health (link); 4. Eurosurveillance (link).
BEST PRACTICES FOR REOPENING SCHOOLS HAVE EMERGED OVER THE PAST FEW MONTHS

### Planning for reopening

- **When to reopen**
  - **Community spread should be low**: though there is no consensus on exact thresholds, successful countries generally have had \( \sim 1-4 \) new cases/100k at reopening\(^1,2\)
  - Thresholds should be clearly defined and communicated to enable effective planning
  - Some US localities are using % positive rates as thresholds for reopening, including NY state (5%)\(^3\), and NYC (3%)\(^4\), while others, like MN, will use case rates (<100/100k in 14 day period)\(^5\)
  - Generally, epidemiologists agree upon a 5% positive rate as an adequate threshold for reopening\(^8\)
- **For whom to reopen**
  - Several studies suggest transmission is less common among children <10\(^6\), though those aged 10-19 may be more likely to transmit compared to adults\(^7\)
  - Hybrid schedules or prioritizing the return of younger children may limit risk while focusing on age groups for which distance learning is not as effective
  - Reopening schools for vulnerable populations should also be prioritized

### Executing reopening

- **Limit importation**: The first priority should be to stop cases from entering the school
  - Health screening paired with testing (health screening alone unlikely to effectively diagnose infection)
  - Strict policies on symptomatic individuals or close contacts staying home
  - Limit unnecessary visitation (i.e., parents)

  **If the virus makes it into a school...**

- **Limit transmission**: The school environment should be as safe as possible, including:
  - Proper ventilation and air quality
  - Sanitized surfaces and materials
  - Mask mandates for students/employees
  - Social distancing to the extent possible (enabled by hybrid schedules)
  - If distancing not possible, physical barriers paired with good ventilation/airflow

  **If the virus does transmit within a school...**

- **Limit impact**: Interactions should be limited so that a transmission event does not effect the entire school/community
  - Consistent student cohorts with limited interaction between cohorts
  - Limited movement, including restricting cohorts to a single classroom

### Continuing operations

- **When to reclose**: Schools and the relevant authorities should have a clearly defined and communicated response to any positive cases within the student body or staff that includes:
  - Defined threshold of positive cases at which the school recloses
  - Clearly defined plan or policy for when to reopen (likely will be able to utilize primary reopening plan thresholds)
  - Testing policies allowing for rapid diagnosis
- **How much to reclose**: Extent of closures can vary – plans should consider extent and duration to reclose and clearly communicate those specifications, e.g:
  - **Taiwan** suspends a specific class or grade for 14 days if a student tests positive
  - **Israel** shuts down entire schools indefinitely if a student tests positive
  - **South Korea** shuts down all schools indefinitely in an area as a general response to outbreak
  - At the very least, any students or classrooms that came into contact with the infected student should quarantine for 2 weeks
- **Continuing services** while reclosed: Authorities should prepare for extensive periods of distance learning, focusing on the continuity of instruction and other services

Many school plans have gaps in testing infrastructure and proper air ventilation/filtration

---

\(^1\) NPR; \(^2\) Center for American Progress; \(^3\) NY Gov; \(^4\) Gothamist; \(^5\) Star Tribune; \(^6\) Stat News; \(^7\) CDC; \(^8\) NYT; \(^9\) CFR
Limit importation

- At minimum, most countries have instituted temperature checks upon arrival
  - Many countries temperature check at least twice daily
- Most countries are monitoring additional symptoms, e.g.:
  - Norway has encouraged student/parent self-reporting to the greatest extent possible
  - Denmark has encouraged remote attendance if symptomatic
- Few schools have implemented routine testing, but several US universities are planning to test their students and faculty regularly
- Contact tracing varies widely by country, but some like New Zealand or South Korea have made substantial efforts to contact trace all cases tied to a school

Limit spread

- China and Taiwan have provided and mandated masks for students and teachers
- Indoor sports activities have generally been suspended
- Desks are spaced as far apart as possible, though exact distance varies by country
- Most countries have integrated frequent handwashing into daily schedules, often at least every 2 hours
- Most countries have issued guidance to wipe high-contact areas (doorknobs, desks) frequently, preferably every 2 hours
  - Additionally, guidance suggests shared materials be limited in most cases
  - These efforts are unlikely to have a large enough impact on transmission to justify the effort
- Many countries have augmented educational staff with former teachers or non-teaching staff members to enable smaller classroom sizes
- Denmark has utilized outdoor areas, gyms, libraries, etc. as secondary classrooms

Limit impact

- Many countries are embracing alternative schedules, e.g.:
  - Staggering school attendance (either by arrival time, Hong Kong, or alternating days of attendance, Austria)
  - Reducing movement by limiting classes to a single homeroom; teachers switch rooms throughout the day (Taiwan)
  - Integrating home-based learning into normal weekly schedules (Singapore)
- For younger students, Singapore divided classes into stable groups and limited interaction between groups
- Schools in Hong Kong have attempted to ensure adequate space in school facilities to separate symptomatic children from the rest of the student body

Continuing operations

- Standard response models for symptomatic children include:
  - Immediate quarantine until asymptomatic (Norway)
  - Immediate 14-day quarantine (China)
  - Quarantine of sick child and all close contacts, even if asymptomatic (Denmark)
- Generally, schools have attempted to prepare for extended re-closures
  - Curriculum and assignments are able to be completed at home (Norway, Denmark)
  - Educators have been trained for remote learning in various countries
  - The United States is developing distribution plans for students who rely on school meals
- Testing of students/staff is rare, and usually specific to certain schools or districts
- Singapore has loaned out thousands of laptops and internet enabling devices to enable home-based learning for disadvantaged students
- Uruguay has prioritized vulnerable students without strong access to the internet by beginning their phased approach with reopening rural schools
SCHOOL REOPENING PLANS VARIED WIDELY IN THE UNITED STATES ACROSS REGIONS AND EDUCATIONAL LEVELS

**Young Childcare**

- Daycares and other young childcare facilities have been reopening across the US, including in hard hit areas like NY and NJ\(^1,2\).
- These reopenings come with several safety regulations, including:
  - Temperature checks of staff and students each day
  - No parents entering/exiting facility
  - Pre-packaged meals/food
  - PPE for all in facility (staff & students)
- Other measures amend pre-existing childcare regulations:
  - Most notably, many states have instituted ratios of supervisors to children and set limits on max room occupancy
  - E.g., Massachusetts mandated a 1:5 ratio with no more than 12 people (staff and students) in a room\(^3\)
  - As childcare is increasingly viewed as a central component of allowing parents to return to work, some states are expanding these ratios over time\(^15\)
- Pre-COVID ratio mandates and the non-mandatory aspect of daycare has eased adaptation, but many care centers are reporting limited attendance and enrollment, either due to parental health concerns or budget constraints\(^4\)
- Even with full enrollment many daycare providers are unsure how long they can remain in the black, due to lower class sizes and increased budget for sanitary materials\(^16\)

**K-12**

- Strong pressure from Federal Govt. to reopen quickly
- From a limited survey of K-12 schools, roughly ~20% are currently in-person with full capacity, with another ~35% solely utilizing distance learning\(^18\)
- A common theme, with ~45% of surveyed schools, is a hybrid model, limiting hours and capacity for in-person learning
  - NYC has planned for most students to attend 2-3 days a week, with online learning on the other days\(^5\)
  - Voluntary attendance is common; NYC and Santa Ana are allowing students to engage in 100% distance learning\(^6\)
  - Other potential models include an AM/PM split, remote attendance for older students so that younger ones can use excess facilities, or in-person learning for core subjects only\(^7\)
- Reopening is dependent on severity of outbreak:
  - New York has issued data-driven guidance, utilizing a <3% daily infection rate as gating criteria to keep schools open in a given area\(^12\)
  - Other large school districts, like the Los Angeles and San Diego school districts announced full distance learning in the fall\(^14\)
  - However, these distance learning plans have been met with resistance from parents, as they claim the efficacy is too low to give their children adequate education\(^17\)
- Generally, states have not offered data-driven guidance on reclosing schools with confirmed cases, giving autonomy to local authorities

---

**EARLY EVIDENCE SUGGESTS THAT K-12 SCHOOLS HAVE NOT FREQUENTLY BEEN HOME TO SUPER-SPREADER EVENTS**

Infection rates in k-12 schools\(^1\)

| Date Range       | Student Confirmed Rate | Staff Confirmed Rate |
|------------------|                        |                     |
| 8/31 - 9/13      | 0.08%                  | 0.09%               |
| 9/14 - 9/27      | 0.14%                  | 0.14%               |
| 9/28-10/11       | 0.16%                  | 0.24%               |
| 10/12-10/25      | 0.35%                  | 0.19%               |

**To date, k-12 schools do not appear to be driving substantial case growth**

- As seen above, <0.2% of students in a large sample of k-12 schools had confirmed cases during September
- Though staff rates were slightly higher, they were still very low in absolute terms

**Note:** Sample dataset has increased in size (~17,500) but is still heavily skewed towards reporting in the Northeast US, and may not be representative of the k-12 picture throughout the country

---

\(^1\)Qualtrics, Brown University; Data is from survey sample of 882 schools, including elementary, middle, and high schools operating under in-person or hybrid learning models (response rate varies by question); Infection rate defined as total confirmed cases in subpopulation over specified time period divided by estimated daily in person population during specified time period

\(^2\)School outbreak is defined as two or more laboratory confirmed COVID-19 cases among students or staff with onsets within a 14 day period, who are epidemiologically linked within the school setting, do not share a household, and were not identified as close contacts of each other in another setting during standard case investigation or contact tracing.

---
**RECLOSURES: IN THE NORTHEAST, GUIDANCE ON SCHOOL CLOSURE VARIES BY STATE AND GENERALLY ALLOWS FOR LOCAL HEALTH OR EDUCATION AUTHORITIES TO OPINE ON THE SPECIFIC SITUATION**

A single classroom is likely to be closed when....
- There is a single confirmed case OR outbreak is limited to single classroom
- The local education authority or public health department specifically recommends a closure

Multiple classrooms are likely to be closed when...
- There are multiple cases in the school, within different classrooms
- The local education authority or public health department specifically recommends a closure

Entire schools are likely to be closed when...
- There are multiple cases in the school, within different classrooms, where:
  - Contact tracing indicates that significant in-school, cross-classroom spread was occurring
  - Contact tracing is inconclusive in establishing a link between the cases
- Overall level of community transmission is relatively high\(^1\)
- The local education authority or public health department specifically recommends a closure

With the exception of NY and NJ, Northeast states have avoided imposing strict quantitative criteria for reclosure, instead planning to rely on a case-by-case, holistic assessment from relevant authorities

---

WHILE UNIVERSITIES HAVE COMMON PLAN COMPONENTS, EXECUTION IS VARIED, LEADING TO MIXED RESULTS

<table>
<thead>
<tr>
<th>Testing</th>
<th>Quarantines</th>
<th>Monitoring and policing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Universities are attempting to test their student body, though plans and resources vary significantly across campuses</strong></td>
<td><strong>After identification, students are generally asked to self-isolate, though stringency and enforceability of these requests also vary</strong></td>
<td><strong>Some schools attempt to monitor and enforce both quarantines and general social distancing requirements</strong></td>
</tr>
<tr>
<td>- On-campus testing is heterogeneous across campuses; testing can range from regularly mandated to fully optional</td>
<td>- Some states, such as NY or VT, have mandated pre-instruction quarantine for any incoming students⁸</td>
<td>- Schools are hiring specific police units or asking students to self-report COVID gathering violations¹² while some grassroots efforts by students to monitor their peers have emerged¹⁷⁺¹⁸</td>
</tr>
<tr>
<td>- Some students have expressed frustration at lack of testing availability¹², and few campuses have the capacity to test adequately, according to experts¹³,¹⁴</td>
<td>- Many other colleges have instituted specific self-isolation mandates for affected individuals or entire living arrangements⁹,¹⁰</td>
<td>- In many cases, harsh penalties including suspension, expulsion, and revoking of on-campus housing rights have followed student violations of COVID policies³,⁴,⁵</td>
</tr>
<tr>
<td>- Some campuses are addressing this capacity issue through wastewater testing as a way to test large samples and identify need for individual testing (more information on slide 82)</td>
<td>- Breadth of quarantines vary substantially, with unclear regulations at many schools</td>
<td>- Some students and experts argue the burden of responsibility is unduly falling on students, blaming a lack of planning and cohesive messaging by the universities⁶,⁷</td>
</tr>
<tr>
<td>- However, even where testing capacity is plentiful, such as UIUC, student behavior can still allow COVID to spread rapidly¹⁵</td>
<td>- Infrastructure to support quarantines varies widely as well, with many students unable to secure food or supplies¹⁶</td>
<td>- Others argue it is a reasonable expectation, especially given the public health consequences of COVID spread⁶,⁷</td>
</tr>
</tbody>
</table>

**Key Takeaways**

- Testing is a key cornerstone of university COVID-response to ensure rapid identification of cases; however, few campuses have adequate capacity
- Once identified, students need to self-isolate in order to mitigate spread; Behavioral compliance is as important as testing and identification
- Universities have adopted a variety of tactics to encourage behavioural compliance; further study needed to the most effective efforts

---

COLLEGE REOPENINGS DRIVE INITIAL OUTBREAKS IN COLLEGE TOWNS AND CONTINUE TO CONTRIBUTE TO RISING CASE GROWTH

New cases per 1m, 7-day moving average

College towns with highest case growth

- Ames, IA (Iowa State)
- South Bend, IN (Notre Dame)
- Provo, UT (BYU)
- LaCrosse, WI (UW - LaCrosse)

Reopening colleges can have a dramatic effect on case rates in their local towns...

- The towns above, some of the hardest hit by college reopening, show a general trend of immediate spikes caused by returning students, followed a smaller decline; Despite this decline, **students returning has a lingering effect on community spread**
- New research (in preprint) has suggested that reopening a college campus to students was associated with 17 incremental cases per 1m in the relevant county; restarting in-person instruction was associated with 24 incremental cases per 1m³

... And we are beginning to see state-wide impact

- Research in preprint suggested that as of September 13th, reopened colleges were driving ~3,000 new cases per day, or 7-10% of the ~40,000 new daily cases in the US
- CDC research demonstrates that an increase in case rates among young people is subsequently followed by an increase in older cohorts ~4-15 days later, suggesting that impact from outbreaks in younger populations can spread to older populations as well

1. NYT; 2. College associated cases derived from NYT data set; case growth from OW pandemic navigator model; 3. MedRxiv; 4. CDC
THERE ARE SEVERAL MEASURES THAT HIGHER EDUCATION SYSTEMS CAN TAKE TO MINIMIZE COVID-19 RISK

Behavioral rules and enforcement

- Rules
  - Strict mask wearing requirements
  - Limits on gatherings to very few people, particularly indoors (including dining)
  - Formation of students into pods, where slightly expanded activity is allowed

- Enforcement/reinforcement
  - Student ambassador program where a selected group is responsible for encouraging safe behavior
  - On-campus leaders (e.g. sports captains, club leaders) contributing additional reinforcement of safe behavior
  - Student transfer to remote learning in the event of egregious and/or repeated offenses

Strict quarantining

- Clear guidelines for quarantine criteria and requirements in the event of a positive test, for the affected individual and close contacts
  - Includes providing a clear definition of what constitutes a “close contact”
  - Confirmed cases should be isolated in separate living facilities; close contacts should be housed in separate floor until testing is done

- Ensure conditions that facilitate student transparency and quarantine compliance
  - “Concierge service” for quarantined students (laundry services, mail pickup and delivery, special meal accommodations, etc.)

Extensive testing

- Multi-pronged testing approach, including some combination of:
  - Frequent, randomized PCR testing (of a significant portion of students + staff)
  - Preferred relationships with labs so tests can be done rapidly in times of heightened need
  - Pooled testing to achieve more cost-efficient surveillance, including:
    - Wastewater testing
    - Pooled saliva testing – can be conducted at different granularities (full dorm, specific floor, etc.)

Sophisticated contact tracing

- Contact tracing team comprised of credentialed nurses with appropriate training, including:
  - Sensitivity to PHI
  - Understanding of the role of co-morbidities
  - Familiarity with best practices for recording data

- Close coordination with public health officials to understand potential spread between campus cases and the broader community
GLOBAL REOPENING AND MANAGEMENT
MONITORING FOR BEST PRACTICES ON REOPENING AND ASSESSING RISK OF FURTHER DISRUPTION

Countries across the globe are searching for pragmatic ways to balance public health with economic health.

• As leaders of many geographies have come to grips with the fact that they can not afford to keep their economies shuttered until the virus dies off, we are now witnessing a multi-faceted public health experiment globally, and across the U.S.

• **Resurgence of the virus is inevitable** in many places as regions end containment measures to restart their economies; this resurgence is beginning to be evidenced throughout Asia and Western Europe.

• Leaders may manage the staging and pacing of reopening differently, but with the consistent objective of driving consumer and employee confidence while avoiding a resurgence of cases and deaths that would require further shutdown measures and economic disruption.

• Regions are already differing in their reopening strategies – based in part on their initial experiences with the first peak, local needs, population and cultural dynamics, and available infrastructure.

• Due to high active case counts in many US states during initial reopening, strategies and experiences in those states are fundamentally different than those in Europe/Asia – however, lessons learned should be applied to understand both emerging risk and best practices for reopening in US.
**OW’S GLOBAL MONITORING CAPABILITIES PROVIDE DEEP AND ACTIONABLE INSIGHT TO GOVERNMENTS, EXECUTIVES AND PUBLIC HEALTH AUTHORITIES**

- Complete history of pandemic by region (cases, deaths, infection rates, testing)
- Daily updated case projections for select countries of interest
- Mobility indices and leading indicators
- Population risk factors, include health risks, urban density, age and demographics
- Flexible chart builder and data export tool; explore metrics from any region over any period of time

---

**Daily updated database covering 50+ metrics and 200+ countries; access to relevant COVID information in one convenient location**

**Risk tracker and dashboard identifying likely hotspots and areas of resurgence with key global archetypes**

**In-depth profiles highlighting global themes and detailed developments from any given country**

- Conventional dashboard highlighting key risk factors and current pandemic status by day
- Deep dive worksheets exploring mobility, case, and infection rate growth over variable periods of time
- Analysis of mobility correlations with Oliver Wyman derived infection rates
- Flexible segmentation and archetyping tool, with editable risk thresholds
- Timeline of key developments and government responses over the lifetime of COVID in a given country
- Key lessons learned from each region – detailed notes on what caused a country’s response to be successful (or not)
- Themes that governed a country’s COVID response policy and philosophy
- Other cultural or endogenous factors that directly affected the impact of the disease
THERE ARE A WIDE RANGE OF METRICS THAT CAN HELP INFORM THE “HEALTH RISK” OF A PARTICULAR GEOGRAPHY

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>How severe are outbreaks today?</td>
<td>What is the near-term outlook?</td>
<td>How widespread is testing and contact tracing?</td>
<td>How is human behavior changing?</td>
</tr>
<tr>
<td>• Active cases</td>
<td>• Active case forecasts</td>
<td>• % positive tests</td>
<td>• Impact of mobility on transmission</td>
</tr>
<tr>
<td>• Reproduction rate</td>
<td>• Projected reproduction rate</td>
<td>• # of people tested</td>
<td>• Changes in government stringency</td>
</tr>
<tr>
<td>• Deaths</td>
<td>• Projected deaths</td>
<td>• Level of contact tracing</td>
<td></td>
</tr>
</tbody>
</table>

These factors combined into a “health risk score”, alongside judgement on the ground, can help quickly assess the potential health risk posed by geography in a structured way.
THIS HEALTH METHODOLOGY ENABLES HEALTH RISK MONITORING CAPABILITIES SPANNING THE GLOBE

Oliver Wyman aggregate Health Risk level per country
As of November 1st, 2020

1. Highlighted countries indicate risk monitoring coverage
2. Due to the heterogenous nature of outbreaks in large countries, certain countries dealing with substantial outbreaks in certain localities (e.g., Australia) may appear to be low risk at an aggregate level;
3. Data for countries with less developed infrastructure may be lacking (e.g., Africa) – as a result, health risk scores may be less stable for those countries

© Oliver Wyman
INITIAL EPICENTRES IN EUROPE ARE IN THE MIDDLE OF A SIGNIFICANT RESURGENCE, BUT ACCOUNTING FOR UNDETECTED CASES SUGGESTS A SILVER LINING

While the magnitude of these current outbreaks compared to the first varies by country, a greater proportion of cases are being detected across the continent

1. Undetected cases vary by country and are estimated based on IFR data and deaths
AFTER ATTEMPTING TO USE NARROWER, MORE TARGETED MEASURES TO ADDRESS RENEWED OUTBREAKS, EU GOVERNMENTS ARE NOW RETURNING TO SHUT DOWNS

As cases began to rise in early fall, European countries tried to avoid full lockdown with softer measures

- European countries were hesitant to reimpose broad lockdowns or quarantine mandates over the summer, but have now begun implementing stricter local lockdowns and countrywide restrictions in the face of rising case counts
- Common measures include:
  - **Mask mandates**
  - **Localized lockdowns focused on gathering limits**; mostly strict guidelines limiting gathering sizes and household mixing
  - **Travel screenings** for returnees from high-risk areas
  - **Business closures are becoming more common**, with regions closing non-essential business and limiting food and bars to delivery
- Despite increasingly severe restrictions, **borders within the EU have remained open**, effectively widening pool of potential spreaders
  - E.g., Though Germany may effectively limit internal transmission through lockdowns, it has less ability to reduce spread from foreign cities that have no lockdowns
- **Unrest has grown as a result of new restrictions**; protests (sometimes violent) are increasing regularly in size throughout Europe, especially in hard-hit MSAs like London, Paris, or Madrid

With record case counts in late-Autumn, many European countries are re-imposing strict lockdowns

1. **France** – **new lockdown ordered on October 30th**
   - Citizens will only be allowed to leave their home for essential work, goods, medical help, or to exercise for 1 hr
   - Lockdown is expected to end on December 1st
   - Schools will remain open

2. **Germany** – **new restrictions until Nov 30th**
   - Businesses will be closed, including full closures of cinemas, gyms, saunas, and restaurants will be take-out only.
   - Hotel stays are banned and non-necessary travel is strongly advised against.
   - Schools will remain open

3. **Spain** – **nationwide curfew ordered on Oct 25th**
   - Regional leaders can modify specifics within territories and limit inter-region travel.
   - Originally expected to last 15 days, but Parliament has extended the order to May ’21

4. **The UK** – **new 4 week lockdown ordered on Nov 4th**
   - All must stay at home except for essential work and non-essential businesses will close
   - Indoor meetings and gatherings are not allowed; however, communities can still form support bubbles.
   - Schools will remain open
CASE STUDY: ISRAEL IS THE FIRST COUNTRY TO IMPOSE A SECOND NATIONWIDE LOCKDOWN OF COMPARABLE STRINGENCY TO THE FIRST

Even in regions like Israel that appear initially successful, there is a strong possibility of significant resurgence without adequate suppression measures

**COVID case trajectory in Israel**

- Israel staunched the growth of COVID in the early pandemic (*sections 1 & 2*), but eased restrictions broadly and relatively rapidly after initial suppression (*section 3*)
- With limited restrictions in place, outbreaks rapidly increased (*section 4*); **without the stringency of the initial suppression measures, case growth soon surpassed initial growth**
- Another stringent lockdown on par with the 1st (*section 5*) was put in place and after 27 days restrictions began to loosen (*section 6*)

<table>
<thead>
<tr>
<th>Date</th>
<th>Stage</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/21</td>
<td>1. Restrictions tightening</td>
<td>First confirmed case</td>
</tr>
<tr>
<td>3/15</td>
<td>2. First lockdown</td>
<td>Schools closed, public gatherings &gt;10 banned, non-essential businesses closed</td>
</tr>
<tr>
<td>3/25</td>
<td>3. Restrictions easing</td>
<td>Lockdown begins: movement restricted to immediate area</td>
</tr>
<tr>
<td>4/1</td>
<td>4. Restrictions tightening</td>
<td>Lockdown intensifies; all public gatherings banned, PPE required outside of home</td>
</tr>
<tr>
<td>4/19</td>
<td>3. Restrictions easing</td>
<td>Lockdown begins to ease; some schools, businesses reopen</td>
</tr>
<tr>
<td>5/27</td>
<td>4. Restrictions tightening</td>
<td>Almost all businesses, schools are reopened with limited to no restrictions</td>
</tr>
<tr>
<td>6/3</td>
<td>5. Second lockdown</td>
<td>Schools begin to reclose</td>
</tr>
<tr>
<td>7/6</td>
<td>4. Restrictions tightening</td>
<td>Non-essential businesses begin to reclose; capacity restrictions re-introduced</td>
</tr>
<tr>
<td>9/6</td>
<td>5. Second lockdown</td>
<td>Partial lockdown (curfew &amp; business closures) instituted in certain communities</td>
</tr>
<tr>
<td>9/13</td>
<td>5. Second lockdown</td>
<td>Nationwide lockdown begins; movement restricted to immediate area</td>
</tr>
<tr>
<td>9/25</td>
<td>6. Lockdown loosening</td>
<td>Lockdown intensifies; increased restrictions on public gatherings (incl. protests)</td>
</tr>
<tr>
<td>10/22</td>
<td>6. Lockdown loosening</td>
<td>Lockdown easing requirements reached (fewer than 2,000 daily new cases)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Schools, salons, synagogues allowed to reopen</td>
</tr>
</tbody>
</table>
CASE STUDY: VIETNAM HAS AVOIDED SUBSTANTIAL IMPACT THROUGH STRINGENT MEASURES IN PLACE DURING MOST OF THE PANDEMIC

COVID case trajectory in Vietnam

- Vietnam almost immediately introduced stringent restrictions and lockdowns (sections 1 – 3), waiting until new cases were non-existent to begin easing them.
- **The process of easing restrictions was slow and deliberate**, allowing for careful observation of the effects of doing so (section 4)
- **Ultimately, this careful easing allowed Vietnam to react decisively in a targeted manner when resurgence occurred**, limiting peak active cases to no more than ~35 (section 5)
- Resurgence is inevitable, but well-paced lifting of restrictions enables effective government response and mitigates overall impact

Evolution of restriction measures

<table>
<thead>
<tr>
<th>Date</th>
<th>Stage</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/23</td>
<td>1. Restrictions tightening</td>
<td>First confirmed case</td>
</tr>
<tr>
<td>1/31</td>
<td>First wave of lockdowns</td>
<td>Schools closed, public gatherings &gt;10 banned, non-essential businesses closed</td>
</tr>
<tr>
<td>2/13</td>
<td>First lockdown begins – commune of 10k near capital under stringent quarantine</td>
<td></td>
</tr>
<tr>
<td>3/22</td>
<td>Visas suspended and entry denied to all foreigners</td>
<td></td>
</tr>
<tr>
<td>3/31</td>
<td>Nationwide isolation ordered; mandatory quarantine for all residents</td>
<td></td>
</tr>
<tr>
<td>4/23</td>
<td>Isolation measures ease; businesses begin to reopen</td>
<td></td>
</tr>
<tr>
<td>5/4</td>
<td>Schools reopen for limited in-person instruction</td>
<td></td>
</tr>
<tr>
<td>6/11</td>
<td>Risky businesses (bars, nightclubs) reopen with restrictions</td>
<td></td>
</tr>
<tr>
<td>6/27</td>
<td>First international flights resume (Japan)</td>
<td></td>
</tr>
<tr>
<td>7/28</td>
<td>Affected region of Da Nang placed under lockdown, domestic travel restrictions instituted</td>
<td></td>
</tr>
<tr>
<td>9/5</td>
<td>Lockdown and social distancing measures begin easing in Da Nang</td>
<td></td>
</tr>
<tr>
<td>9/15</td>
<td>6 additional countries (all Asian) allowed to resume international flights</td>
<td></td>
</tr>
<tr>
<td>Theme</td>
<td>Case Study #1</td>
<td>Case Study #2</td>
</tr>
<tr>
<td>-------</td>
<td>--------------</td>
<td>--------------</td>
</tr>
<tr>
<td>1. Effective monitoring and swift reaction to new COVID developments is integral to avoiding further escalation</td>
<td>Germany’s “emergency brake” measures and strong testing capacity ensure that local clusters can be quickly identified and addressed, avoiding increased loss of life and economic disruption from country-wide suppression measures</td>
<td>Outbreaks in factories and plants in the United States have increased due to limited testing capacity and a fragmented and underfunded public health infrastructure; not shutting the plants down likely led to higher case counts</td>
</tr>
<tr>
<td>2. Intra-country mobility is often correlated to infection rates, but proper public behavior and strong government management may mitigate mobility risks</td>
<td>Countries like the United States, United Kingdom, and Mexico all have strong correlations between infection rates and population mobility. However, mobility alone likely does not fully encapsulate the risk posed by large factories or plants deemed “essential”</td>
<td>Despite relatively low reduction in social distancing (~15% reduction from normal at peak vs ~50-60% in many European countries and the US), South Korea has mostly maintained control through a combination of effective testing and tracing, as well as population compliance with social distancing and hygiene</td>
</tr>
<tr>
<td>3. Most countries have logically prioritized risk profiles in determining reopening plans; economic dependencies should also be considered</td>
<td>Denmark and Norway both reopened primary schools and kindergartens very early compared to other Western nations; when doing so, they explicitly noted the decision was driven in part by the high burden of care placed on parents of young children, limiting their ability to work (either from home or on-premise); their decision has not (yet) impacted case growth</td>
<td>The United States has struggled to balance economic activity and public health with regards to childcare, especially as schools begin planning for the beginning of the Fall ’20 term: For example, Florida State University was recently forced to walk back a policy that stated employees could not care for their children while working remotely</td>
</tr>
</tbody>
</table>
### LESSONS LEARNED – KEY GLOBAL THEMES ON RE-OPENING (2/2)

<table>
<thead>
<tr>
<th>Theme</th>
<th>Case Study #1</th>
<th>Case Study #2</th>
</tr>
</thead>
</table>
| 4. Schools should be prepared to A) institute strict prevention measures and B) shut down again if necessary | Denmark, Norway, and Taiwan have all been operating schools throughout May and June. To do so safely, they have instituted daily temperature checks, limited class sizes, and instituted social distancing requirements in classes | “Second” closure can be a targeted measure or a blunt one:  
- Taiwan and Israel will close down specific schools if students, teachers, or administrators have tested positive  
- South Korea re-closed some schools as a reactive measure against rising case counts |
| 5. Consumer confidence and spending is very likely to increase as reopening occurs, but return to pre-COVID levels will take time | As of late June, the United States has seen both consumer confidence and perceptions of financial security rise as the economy has reopened, but indices are still far below pre-pandemic levels, and recent resurgence across the US threatens economic activity again | In China, consumer sentiment has risen fairly steadily since reopening began, and some nonessential spend is increasing above usual rates, suggesting a potential “new normal” with relatively high personal discretionary spend, but limited spend on high-risk activities (travel, dining, etc.) |
| 6. Protecting vulnerable populations (incl. the elderly) is key to managing case and fatality rates | In Ireland, the elderly were excluded from early easing of restrictions to better protect their health, though many countries in Europe disagree with differential age restrictions for mental health reasons | Germany has released some low risk inmates throughout the crisis in order to ensure quarantine space within prisons, mitigating infection risk |
US REOPENING & MANAGEMENT
THERE ARE A WIDE RANGE OF METRICS THAT CAN HELP INFORM THE “HEALTH RISK” OF A PARTICULAR GEOGRAPHY

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>How severe are outbreaks today?</td>
<td>What is the near-term outlook?</td>
<td>How widespread is testing and contact tracing?</td>
<td>How at risk is the population?</td>
<td>How is human behavior changing?</td>
</tr>
<tr>
<td>• Active cases</td>
<td>• Active case forecasts</td>
<td>• % positive tests</td>
<td>• Mask mandates</td>
<td>• Impact of mobility on transmission</td>
</tr>
<tr>
<td>• Reproduction rate</td>
<td>• Projected reproduction rate</td>
<td>• # of people tested</td>
<td>• Public transit commuters in region</td>
<td>• Change in government stringency</td>
</tr>
<tr>
<td>• ICU bed utilization</td>
<td>• Projected deaths</td>
<td>• Contact tracers per new case</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Hospitalization rates</td>
<td>• Deaths</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Deaths</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These factors combined into a “health risk score”, alongside judgement on the ground, can help quickly assess the potential health risk posed by geography in a structured way.
OUR COVID-19 PANDEMIC DATABASE, ARCHETYPE FRAMEWORK AND DETAILED STATE PROFILES PROVIDE AN UP-TO-DATE VIEW OF EVOLVING RISK

OW’s pandemic database compiles key Covid-19 information at a country, state, MSA, and county level.

Database: Rapid export and visualization of 50+ metrics across several market dimensions.


Double click into states to investigate granular views of the cities, counties, and regions driving growth.

Reopening Tracker: State-level reopening measures.
### SEVERAL THEMES HAVE EMERGED FROM THE CYCLES OF CASE GROWTH IN THE UNITED STATES

| 1 | States that have not yet seen a significant peak of case growth are at significant risk | • We have seen several cycles of case growth across the United States, but thus far, new waves are occurring in places where a prior wave had not (e.g., Southern states in the summer, Midwestern states in the fall) |
| 2 | The course can change rapidly, so constant vigilance is required | • Many of the states that originally reopened with more cautious policies or strong testing saw a later surge in cases (e.g., AZ, UT, OR)  
• States that appeared to be spared from initial outbreaks experienced outbreaks later |
| 3 | De-average, de-average, de-average: State-level trends can be misleading | • States like Alabama saw declining growth as a whole when the state reopened, but some counties were still experiencing an uptick in cases, leading to a resurgence  
• In contrast, states like Pennsylvania opened only the areas with a significant decline in cases while waiting for others to cool off, and have not yet seen a resurgence  
• New York adopted a stringent but localized policy of reimposing lockdowns on certain zipcodes with high risk indicators while allowing other areas to remain open |
| 4 | Outbreaks are driven by risky behavior; adequate compliance with COVID guidance is imperative to stopping the spread | • States (or counties) that enforce mask mandates are significantly correlated with lower case growth, with the effect increasing over time; Enforcing mask wearing early (and creating a culture of compliance) will likely reduce spread substantially  
• States with high case growth tend to have strong correlation between mobility and infection rates, suggesting lower rates of "learned behavior" and increased risk of resurgence |
| 5 | Risk increases when people are driven indoors | • Outbreaks in the South over the summer were driven, in part, by people congregating indoors in venues like bars or restaurants – this may have been influenced by the hot temperatures over the summer driving people indoors  
• As weather cools off in late fall and into the winter, we are beginning to see increased growth rates |
RESURGENCE IS EVIDENT ACROSS THE UNITED STATES, MOST NOTABLY IN THE MIDWEST AND RURAL STATES WITH MANY STATES REVERSING THEIR REOPENINGS

Data as of: 11/2

**South/West High Risk**
- Hit hard during the surge over the summer, but started to recover in early Autumn
- Cases have begun to increase over the last month and are projected to reach close to their peak summer levels over the next month

**Rural States Critical Risk**
- Rural counties now have almost double the case counts per capita as Urban areas, a reversal of the trend seen since before August
- Region is still increasing its confirmed case counts by >25%, but case growth is starting to decelerate. However, there is uncertainty around true case counts given high positivity rates

**Midwest Critical Risk**
- Moderately spared during the initial outbreak and during early summer, but now driving the Autumn wave
- Some states still have inadequate testing to properly assess current case growth
- Region has the top 5 states by case growth

**Northeast/Mid-Atlantic Moderate – High Risk**
- Generally hit hard by the initial outbreak
- Cautiously reopened after case counts declined, but some are now reversing (such as NY and MA), having learned of the necessity of restrictions during the initial outbreak
- Overall, have the strongest testing infrastructure

---

1. “Fully reopened” defined as when a majority of high risk businesses, including bars, movie theaters, or gyms, have been reopened with indoor service. This chart does not account for regulatory restrictions that may or may not be in place in those businesses, including mask wearing or capacity constraints; 2. South Carolina reports case data inconsistently, limiting analysis of case growth

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THOUGH SOUTHERN STATES HAVE DECLINED FROM SUMMER PEAKS, WE ARE NOW SEEING A RESURGENCE IN THE MIDWEST LARGER THAN THE EARLIER PEAKS

Active cases per million by state
As of November 2nd, 2020
CURRENTLY, ALL BUT 1 OF THE LARGEST 25 MSAS ARE EXPERIENCING CASE GROWTH AND MOST ARE PROJECTED TO CONTINUE INCREASING

Active cases per 1M, 2-week case growth rate and case count forecasted direction for the top 25 MSAs by population
As of November 3rd, 2020

<table>
<thead>
<tr>
<th>MSA</th>
<th>Active cases per 1M</th>
<th>2 week growth rate</th>
<th>Forecast trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYC</td>
<td>1.7k</td>
<td>57%</td>
<td>▼</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>1.9k</td>
<td>49%</td>
<td>▲</td>
</tr>
<tr>
<td>Chicago</td>
<td>6.2k</td>
<td>97%</td>
<td>▲</td>
</tr>
<tr>
<td>Dallas</td>
<td>3.0k</td>
<td>22%</td>
<td>▲</td>
</tr>
<tr>
<td>Houston</td>
<td>1.7k</td>
<td>26%</td>
<td>▼</td>
</tr>
<tr>
<td>Washington DC</td>
<td>1.7k</td>
<td>38%</td>
<td>▲</td>
</tr>
<tr>
<td>Miami</td>
<td>3.2k</td>
<td>75%</td>
<td>▲</td>
</tr>
<tr>
<td>Philadelphia</td>
<td>2.2k</td>
<td>64%</td>
<td>▲</td>
</tr>
<tr>
<td>Atlanta</td>
<td>1.9k</td>
<td>14%</td>
<td>▲</td>
</tr>
<tr>
<td>Phoenix</td>
<td>2.2k</td>
<td>46%</td>
<td>▲</td>
</tr>
<tr>
<td>Boston</td>
<td>2.1k</td>
<td>49%</td>
<td>▼</td>
</tr>
<tr>
<td>San Francisco</td>
<td>0.8k</td>
<td>24%</td>
<td>▲</td>
</tr>
<tr>
<td>Riverside</td>
<td>2.2k</td>
<td>21%</td>
<td>▲</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MSA</th>
<th>Active cases per 1M</th>
<th>2 week growth rate</th>
<th>Forecast trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detroit</td>
<td>3.2k</td>
<td>109%</td>
<td>▼</td>
</tr>
<tr>
<td>Seattle</td>
<td>1.4k</td>
<td>45%</td>
<td>▲</td>
</tr>
<tr>
<td>Minneapolis</td>
<td>5.2k</td>
<td>99%</td>
<td>▲</td>
</tr>
<tr>
<td>San Diego</td>
<td>1.4k</td>
<td>26%</td>
<td>▲</td>
</tr>
<tr>
<td>Tampa</td>
<td>2.1k</td>
<td>27%</td>
<td>▲</td>
</tr>
<tr>
<td>Denver</td>
<td>5.4k</td>
<td>119%</td>
<td>▲</td>
</tr>
<tr>
<td>St. Louis</td>
<td>4.5k</td>
<td>37%</td>
<td>▲</td>
</tr>
<tr>
<td>Baltimore</td>
<td>1.8k</td>
<td>53%</td>
<td>▲</td>
</tr>
<tr>
<td>Charlotte</td>
<td>2.9k</td>
<td>21%</td>
<td>▲</td>
</tr>
<tr>
<td>Orlando</td>
<td>2.2k</td>
<td>27%</td>
<td>▲</td>
</tr>
<tr>
<td>San Antonio</td>
<td>1.3k</td>
<td>-55%</td>
<td>▼</td>
</tr>
<tr>
<td>Portland</td>
<td>1.5k</td>
<td>49%</td>
<td>▲</td>
</tr>
</tbody>
</table>

**Key:**
- **Decrease**
- 0-50% increase
- >50% increase

Information as of 11/3/20
RURAL COUNTY CONTRIBUTION TO OVERALL CASE GROWTH HAS CLIMBED THROUGHOUT THE PANDEMIC AND HAS NOW OUTSTRIPPED URBAN GROWTH

Daily new cases per 10,000 (7MA) – urban vs rural US counties
Data as of Nov 2, 2020

The first outbreak was primarily driven by large metropolitan areas, such as NYC

The second outbreak was still driven by Urban areas, but Rural counties had a higher contribution to overall US case growth than in the first outbreak

Due to population densities, most cases in the third wave are still from Urban areas, but Rural counties now far exceed the per capita case counts of Urban counties
RURAL AREAS ALSO CURRENTLY HAVE MUCH HIGHER RATES OF UNDETECTED CASES PER EACH DETECTED ACTIVE CASE, A HEADWIND TO CURTAILING FURTHER SPREAD

South Dakota active cases
Data as of Nov 1, 2020

Rhode Island active cases
Data as of Nov 1, 2020

South Dakota has a 50% test positivity rate, leaving many cases undetected in the population. In the US, rural areas have far worse testing infrastructure, allowing cases per capita in these regions to increase easily.

Rhode Island has a <5% test positivity rate, allowing the state to detect the majority of its extant cases.
AS CASES ACROSS THE COUNTRY SURGE, HOSPITAL SYSTEMS IN BOTH RURAL AND URBAN AREAS ARE BECOMING OVERBURDENED

Many regions across the US are nearing, reaching, or exceeding ICU capacity as cases continue to increase.

- **Idaho**: On Nov 4, many rural hospitals have reached capacity in the state and are transferring patients to city hospitals. Some city hospitals have begun to warn that they are weeks away from being forced to ration care.
- **North Dakota**: On Nov 5, 3 of ND’s 7 ICU facilities have no spare capacity.
- **Wisconsin**: On Oct 29, officials warned that ICU beds across the state would hit capacity in 2-6 weeks.
- **Minneapolis**: On Nov 4, authorities declared that ICU beds were at 98% capacity in the metro area.
- **Salt Lake City**: On Oct 16, University of Utah Health hospital hit 104% ICU capacity.
- **El Paso, TX**: On Oct 25, all area hospitals reached 100% capacity.
- **Idaho**: On Nov 4, many rural hospitals have reached capacity in the state and are transferring patients to city hospitals. Some city hospitals have begun to warn that they are weeks away from being forced to ration care.
- **Wisconsin**: On Oct 29, officials warned that ICU beds across the state would hit capacity in 2-6 weeks.

In the US, rural areas have 40% fewer ICU beds per capita than urban areas. More than half of all rural low-income communities in the US have 0 ICU beds.


© Oliver Wyman
Mask mandates continue to correlate to lower case growth and more effective case management

Mask mandates by state

Mask mandates’ impacts on case growth

- Mask mandates are highly correlated with declining case growth
  - Evidence suggests that up to 450k cases may have been avoided due to mask mandates as of May 22\(^1\)
  - A study of 15 states + DC showed that daily case rates declined by up to two percentage points after signing a mask mandate, with the effect increasing over time\(^1\)
  - Arizona saw a 75% drop over the month following the imposition of their mask mandate\(^3\)
  - Another study found a 50% decrease in case counts over 2 weeks in KS counties with mask mandates compared with KS counties without\(^4\)

- Many states have employee only mask mandates in effect: however, a study found little to no change to COVID-19 growth rates pre- and post-mandate in states that only had employee-use mandates\(^1\)

1. Health Affairs; 2. CUSP; 3. CDC; 4. University of Kansas
06
TESTING AND DIAGNOSTICS
### Three Primary Types of Tests Are Being Utilized Today; Work Is Ongoing to Improve and Expand Each Type

<table>
<thead>
<tr>
<th>Type of Test</th>
<th>Molecular Test (PCR)</th>
<th>Antigen Test</th>
<th>Serology Test (Antibody)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test detects genetic material from the virus; if present, a series of chemical reactions will copy the viral genetic material</td>
<td>Test detects antigens (pieces of the virus) that the immune system recognizes. Chemicals fragment the virus, then antibodies attached to a plate detect the fragmented antigens</td>
<td>Test detects antibodies: Y-shaped molecules made by the immune system to disable the virus or mark it for destruction; if present, antibodies will bind to a coronavirus sample</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Nasal or throat swab; some saliva tests available, though rare</th>
<th>Nasal or throat swab</th>
<th>Blood draw</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>What the Test Tells You</th>
<th>If you are infected now</th>
<th>If you are infected now</th>
<th>If you were infected in the past</th>
</tr>
</thead>
</table>

| Why It’s Helpful | Used to isolate those infected so treatment can be provided and other potential cases of infection can be traced; also removes them from circulating and transmitting the virus further | Provides the same information as a molecular test in 15 minutes and can be done in a doctor’s office | Identifies people who may have immunity and whose antibodies could be used to treat COVID-19 patients |

| Limitations | A negative result does not guarantee uninfected status in the future | A negative result does not guarantee uninfected status in the future | Unclear if antibodies provide protection, how long immunity lasts, or what level and kind of antibody response is protective; antibody levels may not represent the full picture of conferred immunity |
### THESE THREE TYPES VARY WIDELY IN COST, TURNAROUND, ACCURACY, AND AVAILABILITY

<table>
<thead>
<tr>
<th></th>
<th>Molecular (PCR)</th>
<th>Antigen</th>
<th>Serology (Antibody)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>Tests for active infections</td>
<td>Tests for active infections</td>
<td>Tests for previous infections</td>
</tr>
<tr>
<td></td>
<td>Established method to detect virus RNA</td>
<td>Detects proteins attached to the virus</td>
<td>Detects antibodies that fight the virus</td>
</tr>
<tr>
<td></td>
<td>Sample collection: Nasal/throat swab, saliva</td>
<td>Sample collection: Nasal/throat swab</td>
<td>Sample collection: Blood</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>Lab-based: $100-175/test</td>
<td>$5-25/test + $0-1.2k/machine(^1,2)</td>
<td>Lab-based: $50-150</td>
</tr>
<tr>
<td></td>
<td>Onsite: $20/test + $9k/machine(^1)</td>
<td></td>
<td>Onsite: $50-150</td>
</tr>
<tr>
<td></td>
<td>Lab-based home collection (Saliva):</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>As low as $10/test</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Turnaround Time</strong></td>
<td>Lab-based: 2-14+ days after receipt</td>
<td>Onsite: 5-15 minutes</td>
<td>Lab-based: 1-3 days</td>
</tr>
<tr>
<td></td>
<td>Onsite: 30-60 minutes</td>
<td></td>
<td>Onsite: &lt;1 hour</td>
</tr>
<tr>
<td></td>
<td>Lab-based home collection (Saliva):</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-2 days after receipt</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Accuracy(^3)</strong></td>
<td>Gold standard</td>
<td>Moderately accurate</td>
<td>Not accepted as a diagnostic test</td>
</tr>
<tr>
<td></td>
<td>&gt;95% sensitive; 100% specific</td>
<td>84-97% sensitive; 98-100% specific</td>
<td>Accuracy of these tests was under question at beginning of pandemic, but most of the bad tests have been cleared out of the market</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Negative results may need to be confirmed with PCR test</td>
<td></td>
</tr>
<tr>
<td><strong>Availability</strong></td>
<td>Lab-based: High</td>
<td>Limited mfg. capacity but rapidly increasing</td>
<td>Lab-based, Onsite: High</td>
</tr>
<tr>
<td></td>
<td>Onsite, Saliva: Limited but increasing</td>
<td>High availability expected by end of year</td>
<td>Many tests with FDA EUA</td>
</tr>
<tr>
<td></td>
<td>PCR reagent supply may cause delays in lab</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Many tests with FDA EUA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Costs represent the materials price from manufacturer. Additional costs may be incurred from test provider.  
2. Abbott BinaxNOW test does not require a testing machine. $1.2k based on cost of Quidel Sofia testing machine; other antigen test costs TBD  
3. Sensitivity measures the rate of true positives, whereas specificity measures the rate of true negatives
IN ADDITION, THERE ARE THREE EMERGING COVID-19 TEST TECHNOLOGIES THAT ARE EXPECTED TO ENTER THE MARKET AT SCALE OVER THE REST OF 2020

<table>
<thead>
<tr>
<th><strong>LAMP</strong></th>
<th><strong>CRISPR</strong></th>
<th><strong>Next Gen. Sequencing</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Offers PCR-level accuracy with less required lab equipment and reagents</td>
<td>Offers lab-based test or onsite rapid test that produces PCR-level accuracy without need for PCR reagents</td>
<td>Capable of accurately processing up to 3,000 samples simultaneously</td>
</tr>
</tbody>
</table>

| **Description** | Tests for active infections Emerging method to detect viral RNA Sample collection: Nasal/oral swab, saliva (future) | Tests for active infections Uses gene-editing tool to detect viral RNA Sample collection: Nasal swab, saliva (future) | Tests for active infections Emerging method to detect viral RNA Sample collection: Nasal or throat swab, saliva |

| **Cost** | ~$50/test + $4.5k/machine<sup>1,2</sup> | Prices not yet published Intended as a low-cost solution | Prices not yet published More expensive than PCR equipment, will require significant investment |

| **Turnaround Time** | Lab-based: 1-3 days Onsite: .5-2 hours | Lab-based: TBD Onsite: 20 – 70 minutes | <24 hours Can process >3k samples simultaneously |

| **Accuracy<sup>3</sup>** | Potential to rival accuracy of PCR 94-98% sensitive; 98% specific | Potential to rival accuracy of PCR 95-97% sensitive; ~100% specific (claimed by companies, not market tested) | Potential to rival accuracy of PCR ~97% sensitive; 100% specific (claimed by companies, not market tested) |

| **Availability** | Lab-based, Onsite: Limited but increasing Three tests with FDA EUA | Not yet commercially available Two tests with FDA EUA Does not require reagents used by PCR | Not yet commercially available Expected to launch Fall 2020 Three tests with FDA EUA |

---

1. Costs represent the materials price from manufacturer. Additional costs may be incurred from test provider. 2. Abbott BinaxNOW test does not require a testing machine. $1.2k based on cost of Quidel Sofia testing machine; other antigen test costs TBD 3. Sensitivity measures the rate of true positives, whereas specificity measures the rate of true negatives
## COVID test types

- PCR - Lab
- PCR - Onsite
- PCR – At home (Saliva)
- PCR – At home collection
- LAMP/iAMP
- Antigen
- CRISPR
- Next Gen. Sequencing

## Desired characteristics

- **Cost:** Low cost per test and minimal purchase commitment
- **Turnaround time:** Employee testing: <24 hours; customer testing: hours
- **Accuracy:** High sensitivity (how often test correctly generates a positive result) and specificity (how often test correctly generates a negative result)
- **Test and Partnership Availability:** Test is in production and available in the market or through partnerships
- **FDA Authorization:** Received FDA approval or EUA authorization (and other regulatory bodies)
- **Acceptance:** Negative results potentially recognized by govt’s and other entities to enable physical access and gain exemptions from quarantine requirements
CURRENT COVID TESTING MARKET: THERE IS NO SILVER BULLET OR ONE TEST THAT IS THE BEST SOLUTION ACROSS ALL CRITERIA

1. Next Gen. Sequencing produces results quickly for batched tests – it will quickly identify if one sample within the batch is positive, but will require additional testing to identify the individual
2. At home PCR accuracy could be reduced due to self-collection 3. PCR lab tests are commercially available, however availability may be strained due to shortage of reagents required to conduct tests; 4. PCR tests commonly require a nasal swab – saliva tests use the same methodology as standard PCR tests but require a substantially less invasive saliva collection

© Oliver Wyman
OF THE TESTS IN THE MARKET, VERY FEW MEET AN AVERAGE COMPANY’S CRITERIA FOR AT-SCALE, RAPID TESTING, THOUGH SOME EMERGING TESTS SHOW PROMISE

Hundreds of tests available or in development

Evaluation Criteria

Takeaways

- **Cost**
- **Turnaround Time**
- **Accuracy**
- **Test and Partnership Availability**
- **FDA Authorization**
- **Acceptance**

Limited options to deploy at scale given supply availability and price levels

For certain, more targeted use cases, there are effective solutions available but cost might be a factor for some

Companies can also use a multi-prong approach with different testing solutions for different use cases, but this adds increased complexity

Testing market continues to evolve rapidly with cost, turnaround time, accuracy, and supply improvements expected to continue over the next few months
EMERGING TECH. PROFILE: NEW ABBOTT TEST SHOWS PROMISE, BUT ACCESSIBLE SUPPLY IS UNKNOWN AND IT REQUIRES MEDICAL PROFESSIONAL TO ADMINISTER

Inside the COVID-19 testing advancements that enabled the BIG 10 to resume its college football season

BinaxNOW antigen test summary
Abbott received FDA Emergency Use Authorization for BinaxNOW antigen test on 8/26

Positives:
• Potential to be a gamechanger when it comes to price, manufacturing scale and accuracy (for antigen tests)
• That being said, accuracy is still below PCR tests, which is considered gold standard and recognized by government for travel
• Nasal – not nasopharyngeal, slightly less invasive

Potential cons:
• Requires medical professional to administer and despite high production volumes, unclear of availability
• Demand for test will likely outstrip supply. Deal announced for US gov’t to purchase 150M tests

<table>
<thead>
<tr>
<th>Key facts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Type</td>
</tr>
<tr>
<td>Cost</td>
</tr>
<tr>
<td>Time</td>
</tr>
<tr>
<td>Accuracy</td>
</tr>
<tr>
<td>Display</td>
</tr>
</tbody>
</table>
EMERGING TECH. PROFILE: SALIVADIRECT IS A LOW COST, NON-INVASIVE ALTERNATIVE TO TRADITIONAL PCR TESTS

The test, developed by Yale University, is being used on NBA players and staff in the Orlando bubble.

SalivaDirect antigen test summary
Yale researchers received FDA Emergency Use Authorization for SalivaDirect PCR test on 8/15

Positives:
• Less invasive sample collection
• Low cost
• Lack of proprietary reagents will limit supply-chain related disruption
• No need for expensive startup investment in machines/instruments

Potential cons:
• Not POC or at-home; results still need to be tested in CLIA certified lab
• Slightly lower sensitivity than most standard PCR tests
• Up to 24 hour turnaround time
• Not authorized for asymptomatic individuals, though researchers are currently seeking asymptomatic FDA EUA

<table>
<thead>
<tr>
<th>Key facts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test Type</strong></td>
</tr>
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</tr>
<tr>
<td><strong>Accuracy</strong></td>
</tr>
<tr>
<td><strong>Availability</strong></td>
</tr>
</tbody>
</table>
EMERGING TECH. PROFILE: COLOR GENOMICS AT-HOME SAMPLE COLLECTION MAY BE VIABLE OPTION FOR LARGE ENTERPRISES, BUT AVAILABILITY IS LIMITED AND TURNAROUND TIME RELATIVELY HIGH

The test is offered to certain United Airlines customers before their flights to destinations with health or quarantine requirements

**SalivaDirect antigen test summary**
Color received FDA EUA for at-home collection of samples for its RT-LAMP Diagnostic Assay on 9/16

### Positives:
- Convenient sample collection; reduces bottleneck of sample collection, allowing for more efficient testing
- No need for clinical supervision; lowers labor cost
- Proven success as partner for private enterprise testing programs
- High-throughput lab in CA can process “tens of thousands” of samples per day

### Potential cons:
- Tests still need to be processed at CLIA certified labs
- Standard turnaround time
- Only available in private partnerships at this point; not available for general providers or consumers

---

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Nasal-swab based LAMP test, laboratory processed, at-home collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>Pricing unavailable; likely bespoke by client</td>
</tr>
<tr>
<td>Time</td>
<td>Turnaround time of ~1-2 days</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Not specified, but “equivalent to current gold standard”</td>
</tr>
<tr>
<td>Availability</td>
<td>Available for private partnerships (universities, airlines, etc.) but not yet available for general providers or consumers</td>
</tr>
</tbody>
</table>
## RECENT DIAGNOSTIC DEVELOPMENT NEWS

<table>
<thead>
<tr>
<th>Test</th>
<th>Recent development news</th>
<th>Recent partnership news</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCR</td>
<td>• The <strong>Israeli Health Ministry</strong> announced a new system that cuts the time to process a PCR test from several hours to one hour by automating and mechanizing the transfer of samples, shortening the time it takes to inactivate the virus, and enhancing software to quickly process the results</td>
<td>• In Britain, <strong>Liverpool</strong>, a city of 500,000 people, will receive regular PCR tests in an attempt to curb high infection rates and is seen as a test run for a <strong>national testing program</strong>&lt;br&gt;• <strong>Walgreens</strong> announced the availability of PCR tests to those <strong>age 3 and older</strong>, lowering the age from 18 previously</td>
</tr>
<tr>
<td>LAMP</td>
<td>• EUA granted to <strong>DetectaChem</strong> for portable LAMP COVID diagnostic; may be deployed for high-throughput processing at POC</td>
<td>• United Airlines has partnered with <strong>Color Genomics</strong> to offer at-home collection for Color’s rt-LAMP assay test&lt;br&gt;– Other airlines (American, JetBlue, Hawaiian) are rolling out partnerships, but none utilize LAMP technology other than United/Color</td>
</tr>
<tr>
<td>Antigen</td>
<td>• <strong>LumiraDx</strong> given EUA on 8/19 for rapid, low cost, POC test — results in ~12 min&lt;br&gt;• <strong>Abbott</strong> given EUA on 8/27 for antigen test costing only $5 per unit&lt;br&gt;• States have expanded purchasing plans for rapid antigen machines from various companies, including <strong>BD</strong> and <strong>Quidel</strong></td>
<td>• <strong>Germany</strong> is bulk-buying antigen tests in an attempt to allow visitors to nursing homes to be rapidly tested and relieve some of the anxiety around isolation&lt;br&gt;• <strong>UNITAID</strong> and <strong>Africa CDC</strong> will distribute a portion of 120 million rapid tests to 20 different African nations</td>
</tr>
<tr>
<td>CRISPR</td>
<td>• <strong>UConn</strong> researchers have validated the clinical feasibility of a rapid, low-cost CRISPR diagnostic platform that could be used for COVID&lt;br&gt;• Researchers at <strong>MIT</strong> and the <strong>Broad Institute</strong> published findings from their STOPCovid CRISPR test, showing sensitivity and specificity similar to PCR tests; Turnaround time can be &lt;1 hour&lt;br&gt;• New preprint research demonstrated effectiveness of a 5 minute, phone-based CRISPR diagnostic</td>
<td>• <strong>Mammoth Biosciences</strong> and <strong>GlaxoSmithKline</strong> partnered to develop at-home CRISPR test&lt;br&gt;• <strong>Sherlock Bio</strong> partnered with <strong>Danaher IDT</strong> to scale up production of its test</td>
</tr>
<tr>
<td>Next-generation sequencing (NGS)</td>
<td>• <strong>UCLA</strong> given EUA on 10/7 for NGS diagnostic <strong>SwabSeq</strong> that costs $10, can pool thousands of samples, and turnaround results in &lt;1 day</td>
<td>• Limited partnership news in US</td>
</tr>
</tbody>
</table>

Experimental technology is also being developed that may increase the scope and timeliness of testing — these new technologies include rapid detection from saliva, breathalyzers, soundwave detection, or gold nanoparticles. These technologies should not be considered as anything more than experimental without further study.
CURRENT SNAPSHOT: THE UNITED STATES CONSISTENTLY HAS ~20% OF THE COUNTRY WITHOUT ADEQUATE CAPACITY, THOUGH WHICH STATES REPRESENT THAT 20% VARIES OVER TIME

New cases per thousand (including undetected cases) by tests per thousand for each state
As of November 1st, 2020

Information as of 11/1/20
LATIN AMERICA CONTINUES TO STRUGGLE TO KEEP UP WITH THEIR HIGH CASE RATE, WHILE WEST EUROPE HOTSPOTS SUCH AS FRANCE AND ITALY CONTINUE TO WORSEN

New cases per thousand (including undetected cases) by tests per thousand for each state
As of November 1st, 2020
PRIVATE SECTOR TESTING IS BECOMING INCREASINGLY COMMON AS A COMPLEMENT TO PUBLIC TESTING THOUGH SUPPLY AND COST HAVE LIMITED WIDER ADOPTION

Some private institutions are currently or planning to regularly and broadly test their populations

- Universities are among the most common organizations ramping up private testing
- Companies with large workforces in confined spaces tend to be at the forefront of private sector testing
- Professional sports leagues, technology, financial services, industries etc. have also been more aggressive for employee testing
- Legislators also indicated a desire to fund regular testing at key locations, including schools, nursing homes, and prisons, though funding is to be secured

Though operational and cost considerations have limited wider adoption

**Limited implementation**
A June survey of 40 large US employers found only 6% were definitely planning to implement onsite workplace testing, with only 11% saying that regular testing was required for employees

**Cost and Frequency**
- Testing should occur multiple times a week, preferably daily, to prevent outbreaks and drive appropriate behavior
- At ~$100 USD per test, cost becomes significant for any company with multiple employees tested multiple times a week
- Emerging tech with lower cost and more rapid turnaround are not yet widely available at scale

**Strained capacity**
- Testing capacity is relatively strained throughout the United States, with turnaround times still upwards of 2-3 days in some areas
- Strain varies heavily by region, with capacity more limited in rural and Midwestern states, whereas the Northeast has more than adequate capacity

# Wastewater Testing is an Effective Complement to Standard PCR/Antigen Testing, Enabling Early Detection in Large Populations

## Overview & Benefits
- Wastewater surveillance is the regular sampling and testing of sewage water for the presence of COVID
- Enables early detection of COVID in pre- or asymptomatic individuals
- **Leading indicator independent of healthcare-seeking behaviors or clinical testing availability/capacity**
- It can be done at a micro (testing of individual buildings/residences) or macro (testing of entire municipalities) level
  - Can be used in lieu of sample pooling to increase scale of testing within discrete populations (e.g., dormitory or prison)
  - Can indicate relative levels of viral load in entire community, helping inform policy decisions and enable analysis of those decisions’ efficacy
- Unlike clinical testing, cost does not scale with increased infections

## Current status in US
- The US is developing a data portal (the NWSS) to aggregate, summarize and interpret local wastewater testing data for public health action; currently ramping up efforts through partnership with local authorities
- Both local authorities as well as private institutions are ramping up wastewater detection capabilities
- If pursuing wastewater testing “in-house”, the Water Research Foundation (WRF) has provided best practices and recommendations for setting up surveillance
- If pursuing an outside partnership, the WRF has provided a (non-exhaustive) list of laboratories interested in studying COVID in wastewater

## Case Study: University of Arizona
- University of Arizona is currently conducting regular testing of wastewater from 20 on-campus buildings
- If a sample comes back positive, the school then tests everyone who lives or works in the building using traditional PCR or antigen tests
- After detecting viral loads from one dorm, university officials were able to quickly test and isolate all 300+ students in the dorm, detecting two cases among asymptomatic individuals
- These individuals were quarantined, limiting exposure and preventing further outbreak within the dorm
- In doing so, the university detected and suppressed a potential outbreak without the need for recurring, costly and compliance-dependent schoolwide PCR testing

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1. VT Digger; 2. CDC; 3. WRF; 4. WRF; 5. NBC; 6. Stat News; 7. Technology Networks; 8. NYT;
OLIVER WYMAN PANDEMIC NAVIGATOR: FORECASTING AND SCENARIO MODELING
PANDEMIC NAVIGATOR OVERVIEW

Oliver Wyman’s Pandemic Navigator provides COVID-19 forecasts and scenarios to help policymakers and business leaders navigate the long haul of suppression.

Robust model for 90+ countries, 50 states, and 3000+ counties... ...with predictive forecasts and plausible scenarios... ...to support high-stakes policy decisions to manage the long haul of suppression

EXAMPLE USE CASES FOR POLICYMAKERS

- Provide lead time to plan for future “hotspots”
- Manage COVID-19 local outbreaks based on local hospital bed & ICU capacity
- Measure impacts of specific policy actions on future COVID-19 cases (e.g., dining restrictions, tourism policies, school reopening strategies)
- Weigh tradeoffs between various lockdown strategies and local economic impacts
- Develop tourism strategy considering COVID-19 outbreak risk locally and from feeder locations
- Assess how upcoming flu season might impact COVID-19 policy decisions

Explore select insights at [https://pandemicnavigator.oliverwyman.com/](https://pandemicnavigator.oliverwyman.com/)
PANDEMIC NAVIGATOR OVERVIEW

Over the past six months, our model is emerging as one of the top COVID-19 models according to multiple independent model comparisons.

What others are saying about the Pandemic Navigator:

- Only leading model to beat baseline forecasts 100% of weeks, compared to other CDC listed deaths forecasts.
- “A” rating according to National Forecasting Evaluation Report comparing CDC-listed models for deaths forecasts.
- Regularly recognized as leading model in independent modeler’s COVID-19 “Power Rankings”.

Oliver Wyman “instantly became one of the top-performing models since its release... one of the few other models to have estimates of true infections.”

PANDEMIC NAVIGATOR OVERVIEW
The Pandemic Navigator is informed by a wide range of data sources to produce the latest insights

- **Reported case counts** by geography (90+ countries, US states and Canadian provinces, US zip codes) daily from Johns Hopkins
- **Undetected to Detected ratios**
- **Google/Apple Mobility indices**
- **Oxford Stringency Index** evaluates the robustness of worldwide government responses by country
- **Epidemiology expertise**, including the latest medical findings
- **# of tests conducted**

**Compartmental Model**

**Health Risk Scorecard**

**Pandemic Navigator Capabilities:**

1. **COVID-19 forecasts**
   - Detected and Undetected cases, recoveries, deaths, transmission rates
2. **What-if analysis**
   - ‘What if’ capabilities linking testing and mobility to COVID-19 case forecasts
3. **Scenarios**
   - Nine plausible scenario pathways, with latest vaccine developments
4. **Health risk score**
   - Proprietary risk score, calibrating forecasts and other leading indicators
5. **Gathering risk**
   - Probability score of active COVID-19 infection in a gathering
FORECASTS

The Pandemic Navigator provides forecasts for reported cases as well as estimates for undetected cases for 90+ countries and US states & counties.

Los Angeles, CA

Show forecast →

Click on one or more counties.

Explore this view at our website https://pandemicnavigator.oliverwyman.com/
**FORECASTS: SCHOOL RE-OPENING CASE STUDY**

Using our leading forecasts, we modeled impacts of various school reopening scenarios to help one client decide what strategy to pursue.

<table>
<thead>
<tr>
<th>Impact type</th>
<th>Description</th>
<th>Impact (relative to base forecast)</th>
</tr>
</thead>
</table>
| **1**       | Increased interactions among people | • As K-12 schools and colleges reopen, opportunities for students to interact with one another and with adults (e.g. teachers, other personnel) will increase significantly  
• Due to school reopening, parents are more likely to be able to return to work and interact with others, and other community interactions may increase as well | • Sustained increase in R(t) |
| **2**       | Introduction of out-of-state higher ed. Students | • The population living (and being tested) in Vermont will experience a sudden increase due to out-of-state students, who may be more likely than a Vermonter to be COVID-positive upon entry | • Addition to New Cases during the transition |
| **3**       | Increase in testing at colleges (and potentially K-12 schools) | • Most higher ed. institutions are testing most or all students at least once upon return to campus, which will cause a sudden spike in state-wide tests  
• Many higher ed. Institutions are testing of many or all students at regular intervals during the semester, which will cause state-wide testing levels to be above the current level, even after the initial spike | • Increase in percentage of total Cases that are detected (initial spike, and then sustained elevated levels) |
| **4**       | Change in rate/effectiveness of quarantine enforcement | • Vermont seeks to ramp up quarantine enforcement and contact tracing efforts as part of school reopening  
• However, increased efforts at enforcing quarantine requirements may be offset by an infected population that is less willing on average to comply with requirements (i.e. higher ed. students) | • Potential decrease in Active Cases (dependent on assumptions) |
**SCENARIOS**

We regularly analyze 9 scenarios for the long haul, which can be used to support longer term planning through the crisis.

### Standard Scenarios

- **Crush the Virus**
- **Smart and Lucky**
- **Strong Seasonality**
  - **Plausible but Optimistic**
  - **Plausible but Pessimistic**
- **Frequent, Blunt Lockdowns**

- **Scenarios assume rapid containment of the current wave**

- **Scenarios contemplate cycles of loosening and tightening with lockdown measures the primary method of suppression**

- **Scenarios look at what it would take to manage the virus within a target range while maximizing health outcomes**

- **Scenarios explore an inability to control the virus due to a lack of government and individual will to impose necessary restrictions**

### Twin peaks

- **Slow to contain**
- **Twin peaks**
- **Health Crisis**
**SCENARIOS**

We can toggle the vaccination assumptions within any scenario, which can have a significant impact on outputs.

---

**Reported New Cases and Deaths**

2020-2021, under two different scenarios and three vaccination assumptions

<table>
<thead>
<tr>
<th>SCENARIOS</th>
<th>United States: Strong Seasonality scenario</th>
<th>United States: Plausible but Pessimistic scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>New Cases¹ (000s)</td>
<td>Deaths (000s) Oct ’20 – Dec ’21</td>
</tr>
<tr>
<td>No Vaccination</td>
<td><a href="#">Graph</a></td>
<td>280.0</td>
</tr>
<tr>
<td><strong>“Baseline” Vaccination:</strong></td>
<td><a href="#">Graph</a></td>
<td>267.2</td>
</tr>
<tr>
<td>33% coverage, coming primarily in Q3-Q4 ’21</td>
<td></td>
<td>174.6</td>
</tr>
<tr>
<td><strong>“Optimistic” Vaccination:</strong></td>
<td><a href="#">Graph</a></td>
<td>249.4</td>
</tr>
<tr>
<td>54% coverage, coming primarily in Q2-Q3 ’21</td>
<td></td>
<td>150.2</td>
</tr>
</tbody>
</table>

1. 5-day averages are shown

Notes: All scenarios assume 50% vaccine efficacy, and assume that individuals have long-term immunity after infection.

© Oliver Wyman
SCENARIOS: MACROECONOMIC IMPACTS CASE STUDY
We have linked our epidemiology scenarios to key macroeconomic indicators to help policymakers assess weigh lockdown strategies.

Macro scenarios derived from epidemiological scenarios

Pandemic Navigator outputs
\[ Active \ Covid-19 \ cases \ (000s) \]

\[ Scenario \ 1: \ Smart \ and \ also \ lucky \]

\[ Scenario \ 2: \ Plausible \ but \ pessimistic \]

\[ Scenario \ 3: \ Economic \ crisis \]

Macro variables:
\[ Unemployment \ rate \]

Methodology for macro scenarios

- The current crisis is driven by policy actions implemented to manage the pandemic. High-frequency economic data, such as weekly unemployment claims, have demonstrated high correlation with policy actions, indicating a close link between pandemic and macroeconomics.

- Key variables with direct impact on loss forecasts of consumer products are forecasted with high granularity, e.g., unemployment rates and HPI are forecasted at State-level.

- Other variables are forecasted at country level, e.g., real GDP growth rate, real income, household debt as a percentage of GDP, S&P 500, Manheim index, as well as interest rates.
SCENARIOS: SECTOR IMPACTS CASE STUDY

We also measure specific sector impacts under various epidemiology scenarios.

Select Sectors

We also measure specific sector impacts under various epidemiology scenarios.
**HEALTH RISK SCORE**

We have developed a framework to define, calibrate, and monitor several metrics into a “health risk score” for each region.

### Health Risk Score approach

<table>
<thead>
<tr>
<th>Category</th>
<th>Risk indicator</th>
<th>Risk level</th>
</tr>
</thead>
<tbody>
<tr>
<td>How serious are any current outbreaks?</td>
<td>Detected active cases per thousand</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Reproduction rate (Rt)</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>ICU bed utilization</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>COVID-19 hospitalizations per thousand</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Daily deaths per million</td>
<td>High</td>
</tr>
<tr>
<td>What is the near-term (3 week ahead) outlook?</td>
<td>Projected active cases per thousand</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Projected reproduction rate (Rt)</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Projected daily deaths per million</td>
<td>High</td>
</tr>
<tr>
<td>How widespread is testing and contact tracing?</td>
<td>% Positive tests</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td># of tests per day per thousand</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td># of contact tracers per new case</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td># of contact tracers per thousand</td>
<td>Medium</td>
</tr>
<tr>
<td>How at risk is the population?</td>
<td>% Public transit usage in region</td>
<td>Low</td>
</tr>
<tr>
<td>How is human behavior changing?</td>
<td>Week-over-week change in impact to transmission rate from mobility</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Mask wearing mandates</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>3-week change in government stringency</td>
<td>Low</td>
</tr>
</tbody>
</table>

**How are clients using this?**

- Decision-oriented health risk score distills the many factors that contribute to current and future COVID-19 outbreaks into a **single, digestible score**
- Scores are **linked to risk appetite** and play an important role in strategic and operational decisions like:
  - What operational protocols should be implemented in each location?
  - How can I **communicate changes** to COVID-19 risk to employees?
  - Between which locations can employees travel?
  - Where is there **elevated risk of disruption** in local offices?
HEALTH RISK SCORE: TOURISM CASE STUDY

Health risk scores are helping clients benchmark relative COVID-19 risk between states and counties to determine risk of COVID-19 outbreaks introduced from tourist feeder locations.

Health Risk Scores provide a quick, digestible view of local risk, which one client is using to allocate marketing spend across tourist feeder locations.

Interactive, web-based dashboard updated on a daily basis.
The Large Gathering Tool can determine the probability that at least one randomly selected attendee at an event of a given size has an active COVID-19 infection.

The tool can take into account people coming from multiple geographies: counties, cities, states, or countries.

Applications include determining the risk of large concerts, sporting events, and returning students back to school.

This determination requires more inputs, such as the dimensions of the event venue, mask requirements of attendees, and ventilation rates.

This advanced tool is useful to determine the public health risk of allowing larger gatherings.
One client is using the gathering tool to make data-driven decisions on indoor dining capacity restrictions.

### Assumptions for a sample restaurant seating

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of detected cases who quarantine</td>
<td>80%</td>
</tr>
<tr>
<td>% of undetected cases who quarantine</td>
<td>0%</td>
</tr>
<tr>
<td>Restaurant dimensions</td>
<td>100ft² per customer at maximum capacity, 9ft ceiling height</td>
</tr>
<tr>
<td>Active Cases / Million</td>
<td>VT: 107, RI: 1,371 (based on Sept 22 data)</td>
</tr>
<tr>
<td>Maximum restaurant capacity</td>
<td>100 people</td>
</tr>
<tr>
<td>Time spent in restaurant</td>
<td>2 hours</td>
</tr>
<tr>
<td>% of diners with immunity</td>
<td>0%</td>
</tr>
<tr>
<td>% of diners wearing masks</td>
<td>0%</td>
</tr>
</tbody>
</table>

### Results – Risk of contracting COVID-19 in a restaurant

For Vermont and Rhode Island

<table>
<thead>
<tr>
<th>% of maximum legal capacity</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diners from VT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability at least one person arrives infective</td>
<td>0.6%</td>
<td>1.2%</td>
<td>1.8%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Probability a random diner becomes infected</td>
<td>0.01%</td>
<td>0.01%</td>
<td>0.02%</td>
<td>0.03%</td>
</tr>
<tr>
<td>Expected number of new resulting infections</td>
<td>0.002</td>
<td>0.006</td>
<td>0.014</td>
<td>0.025</td>
</tr>
<tr>
<td>Diners from RI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability at least one person arrives infective</td>
<td>16.9%</td>
<td>30.2%</td>
<td>40.9%</td>
<td>49.5%</td>
</tr>
<tr>
<td>Probability a random diner becomes infected</td>
<td>0.20%</td>
<td>0.40%</td>
<td>0.60%</td>
<td>0.80%</td>
</tr>
<tr>
<td>Expected number of new resulting infections</td>
<td>0.042</td>
<td>0.140</td>
<td>0.266</td>
<td>0.403</td>
</tr>
<tr>
<td>Assume exactly one infective diner</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability a random diner becomes infected</td>
<td></td>
<td></td>
<td></td>
<td>1.1%</td>
</tr>
<tr>
<td>Expected number of new resulting infections</td>
<td>0.26</td>
<td>0.54</td>
<td>0.81</td>
<td>1.09</td>
</tr>
</tbody>
</table>

- Vermont’s **low active cases per capita** indicates that the likelihood that any diner arrives infected is low, which in turn yields a **low probability of another diner becoming infected**

- The inherent riskiness of indoor dining is exhibited by the notion that **if 1 of 100 diners arrives infected to a 2-hour seating, it is expected that an additional 1+ diner will become infected** during that seating.

1. Additional assumptions about technical virus transmission parameters are shown on following slide
2. Shown here indicatively using Vermont DFR’s Active Cases metric. The Large Risk Gathering Tool uses an Active Cases metric that reflects the probability that Detected and Undetected cases will be quarantining.

© Oliver Wyman
TOOL SUITE
Oliver Wyman has incorporated our wide array of COVID data and insights into an integrated tool ecosystem

The Pandemic Navigator Tools have proven features that are customizable and ready to use

Forecasting module
Up-to-date case information tailored to corporate footprint
• Country, state and county level information across 90+ countries
• Peak forecasts and estimated active cases
• Highly accurate: one of 7 models chosen for CDC website to forecast active cases

Phone app
A two-way communications channel directly with employees
• Pulse checks and key survey questions
• Symptom and temperature self-attestation
• Manage office capacity in-app, check-in/out
• Reassure employees with tailored questions

Management hub
Digitize management workflows and integrate data for governance
• COVID central “Control Tower”
• Track workplace readiness and compliance
• Contact tracing, personnel status tracking
• Many other workflows, and easy to build more
AN END TO THE CYCLE: THERAPEUTICS, VACCINES AND CUMULATIVE IMMUNITY
THREE CATEGORIES OF THERAPEUTICS COULD LESSEN THE BURDEN OF SEVERE DISEASE AND MORTALITY

<table>
<thead>
<tr>
<th>Product type</th>
<th>Description</th>
<th>Examples</th>
<th>Current state</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Antivirals and products with antiviral effects</strong></td>
<td>• Products either directly target the virus or prevent it from targeting/entering cells&lt;br&gt;• Many of these products have already been proven safe as a result of clinical trials for efficacy against other diseases&lt;br&gt;• These products generally work best when given early in the course of the disease</td>
<td>• Remdesivir (Ebola)&lt;br&gt;• Chloroquine/Hydroxychloroquine (Malaria)&lt;br&gt;• Kaletra (HIV)&lt;br&gt;• Favipiravir (Influenza)&lt;br&gt;• Avigan (Influenza)&lt;br&gt;• Lopinavir (HIV)&lt;br&gt;• Galidesivir</td>
<td>• The FDA granted full approval to Remdesivir for treating COVID-19 patients currently in the hospital; the existing EUA has been extended to patients below the age of 12 as pediatric trials on the efficacy of the treatment continue&lt;br&gt;• Approval comes after the NIH, among two other randomized trials, showed that patients on a course of Remdesivir recovered a median of 5 days faster than those who took a placebo&lt;br&gt;• Pharamasyntez, a Russian drugmaker, has asked the Kremlin for permission to produce a generic version of the Gilead drug, which will likely proceed without Gilead’s consent</td>
</tr>
</tbody>
</table>
## WHAT ARE THERAPEUTICS LIKE REMDeSIVIR AND DEXAMETHASONE DOING FOR US AND WHY THEY WON’T BE A MAGIC BULLET

<table>
<thead>
<tr>
<th>Remdesivir</th>
<th>Dexamethasone</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Potential benefits:</strong></td>
<td><strong>Potential limitations:</strong></td>
</tr>
<tr>
<td>• Initial data suggested an improvement in the recovery time of severely ill patients from 15 days to 11</td>
<td>• Trial results demonstrated a reduction in mortality in severely ill patients (29% in ventilated patients and 11% in patients on oxygen)</td>
</tr>
<tr>
<td>• This can help alleviate the pressure on hospitals (particularly ICU) and improve overall outcomes and fatality rates</td>
<td>• Among patients with acute respiratory distress syndrome (a common comorbidity), Dexamethasone was associated with 40% fewer days on a ventilator than patients who did not receive the drug</td>
</tr>
<tr>
<td>• Though a second set of data (published by the manufacturer) demonstrated a reduction in mortality in the most severely ill by 62%, some experts have criticized the study design and claim the results are unreliable</td>
<td>• This can substantially help overall outcomes and fatality rates, if used on severely ill patients and patients with comorbidities</td>
</tr>
<tr>
<td>• Trial results demonstrated a reduction in mortality in severely ill patients (29% in ventilated patients and 11% in patients on oxygen)</td>
<td></td>
</tr>
<tr>
<td>• Among patients with acute respiratory distress syndrome (a common comorbidity), Dexamethasone was associated with 40% fewer days on a ventilator than patients who did not receive the drug</td>
<td></td>
</tr>
<tr>
<td>• This can substantially help overall outcomes and fatality rates, if used on severely ill patients and patients with comorbidities</td>
<td></td>
</tr>
</tbody>
</table>

**Potential limitations:**

- Remdesivir is administered intravenously, in a hospital setting, by a trained clinician in PPE – this means it is not currently usable for prophylaxis or in early disease and does not alleviate the pressure on scarce resources (e.g., staff, PPE)
- As mentioned above, experts are still waiting on stronger evidence of reduced mortality
- Existing data does not suggest material improvements in non-hospitalized patients

**The bottom line:**

- Though the drug is effective at reducing severity in hospitalized patients, it has not demonstrated an effectiveness at reducing either mortality or hospitalization rates
- Though the drug reduces (but does not eliminate) mortality risk in severe patients, it cannot be used to prevent initial infection or the development of severe symptoms
WE WILL BEGIN TO RECOVER WHEN OUR CUMULATIVE IMMUNITY REACHES THE POSSIBLE HERD IMMUNITY THRESHOLD

**MIDST OF THE PANDEMIC**
Restrictions required to flatten the curve

**LONG TAIL END OF TRANSMISSION**
No restrictions required

Susceptible population reduces over time through natural infection and vaccination (when available)

Exponential case growth will occur without constraints on human behavior (masks, social distancing, etc.)

Virus will still circulate, and individuals can still become infected; vulnerable populations should still wear masks and practice social distancing until pHIL is achieved

Possible Herd immunity threshold (pHIT)
Transmission rate naturally declines to 1, implying subsequently decreasing new case rates *Peak of an unconstrained case curve*

Possible Herd immunity level (pHIL)
Transmission rate naturally falls to 0, implying no further transmission *Y-intercept of an unconstrained case curve*
CUMULATIVE POPULATION IMMUNITY CAN BE CONFERRED IN MULTIPLE WAYS

Building blocks of herd immunity – illustrative example

Possible Herd Immunity Level (pHIL)
The point at which transmission stops

Possible Herd Immunity Threshold (pHIT)
The point at which effective reproduction rate without most restrictions is equal to 1 and daily new cases start to decline

- Natural infection
  We assume that natural infection (including when undetected) confers immunity for at least 18 months

- Pre-existing immunity
  Some portion of the population may have pre-existing immunity mediated by T-cells, but exact implication and proportion in the population is unknown

- Vaccination
  Over time, COVID vaccinations will confer immunity and help push us towards the herd immunity threshold

- Cumulative Immunity

Some people with pre-existing immunity or undetected infection are expected to be vaccinated; this does not have incremental benefit, increasing road to herd immunity.
OUR CURRENT LEVEL OF IMMUNITY CONFERRED VIA NATURAL INFECTION VARIES WIDELY WITHIN THE UNITED STATES

Estimated infected proportion of population

Outside of a few, geographically limited areas like NYC, the US is nowhere close to achieving herd immunity through natural infection alone.

Regional variation in natural infection will lead to differential timing to achieve pHIT, as well as differential need for vaccinations to reach the threshold.

Sources: Total confirmed cases as reported by JHU, 10/7/2020; total population for MSAs as reported by Claritas. 1. Estimated total infected based on Oliver Wyman Pandemic Navigator Model; 2. Current assumption is that immunity is conferred for at least one year after infection 3. NYC includes five boroughs only, not full MSA
HOW “HOT” WE RUN GOING FORWARD MATTERS IN OUR PROGRESS TOWARDS IMMUNITY; 75K CONFIRMED CASES NOW IS NOT THE SAME AS IN APRIL

Daily new confirmed (7MA), daily new estimated undetected cases (7MA), and daily new deaths in the United States Data as of October 20, 2020

High ratio of undetected to detected implies only the sickest are being detected; as a result, mortality and hospitalization represented a large proportion of detected cases

Lower ratio of undetected to detected implies a significant number of detected mild cases; as a result, mortality and hospitalization represented a much lower proportion of detected cases

75k daily detected cases

40k daily detected cases

© Oliver Wyman
RECOVERY WILL BE AIDED BY A SUCCESSFUL VACCINE, BUT DEVELOPMENT AND PRODUCTION OF A VACCINE IS A COMPLEX, MULTI-STEP PROCESS UNDER THE STANDARD TIMELINE

<table>
<thead>
<tr>
<th>Research</th>
<th>Preclinical preparation</th>
<th>Clinical Trials</th>
<th>Approval and Licensure</th>
<th>Manufacturing</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-4 years (or more)</td>
<td>2 years</td>
<td>Up to 5 years</td>
<td>1 year</td>
<td>2 years</td>
<td>3-6 months</td>
</tr>
</tbody>
</table>

- **Research**
  - Basic scientific research
  - Antigen development
  - In vitro (cell-based) and animal trials

- **Preclinical preparation**
  - Phase 1: Safety (10’s of people)
  - Phase 2: Efficacy, dosing (100’s of people)
  - Phase 3: Safety and efficacy, comparison with placebo (1000’s of people)

- **Clinical Trials**
  - Presentation of data
  - License application
  - Inspection of manufacturing facility and product labelling usability testing
  - Technology transfer agreements

- **Approval and Licensure**
  - Scaled up production capabilities
  - Production in batches (lots)
  - Testing of all lots for safety and efficacy
  - FDA approval of each lot
  - On-going inspection of manufacturing facilities

- **Manufacturing**
  - Cold chain logistics
  - Stocking of necessary supplies (e.g., syringes, needles)
  - Education campaigns to achieve target vaccination rates

- **Distribution**

Fewer than 10% of all drug trials are ultimately approved. With most failing at the clinical trial phase (88%) and another 2-3% failing at approval.
What is the current status of all COVID vaccines in development?

- As of 11/4, there are 36 vaccines in Phase I, 14 vaccines in Phase II, 11 vaccines in Phase III, and 6 vaccines approved for early/limited use
- Two broad categories of vaccine are under development:
  - **Traditional, protein-based:**
    - Inactivated vaccine or proteins from it are grown in animal cells and then injected into the human body
    - Category has been proven to work and will rely on existing infrastructure, however will take longer to develop
    - Efforts of note: Partnership between GSK and Sanofi, Novavax
    - Potential timeline – Currently in Phase I/II combined trials, vaccine wouldn’t be approved and available until 2021
  - **Modern, nucleotide-based:**
    - mRNA, DNA or inactivated virus is injected into the human body, so that its cells can make viral proteins
    - Category has not been proven, but has a much more rapid timeline to development
    - Efforts of note: Moderna, Pfizer, AstraZeneca – J&J – Oxford University partnership, Innovio
    - Potential timeline – Phase III trials have started and trials are either close to or completely subscribed, data is yet to be released pushing an approval timeline to Q1 2021 with some as late as Q2 2021

1. Estimated timeline determined using aggregated timelines of three vaccines considered most likely to be approved in US – AstraZeneca/Oxford, Pfizer/Biontech, and Moderna; 2. Distribution and approval timelines presented here are best case scenario; it is plausible that approval and subsequent distribution are delayed through Q2 ’21 or further - distribution is unlikely to begin until after approval; 3. Duration of manufacturing/distribution will depend heavily on available production capacity from approved manufacturers, as well as total population coverage achieved; Sources: H1N1 timeline (link), Credit Suisse Equity Research, Nature (link), Artis Ventures (link), Biocentury (link) and DowJones

**EVEN WITH AN EXPEDITED TIMELINE, APPROVAL, DISTRIBUTION, AND ADMINISTRATION OF A COVID VACCINE MAY TAKE MULTIPLE YEARS**

**Estimated timeline of COVID vaccine development among frontrunners**

<table>
<thead>
<tr>
<th>Activity</th>
<th>2020</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jan</td>
<td>Feb</td>
</tr>
<tr>
<td>Research</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preclinical preparation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical trials</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Approval and licensure  |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | 1. Estimated timeline determined using aggregated timelines of three vaccines considered most likely to be approved in US – AstraZeneca/Oxford, Pfizer/Biontech, and Moderna; 2. Distribution and approval timelines presented here are best case scenario; it is plausible that approval and subsequent distribution are delayed through Q2 ’21 or further - distribution is unlikely to begin until after approval; 3. Duration of manufacturing/distribution will depend heavily on available production capacity from approved manufacturers, as well as total population coverage achieved; Sources: H1N1 timeline (link), Credit Suisse Equity Research, Nature (link), Artis Ventures (link), Biocentury (link) and DowJones
THE COVID-19 VACCINE FACES A NUMBER OF ADDITIONAL CHALLENGES

1. Timeline is compressed
   – Given the scale and impact of the pandemic, the typical timeline of 8-15 years is unpalatable
   – Basic scientific research and our understanding of the vaccine’s mechanism of action and level of mutation along with the body’s reaction to the virus is developing simultaneously to vaccine development – there is a potential that a critical piece of information will emerge and drastically impact vaccine development mid-stream
   – As a result, clinical trials are compressed – we may not have the level of data on safety and persistent efficacy that we normally would

2. Target vaccine efficacy and vaccination levels are very high
   – Modeling work has suggested a requirement of 70-80% efficacy alongside 60-75% vaccination rates
   – Some countries may have difficulty effectively vaccinating enough of the population, either due to access issues or lack of compliance (e.g., “anti-vaxxers”)

3. Sheer vaccine volume required is staggering
   – Vaccination will be required globally, given current spread of COVID-19 across the globe
   – Assuming two doses per patient, vaccinating 60% of just the adult population is ~6.5 billion doses (this is equivalent to the WHO’s estimates of annual global pandemic flu vaccine production capacity)
   – While producing these doses, it is critical that production of current vaccines remains uninterrupted (annual flu vaccine production currently requires total vaccine capacity for ~6 months each year)

4. Which processes, components and facilities will be needed at scale is an unknown
   – Vaccines under development span a broad array of types (e.g., RNA, DNA, inactivated virus, surface protein) and each carries different requirements for scaled manufacturing
   – Some require simpler processes, but will rely on entirely new infrastructure while others may leverage existing infrastructure (e.g., inactivated vaccine particle) but may have much more complex processes

5. Equitable distribution and administration also presents a challenge given Global nature of pandemic
   – Vaccine production is centered in the US, China and Western Europe
   – People living in low and middle income countries account for 79% of the world population
   – Achieving vaccination in these populations requires prevention of hoarding by wealthier countries producing the vaccines, adequate supplies (e.g. syringes, needles) and people to administer the vaccines as well as ability to maintain appropriate conditions (e.g. cold chain) while delivering vaccine to all areas

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Source: Adapted from Nature (link), Vaccine (link), Politico (link) and American Journal of Preventative Medicine (link)
### SEVERAL FRONT RUNNER VACCINES HAVE REPORTED INITIAL DATA AND ARE RAMPING UP PHASE 3 TRIALS

<table>
<thead>
<tr>
<th>Vaccine program</th>
<th>Initial results</th>
<th>Current stage</th>
<th>Manufacturing scale / timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Oxford - AstraZeneca</strong></td>
<td>• Results from Phase I/II trial (1,077 participants) showed production of a strong immune response with co-occurrence of mild / moderate side effects which could be managed with paracetamol</td>
<td>• Undergoing Phase II/III trial with 20,000 participants in UK, Brazil, South Africa, and targeting 30,000 in the US</td>
<td>• Manufacturing partners lined up to produce 3B doses (via AstraZeneca and Serum Institute of India) and distributed in partnership with GAVI and CEPI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Sources claim US Gov has plan to fast-track approval, though this is unverified by drug makers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Trials resumed globally after brief pause to investigate side effects in earlier trial</td>
<td></td>
</tr>
<tr>
<td><strong>Moderna</strong></td>
<td>• Results from Phase I trial (45 participants) demonstrated all participants produced antibodies, but had significant side-effects in a dose-dependent manner</td>
<td>• Granted FDA fast track (5/12)</td>
<td>• Partnership with Catalent (100M initial doses) and Lonza to produce 1B doses annually</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Completed Phase IIa (dosage) and b (efficacy) trials currently with 600 participants</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• In Phase III trials, fully enrolled with 30,000 participants</td>
<td></td>
</tr>
<tr>
<td><strong>Pfizer-BioNtech</strong></td>
<td>• Results from Phase I/II trial in US and Germany (45 participants) showed that a 2 dose vaccination elicited strong antibody response, but had frequent mild-moderate adverse effects (e.g., short-term fever, muscle pain, joint pain)</td>
<td>• Granted FDA fast track (7/13) for 2 out of 4 investigational vaccines</td>
<td>• Targeting 100M doses by end of 2020, &gt;1.2B doses by end of 2021</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• In Phase IIb/III trials initially targeting 44,000 participants, enrolled 39,862 and 34,601 have received their “booster dose”</td>
<td></td>
</tr>
</tbody>
</table>

Other manufacturers are also engaged in Phase 3 trials, including U.S. based Johnson & Johnson and Novavax, as well as multiple international candidates from Russia, China, and Australia.
MOST LEADING VACCINES ARE UNLIKELY TO BE APPROVED UNTIL AT LEAST LATE 2020

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>2020</th>
<th>2021</th>
<th>Stated end date of trial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
</tr>
<tr>
<td>Moderna</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CanSino¹</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Oxford⁶,⁷</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pfizer⁷</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sinovac¹,²</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Gamaleya¹</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Johnson &amp; Johnson⁷</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Manufacturers will be applying for EUAs with partial data prior to anticipated end of trials. However, even after partial data is available, weeks will be required for filing, review, and approval.

1. Vaccine already provisionally approved for limited use in home country; 2. Lack of enrollment information limits ability to estimate time to full enrollment & regulatory submission; 3. From CT.gov: Clinical trial reference numbers in appendix; 4. Estimated given enrollment goals and progress towards full enrollment thus far; difficulty of enrollment may change based on outbreak status in country; 5. Assuming additional time needed for multi-dose vaccines, and at least one month of data analysis and reporting before submission; 6. Oxford trial halted in the US; 7. Full phase enrolment data not available

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VACCINATION COVERAGE OVER TIME DEPENDS ON A RANGE OF VARIABLES AND ASSUMPTIONS

Eventual vaccine coverage

Total US population that will ultimately be effectively vaccinated depends on variables like

- Population willingness to be vaccinated over time
- Likelihood of completing a multidose vaccination series
- Presence (or lack) of vaccination mandates
- Availability of pediatric vaccine
- Vaccine efficacy

Vaccine approval

There are multiple different vaccine approval scenarios, which vary according to

- Which vaccines are ultimately approved
- When each of these vaccines is approved
- How long it will take between approval and the beginning of vaccine administration

Manufacturing, distribution, and administration limits

There is a maximum amount of possible vaccinations that can occur each month, limited by

- Total available supply and manufacturing capacity of approved vaccines over time
- US distribution and cold storage capacity limits
- US administration limits (e.g. labor, supplies)
- Externalities & potential limitations of distribution or administration
THERE ARE MANY POSSIBLE PATHS TO THE HERD IMMUNITY THRESHOLD

Each example below represents only one of many possible pathways to herd immunity threshold; pathways become more distinctive and flexible the further out the target date.

**TODAY**

- **Natural infection**
- **Pre-existing immunity**
- **Vaccinations**

**75K new COVID-19 cases per day**
- 10% pre-existing T-cell immunity
- 2 vaccines in Q4 '20
  - 75% efficacy
  - National mandate (70% adults)
  - 100% increase in administration capacity

**70K new COVID-19 cases per day**
- 10% pre-existing T-cell immunity
- 2 vaccines in Q4 '20
  - 70% efficacy
  - National mandate (55% adults)
  - 10M incremental doses (Moderna)

**70K new COVID-19 cases per day**
- No pre-existing T-cell immunity
- 1 vaccine in Q4 '20; 1 by end of Q2 '21
  - 75% efficacy
  - No mandate (41% population)

**40K new COVID-19 cases per day**
- 5% pre-existing T-cell immunity
- 1 vaccine in Q1 '21, 1 in Q2
  - 65% efficacy
  - No mandate (49% population)

**Apr '21**

**Jul '21**

**Sep '21**

**Dec '21**
MACROECONOMIC OUTLOOK
2020: A YEAR FOR THE HISTORY BOOKS

Worst global economy since the Great Depression

2020 global GDP forecasts
• -4.9% (IMF)
• -6%/-7.6% (OECD)

“No country has been spared”
Gita Gopinath – head of the IMF

Lost government revenue: $10TN

Global public debt will hit 100% of GDP
• Surpass levels in WW2
• U.S. deficit: 24% of GDP
Federal Reserve Balance Sheet
2003 – 17 June 2020

- 68% increase in total assets since March 4th 2020
- Other central banks’ balance sheets have increased 30%+
  - Bank of England: £791B (~$986B)\(^1\)
  - ECB: €5.6T (~$6.3T)\(^2\)
  - Bank of Japan: ¥639T (~$5.9T)\(^3\)

2. European Central Bank Weekly Financial Statements
3. Balance Sheets of the Bank of Japan
© Oliver Wyman
THE US ECONOMY IS EXPERIENCING A SEVERE SHOCK: GDP
The escalation of the COVID-19 crisis has resulted in unprecedented volatility in forecasts

U.S. Real GDP Growth Forecasts – Q3 2020 to Q4 2021
QoQ annualized growth rate, by select economic analysts

<table>
<thead>
<tr>
<th></th>
<th>1Q20</th>
<th>2Q20</th>
<th>3Q20</th>
<th>4Q20</th>
<th>1Q21</th>
<th>2Q21</th>
<th>3Q21</th>
<th>4Q21</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Avg</strong></td>
<td>-4.8%</td>
<td>-33.1%</td>
<td>30.1%</td>
<td>3.3%</td>
<td>4.3%</td>
<td>4.5%</td>
<td>4.3%</td>
<td>3.6%</td>
</tr>
<tr>
<td><strong>Max</strong></td>
<td>-2.3%</td>
<td>-29.0%</td>
<td>37.1%</td>
<td>7.9%</td>
<td>7.0%</td>
<td>7.0%</td>
<td>5.4%</td>
<td>5.9%</td>
</tr>
<tr>
<td><strong>Min</strong></td>
<td>-9.9%</td>
<td>-35.0%</td>
<td>13.8%</td>
<td>0.2%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>1.8%</td>
<td>1.5%</td>
</tr>
<tr>
<td><strong>Act.</strong></td>
<td>-5.0%</td>
<td>-31.4%</td>
<td>33.1%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Key observations from estimates**

- Q2 2020 was the worst quarter on record
- Forecast updates for Q3 2020 have been moving higher (or flat) over the last month, but still with significant uncertainty in forecasts
- Key indicators to track include:
  - Cycle of opening and closing in regional economies
  - Reliance on “smart” mitigation strategies (e.g., mass testing, analytics)

---

1. JP Morgan (October 23), Goldman Sachs (October 19), Morgan Stanley (October 23), UBS (October 21), Bank of America (October 16), Deutsche Bank (October 27), Toronto Dominion (September 17), CBO (July 2), Federal Reserve Bank of Atlanta, Federal Reserve Bank of New York
2. JP Morgan (April 24), Goldman Sachs (April 29), Morgan Stanley (April 27), Toronto Dominion (April 20), UBS (April 29), Bank of America (April 17), Deutsche Bank (April 28), CBO (April 24)
3. JP Morgan (July 17), Goldman Sachs (July 12), Morgan Stanley (July 17), Toronto Dominion (June 17), UBS (July 29), Bank of America (July 24), Deutsche Bank (July 28), CBO (July 2)
4. US Bureau of Economic Analysis; Q2 2020 revised on September 30 (“third estimate”)
U.S. Real GDP quarterly forecasts over time
Annualized growth rate, average from select economic analysts (8)\(^1\),\(^2\)

Key observations from estimates

- Forecasts have been increasingly pulling forward the economic recovery into Q3 2020
- Overall forecasts for 2020 year-end growth also have been rising
  - Overall GDP growth for 2020 is expected to be -3.6%
- Forecasts converge further out ... for now
  - 2021 growth expectation is 4.4%

1. Sources: Bank of America, UBS, Goldman Sachs, Morgan Stanley, TD, JP Morgan, Deutsche Bank, CBO
2. Quarterly estimates in terms of qoq% seasonally adjusted annual rate (saar)
THE US ECONOMY IS EXPERIENCING A SEVERE SHOCK: UNEMPLOYMENT
The escalation of the COVID-19 crisis has resulted in unprecedented volatility in forecasts

U.S. Unemployment Forecasts – Q1, Q2, Q3, and Q4
Quarterly unemployment rate, by select economic analysts

Key insights

- Unemployment claims filed since start of the COVID-19 lockdown have wiped out the last eleven years of job gains.
- Most unemployment forecasts assume a steady recovery for 2H20 and 2021 and appear not (yet) to account for the possibility of subsequent waves of lockdown.
- Unemployment estimates will likely be quite volatile for a while.
- Congressional Budget Office forecasts a slower employment recovery than most major banks.

Institutional Forecasts only

<table>
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<tr>
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<th>3Q20</th>
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<td>8.4% (Aug)</td>
<td>7.9% (Sep)</td>
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</table>

1. Goldman Sachs (October 19), JP Morgan (October 23), Deutsche Bank (October 27), Toronto Dominion (September 17), CBO (July 2); U.S. Bureau of Labor Statistics. 2. U.S. Bureau of Labor Statistics. 3. Tracking unemployment forecasts against unemployment reports may be misleading – unemployment reports only record jobless workers actively searching for employment.
THE ECONOMIC IMPACTS APPEAR TO BE CORRELATED WITH THE STRINGENCY OF GOVERNMENT RESPONSE

Real GDP Growth vs. Oxford Stringency Index
All figures Q2 2020 except as noted below

Key observations

• In general, greater government response in the form of behavior restrictions (“stringency”) corresponded to more adverse immediate economic impact

• However, economic impacts on a specific country likely a combination of other factors beyond government response

• Improved adherence to public health guidance now could allow for more robust recovery later....
  – E.g.: China Q2 growth at +58.9%
  – E.g.: US Q3 growth at +33.1%

Sources: Oxford University, Oxford Economics/Haver Analytics, OECD

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RECENT GDP FORECASTS FROM THE OECD HAVE BECOME MORE OPTIMISTIC FOR 2020, FOLLOWING THE SHAPE OF THEIR EARLIER “SINGLE HIT” SCENARIO

Global outlook varies significantly when accounting for a potential second major outbreak

### 2020 Real GDP Growth Forecasts

<table>
<thead>
<tr>
<th>Country</th>
<th>Single Hit</th>
<th>Double Hit</th>
<th>Interim Economic Outlook</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>-6.0%</td>
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<td>U.K.</td>
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<td>China</td>
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### 2021 Real GDP Growth Forecasts

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<th>Interim Economic Outlook</th>
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<td>Germany</td>
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<td>China</td>
<td>1.8%</td>
<td>8.0%</td>
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</table>

Forecasting two scenarios – one in which a second wave of infections, with renewed lock-downs, hits before the end of 2020, and one in which it is avoided

---

1. Source: OECD.

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LATEST GDP ESTIMATES IN SELECT REGIONS

The evolution of the COVID-19 crisis has most recently led to slight upward revisions in GDP forecasts globally.

Consensus 2020 Real GDP Growth Forecasts, Nov 2019\(^1\) until September 2020\(^2\)

% growth YoY, median

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### Global

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### China

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1. Source: OECD.
2. Sources, date of latest update: Bank of America (October 16), Goldman Sachs (October 19), Morgan Stanley (October 23), Deutsche Bank (October 27), JP Morgan (October 23), TD (September 17), IMF (June 24); GDP growth forecasts obtained as the median of estimates.
3. Source: Oxford Economics. Q1 and Q2 GDP results in terms of qoq annualized rates.
THERE ARE SEVERAL POTENTIAL PATTERNS FOR ECONOMIC RECOVERY

**V-shaped recovery**
- Economy recovers relatively quickly

**U-shaped recovery**
- Economy recovers slower than V-shape

**Swoosh-shaped recovery**
- Recovery slower than V-shape, but faster than U-shape

**W-shaped recovery**
- Economy ‘re-opened’ too quickly
  - Increase in cases causes GDP to suffer

**L-shaped recovery**
- Economy never fully recovers
GDP PROJECTIONS ASSUME A RETURN TO PRE-COVID LEVELS BY EARLY 2022

We continue observing downward adjustments: as of last week, the expectation was to recover by early 2022

U.S. Real GDP relative to Q4 2019 (100) and compared to CCAR and Financial crisis
Estimates as of May-20\(^1\) US GDP Indexed to P0 (CCAR 2020)\(^2\) and 4Q07 (Financial Crisis)\(^3\)

1. Consensus as the average of Bank of America (July 2), Morgan Stanley (June 15), CBO (July 2), UBS (July 1), Goldman Sachs (July 12), JP Morgan (July 2), Deutsche Bank (July 7), Q1 estimates based on latest forecast before release of Q1 GDP Actual
3. Source: Federal Reserve Economic Data

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UNEMPLOYMENT PROJECTED TO RETURN TO PRE-COVID LEVELS BY EARLY 2022

U.S. Unemployment Forecasts compared to CCAR 2020 and Financial Crisis
Q1 2020 – Q4 2021

1. Consensus as the average of Moody's (May 15), JP Morgan (July 2), CBO (July 2), Deutsche Bank (July 7), Goldman Sachs (July 12)
2. Source: “CCAR 2020 data release” - Federal Reserve
3. Source “Unemployment Rate” – Federal Reserve Bank of St Louis

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APPENDIX

Pages are ordered and tagged to correspond to sections in the main body of the Almanac
NOT ALL COVID-19 INFECTIONS ARE CREATED EQUAL: SOME WILL SPARK MORE SUBSEQUENT INFECTIONS THAN OTHERS, WITH SIGNIFICANT IMPLICATIONS

- While R0 denotes the mean number of new infections sparked by any one infection, k reflects the variability inherent in this distribution
- Values of k closer to 1 indicate that the number of new infections sparked tends to be uniform, while values closer to 0 reflect high variability, e.g. most infections will result in no subsequent infections, while a few will result in many
- Very early evidence suggests that COVID-19 has a low k\(^1\), with several implications
  - **Suppression measures**: Situations that pack many individuals together are far more likely to create outbreaks than many one-on-one contacts, suggesting bans on large gatherings are indicated
  - **Second wave**: A second wave will arrive at an unpredictable time post reopening as it may take a long time for any one infection to spark a large number of further infections; states aren’t safe just because they have made it a few weeks past reopening
  - **Luck**: Some geos with good outcomes may simply have gotten lucky, and that luck may run out

### R0 of 3

\[ k = \sim 1 \text{ (low variability– 1918 flu)} \]

\[ k = \sim .1 \text{ (high variability– COVID-19)} \]

1. Science ([link](#))
WHAT IS THE EVIDENCE AROUND EFFECTIVENESS OF SUPPRESSION MEASURES?

While it will take time to truly understand impact of individual suppression measures on $R_0$, initial modeling and empirical evidence is beginning to identify more and less effective measures.

Modeling and now empirical studies have begun to identify more and less effective measures.

**Modeling**\(^1,2,3\)

**Targeted isolation is the biggest bang for the buck**

- Case isolation of infected patients, home quarantines of all patient contacts, and social distancing, esp. of vulnerable populations were estimated to have the greatest impact.
- School closure had a meaningful impact in most models, but was often less impactful (e.g. lowest effect in an Imperial College London Study).
- These assumed ability to ID and intervene the majority of cases; without this capability, broader suppression is necessary.

**Empirical**

**Restaurant closures proved effective, school closures, less so**

- German analysis demonstrated effects for large event cancellation, school closure, business closure, and strict stay at home orders all had effects, though all effects were relatively minor until the full stay at home order\(^4\)
- US study suggest restaurant closures and stay at home orders were most effective, while school closures and large event cancellation did not have a significant effect\(^5\)
- Recent French outbreak connected to schools was misleading: most cases likely predated reopening\(^6\)

But don’t over interpret

- **Error bars are large**: Researchers are using limited sets of noisy data; conclusions are suggestive but not final, and lack of significance does not mean no effect exists.
- **Based on a different stage of the pandemic**: Data is based on growing stages of the pandemic and may not reflect the dynamics of releasing suppression as cases lessen.
- **Results may vary widely by geo**: Suppression measures that are necessary in a geo with limited targeted mitigation capabilities or specific cultural characteristics may not be effective in other geos.

And this is just one half of the equation

- Governments are unlikely to make decisions based purely on suppression measure effectiveness.
- The economic and social impacts of suppression measures will be considered as well.
- For example: limited evidence that school closures are effective will likely lead to significant pressure to reopen schools, mixed evidence around restaurants may result in more conservative behavior.

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1. Imperial College London (link) 2. Science (link) 3. Lancent (link) 4. Science (link) 5. Health Affairs (link) 6. NBC News (link)

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REOPENING SCHOOLS IS A CRITICAL AND HOTLY DEBATED ISSUE – IT LIKELY CAN BE DONE SAFELY ONLY WHEN COMMUNITY SPREAD IS LOW

• America’s economic system can not function fully without schools, placing economic pressure on reopening
  – More than 50 million Americans are unable to return to work fully until schools reopen\(^1\)
  – The federal government has significantly advocated for schools to reopen, suggesting funding may be tied to reopening status\(^3\)

• Pediatric welfare also depends on in-person learning
  – Research suggests students are falling behind standard progress due to remote learning\(^4\)
  – Children may also be at higher risk of abuse and neglect when not in school\(^5\), as well as food insecurity for those who rely on school meals\(^6\)

Reopening schools should be a top priority, but must be done safely – reopening only when community spread is low is the best way to limit further disruption

• Low community spread mitigates risk from reopening schools
  – The U.S. CDC’s official stance is that COVID-19 transmission in schools is not a significant risk when overall community spread is low\(^2\)
  – Independent experts agree, highlighting reopened countries with limited school-related outbreaks who waited until cases were extremely low to reopen: S Korea, Finland, France, Denmark, Norway\(^7\)
  – Due to current transmission in the US, NYC is the only one of the top ten school districts to attempts any level of in-person learning

• Reopening schools without low community spread or adequate precautions can be significantly disruptive:
  – Despite relatively low cases, Israel fully reopened schools relatively quickly, with few mitigating measures. Partially as a result of super-spreader events in schools, Israel is now in a second wave substantially worse than their first peak.
  – The United States has started to reopen schools in the midst of still rising cases, leading to almost immediate disruption
    - Schools in Indiana switched back to online learning after only two days of reopening after staff members tested positive
    - Over 250 employees of an Atlanta-area district are excluded from returning to work due to positive tests, severely limiting the workforce
    - Students in Mississippi have been forced to quarantine after classmates tested positive after less than a week of reopening

### However, Some School Reopening Storylines Have Raised Red Flags, Particularly in Areas with High Community Spread

#### Reopening Protests
Protests on both sides of the school reopening debate have continued, with new efforts from advocates both for and against distance learning

- Teachers across the country, including in California¹, Florida², and Louisiana³ have engaged in protests over school reopening, citing dissatisfaction with district and state leaders’ reopening plans
- On the other hand, parents and students are engaging in protests to reopen schools, claiming distance learning is ineffective and leaving children behind⁴-⁶
  - Orange County students have organized a “zoom out” protest, logging off of distance learning platforms for days to weeks⁵
- While many districts have already reopened, those that have postponed in-person learning must thread the needle of ensuring schools are preparing their students effectively and safely

#### K-12 Reclosures
Some K-12 schools and districts have placed students in quarantine, moved to distance learning for extended periods, or reconsidered reopening plans

- Schools in early reopened states like Indiana, Mississippi, and Georgia all switched for a period of time to distance learning due to substantial outbreaks⁹-¹², while other schools have shut down more recently in areas still dealing with outbreaks (e.g., FL⁵)
- Additionally, thousands of children and staff in reopened school districts in high-community spread areas were quarantined while in-person learning continued¹³,¹⁴
- Even in relatively low risk areas like NYC, some schools shut down after community transmission reached a certain threshold⁷
- Generally, cancellations and quarantines appeared in areas where community transmission is high; schools are at lower risk of disruption in states with low transmission

#### Reporting Opacity
Both K-12 and university systems are struggling with if and how to report confirmed cases among their student/staff populations

- Policies on disclosing COVID information in schools are heterogenous across the US
- Schools in many states (e.g., FL, MI, TN) are not required to disclose positive cases to the state or to the student body, causing concern among many students and parents¹⁹,²⁰
- Over half of US states are not reporting k-12 COVID data, with only 14 reporting at least at a district level granularity²⁴
- Many districts have pointed to federal privacy regulations that limit the sharing of student health information, though CDC guidance has pushed for more transparency¹⁹
- Universities are facing similar restrictions, as schools like UA & BU have announced they won’t disclose COVID data to staff members, students, or the public²²,²³

### Key Takeaways

- There is no single right answer for when and how to open schools, but administrators must ease concerns over safety when doing so
- School reclosures are to be expected, especially in areas with high community spread, but this does not mean that schools are the source of that community spread
- A lack of transparency increases risk for students and staff, and limits the ability of families to work around their own risk tolerances

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EFFECTIVE CONTACT TRACING ALLOWS TARGETED ISOLATION TO AVOID THE NECESSITY FOR BROAD SUPPRESSION

General approach
Pair manual and tech-based approaches with population awareness campaigns

• Expand the public health workforce and leverage existing or newly captured health and movement data to trace contacts of infected individuals

• Mix of manual (individuals IDing and reaching out to contacts) and technological (proximity tracking, cell-phone tracking, credit-card tracking, etc.)

• Scaled abilities to enforce and support quarantine (e.g. food delivery, isolation support, community-based treatment for quarantined individuals)

• S. Korea demonstrated that mass messaging is critical as the outbreak grows¹
  – Encouraging those with potential exposure to get tested
  – Targeted broadcast of the movement of infected individuals to alert those who were exposed

What does it take to be successful?
Massive scale of public health workforce and technological support as possible

• Depending on time required to isolate contacts and success in isolating infected individual, models suggest a 70-85% success rate is necessary to control spread if R0 is ~2², with higher R0s requiring higher success rates¹

• Rapid tracing requires a massive workforce
  – JHU has suggested adding at least 100K individuals to act as contact tracers as a “start” in order to trace every new positive test³
  – Using European CDC manpower estimates, >200K individuals may be required in the US based on current new case projections

• Requires leadership at the local level (state and municipality) with the cooperation of leaders in government, business, education and faith, organizations (extends manpower and improves public cooperation)

• Speed and manpower deficits can be addressed with digital tools, i.e. Bluetooth enabled apps that track proximity positive tests, but this would require high buy in: 60% utilization at least³ (South Dakota’s recently released Care19 app has 2% uptake as of 5/19)

Sources: 1. Lancet (link); 2. Science Magazine (link); 3. Edmon J Safra Center for Ethics: Harvard U (link)
CONTACT TRACING: WILL TECHNOLOGY SAVE US?
There are a few ways technology can supplement the otherwise highly manual contact tracing process but none are a silver bullet

<table>
<thead>
<tr>
<th>Is anyone doing this?</th>
<th>How it could save us</th>
<th>Why it’s complicated</th>
</tr>
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<tbody>
<tr>
<td><strong>Proximity Tracing:</strong> Uses Bluetooth and specialize apps to identify individuals who have been in close proximity for a prolonged period with an individual who is later diagnosed</td>
<td>• In place in Singapore, and planned for Europe and US through a jointly developed Apple-Google tool with which state/country apps can be built</td>
<td>• Requires very high uptake (&gt;60%) to be effective—unlikely • Privacy concerns are likely to continue (“We’re using the DP-3T protocol!” is unlikely to be widely persuasive)</td>
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<tr>
<td>• Short cuts the laborious process required to ID contacts • IDs contacts that would not be revealed in an interview (e.g. stranger on a nearby park bench) • Can maintain a high degree of privacy if it uses the DP-3T protocol as Apple/Google plan</td>
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**Tech Facilitation of Manual Processes:** Make the existing process more rapid and effective with workflow software

| • Several state governments and private companies are working with existing tech vendors such as Salesforce | • Anything that reduces the person-hours and increases the accuracy of contact tracing will increase capacity and make reopening less risky | • Does not fundamentally change the time-consuming process • Privacy concerns are likely to persist |

**Surveillance infrastructure integration:** Harvest data from CCTV, cell data, badge-swipes, payments, etc. to track contact between infected and non-infected individuals

| • South Korea led the way in combining myriad data to effectively trace cases • Private orgs such as universities are considering version of this | • Has the potential to provide a comprehensive view of individuals’ movements without requiring proactive uptake | • Massive privacy concerns—questionable that this would be tenable in most Western countries • Complex from a technological perspective |

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CONTACT TRACING RAN INTO SERIOUS COMPLICATIONS WITHIN THE UNITED STATES BY THE EARLY SUMMER

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<th>Public compliance can be low, limiting efficacy of program</th>
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<td></td>
<td>• In Florida, many contacted individuals are refusing to share workplace details or close contacts with tracers; additionally, employers are not mandated to report positive test cases among their workforce</td>
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<td>• A federal lawsuit in Texas, supported by multiple state legislators, seeks to fully stop the state’s contact tracing program</td>
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<tr>
<td></td>
<td>• Multiple contact tracers in Colorado and Washington have been the subject of harassment or threats, both from constituents and political leaders</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2</th>
<th>Technological adoption slow or non-existent in many states</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Only 3 states have committed to using contact tracing technology; 17 are not planning to use any technology whatsoever, and a further 19 are still in a decisioning phase¹</td>
</tr>
<tr>
<td></td>
<td>• Despite being an early supporter of contact tracing tech (and headquartering the two companies developing the technology), California has publicly walked back any adoption plans</td>
</tr>
<tr>
<td></td>
<td>• Apps likely require an adoption rate of ~60% of the population to be effective; nearly 70% of Americans would not download a contact tracing app, a ~20% decline from April²</td>
</tr>
<tr>
<td></td>
<td>• Finally, some technology-enabled tracing programs like that of New York have been abandoned by counties and regions, as glitches and inconsistencies have frustrated public health officials</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3</th>
<th>Ramp up is slower than anticipated; lack of up to date reporting limits ability to evaluate scope of programs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Oregon allowed some counties to move forward with reopening despite a contact tracing workforce lower than previously set thresholds; since then, data confirming staffing levels has not been published</td>
</tr>
<tr>
<td></td>
<td>• Both South Carolina and Texas recently announced plans to further ramp up tracing, but as of early June had fallen short of stated goals</td>
</tr>
<tr>
<td></td>
<td>• Despite partnerships with hospitals and private labs, Mississippi contact tracers were overwhelmed in late May, and cases have continued to rise</td>
</tr>
</tbody>
</table>

Source: 1. Business insider; 2. Ars Technica
## WHAT IS THE CURRENT STATUS OF CONTACT TRACING IN THE UNITED STATES?

### Reach
- During the late summer peak across the South and West, roughly half of the hardest hit health departments were unable to reach enough infected patients
- According to current estimates, only 4 states have enough contact tracers to adequately handle current case rates; 35 have an estimated capability to reach <50% of all cases
- App-based downloads are minimal; though there is limited information on total downloads, no available information suggests adequate reach

### Resources
- Apple and Google have announced an expansion of their tracing (now called “exposure monitoring”) software, and additional tools for states, but reports still suggest a patchwork technological approach from states and local health departments
- Integration between local and statewide efforts continues to be an obstacle, in terms of both technical issues and coordination
- Many health departments claim under-resourcing, both in terms of funding and labor

### Compliance
- At least a third of contact tracing departments surveyed said they had been materially hindered by non-compliance among infected patients and close contacts
- In general, distrust of the government or potential scammers continues to hinder response rates and compliance across the country
- Contact tracing efforts are underway in colleges, though there is limited current data available on efficacy and compliance among student bodies
- Similarly, many reopened school districts are attempting to contact trace any confirmed cases, with efficacy of such efforts still TBD

Experts continue to tout effective contact tracing as a cornerstone of COVID response, but the US has substantial ground to cover before programs are adequate across the country

**Source:** 1. Reuters; 2. Covid Act Now; 3. Wired; 4. The Atlantic; 5. National Geographic
FEAR OF LIABILITY AND UNCERTAINTY SURROUNDING GOVERNMENT ACTION HAS SPURRED THE PRIVATE SECTOR TO EXPLORE CONTACT TRACING

Private deployment of contact tracing capabilities

- The US Government has indicated that employee COVID tests and related symptom checks are allowable as employers decide who may return to work\(^1\)
- Some companies are considering developing further COVID management capabilities:
  - To care for employees and customers
  - To minimize risk/liability of employees or customers becoming infected
  - To improve consumer confidence
- 25% of CFOs say they will employ contact tracing capabilities with their employees\(^2\)
- Companies are looking to repurpose customer relationship management software and other tools that allow tracking of meetings and contacts, but most are early in the process

Employee and customer reactions

- Data privacy is a perennial concern, but there are indications that individuals will be open to contact tracing
- A recent Oliver Wyman survey found that >60% of individuals would be willing to share personal health data if it would aid in controlling the pandemic
- Some political differences notwithstanding, 66% individuals are willing to have some activity tracked via phone for contact tracing purposes if it will hasten the reopening of schools and businesses\(^3\)
- However, individuals tend to prefer public health agencies rather than private companies to control this information: nearly 2x as many people are willing to share info with the CDC and public health officials vs. major tech companies.\(^4\)

Private activity may be a valuable supplement to public contract tracing capacity

There may be some initial skepticism around private contact tracing, but if it reopens business sooner, the public will likely get on board

AS PRIVATE ORGANIZATIONS THINK ABOUT BUILDING INTERNAL CONTACT TRACING CAPABILITIES, THEY FACE A COMPLEX ENDEAVOR

Multiple roles with rare skillsets and data infrastructure requirements complicate contact tracing

Critical Line Roles (not including supervisors)

<table>
<thead>
<tr>
<th>Role</th>
<th>Activities</th>
<th>Skillset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Tracer</td>
<td>• Interview infected individuals to ID and follow up w/ contacts</td>
<td>• Empathy, rapport building</td>
</tr>
<tr>
<td></td>
<td>• Ensure contacts take appropriate quarantining/medical actions</td>
<td>• Multiple languages</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Local knowledge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Creativity to ID contacts</td>
</tr>
<tr>
<td>Data Mgr</td>
<td>• Build, maintain, and support users of tools holding COVID data</td>
<td>• Experience with a variety of IT and statistical analysis tools (e.g. SAS, R, Excel)</td>
</tr>
<tr>
<td>Social Support Coord.</td>
<td>• Connect infected individuals with necessary medical and social services to support care and sustainable quarantining</td>
<td>• Familiarity with local health systems and social services</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Social work experience</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Multiple languages</td>
</tr>
</tbody>
</table>

Data infrastructure

- Aggregate and organize data on new cases so that it may be easily consumed by newly trained tracers and supervisors within a short period of time (<24 hours ideally)

Other processes/considerations

- Coordination across multiple jurisdictions (governments or private entities) is challenging but necessary
- Roles are unpredictably temporary, further complicating hiring

Private companies will have some advantages and some additional hurdles vs. government entities as they set up their own programs to trace employees and customers

It will be easier for private companies because:

- The population is more homogenous and will have more predictable contact patterns
- Likely to have more success contacting infected individuals and contacts, particularly employees
- Critical information on movements and contacts can be gleaned from calendars, badge swipes, transactions and other data private organizations have access to within their four walls

It will be harder because

- Blind spots outside of the private entities’ scope will be much harder to track down
- Involvement of private companies may spark suspicion
- Engagement in public health activities could expose companies to liability and other risk
## Privately Built Contact Tracing Solutions Are Proliferating and Have Taken a Range of Approaches

### HR System Integration: 
*As deployed by Kronos*¹

- Aggregates employee time-clock data to allow easy ID of employees who may have been exposed to an infected individual
- Only works in situations that include a “clocking in” mandate: does not yet aggregate other data such as badge swipes, transactions, or calendars

### Mandated Proximity Tracing: 
*As deployed by PwC through its “Check-In” package,*² *SaferMe,*³ and and others

- Similar to other Bluetooth-enabled proximity tracking apps, though SaferMe uses GPS records rather than Bluetooth, and others, *e.g.* WiSilica distribute separate wearables rather than rely on personal phones to ensure coverage
- Main differences:
  - Envisioned as a employer-mandated tool in order to achieve critical mass
  - Data is shared with HR to facilitate employer follow-up, not just with individual as with other public versions of the app
- Adoption levels are held closely, but generally seem to be slow
  - Unclear how widespread adoption of PwC’s package is
  - SaferMe has contracted with the New Zealand government to provided free services to NZ-based mining and energy companies⁴
  - WiSilica has contracted with the Hong Kong government but largely to enforce quarantine, not to undertake broad tracing⁴

### Manual Tracing Facilitation: 
*As deployed by Salesforce through its “Work.com” initiative*⁵

- Specifically avoids automated processes: simply provides the data architecture and workflow tools to facilitate traditional contact tracing
- City of New York, states of RI and MA, and a purported but confidential set of private companies and educational institutions are using this system

---

¹ [https://www.kronos.com/resource/download/39761]
³ [SaferMe](link)
⁴ [BuzzFeed News](link)
⁵ Salesforce.com [link]
AN EFFECTIVE SURVEILLANCE SYSTEM IS CRITICAL TO DETECTING NEW OUTBREAKS EARLY ENOUGH TO MANAGE WITHOUT WHOLESALE SUPPRESSION

What do we need?

Data
- Enough COVID-specific testing is taking place to provide a reliable view of COVID prevalence
- Availability of additional clinical and other data that can indirectly ID COVID prevalence (e.g. disproportionately high hospitalization rates for older individuals with pneumonia, travel from hot spots)

Central Aggregation
- Infrastructure and processes to rapidly aggregate data at a geographic level that:
  - Is empowered to make COVID management decisions accounting for any delay in data reporting and aggregation
  - Is large enough to cover the extent of COVID outbreaks (i.e. beyond one state when there is significant interstate commuting)

Analytics
- Analysis that identifies when COVID outbreaks threaten to escape control and guides decisionmakers

When can we get there?

- Testing capacity is significantly strained, though improving recently
- Newly developed tests, including POC, antigen, and various high-throughput tests show promise to further reduce capacity strain
- Additional clinical data is still being studied; in particular, COVID in children is not fully understood, introducing risk to reopened schools
- The US’s data systems are fairly disaggregated, and jurisdiction changes between HHS and the CDC further complicate the issue
- Reporting is heterogenous at a state level, and holistic analysis relies in part on third party organizations aggregating and cleaning available data
- Excess deaths and deaths attributed to pneumonia and influenza are substantially up this year, calling data integrity further into question
- Modeling has continued to improve, and the CDC currently aggregates high-accuracy models into a high performing “ensemble model”
Masks

While respirators may be more effective than medical or cloth masks, it is strongly recommended that everyone wear masks when not social distancing, particularly around vulnerable populations.

<table>
<thead>
<tr>
<th>Mask</th>
<th>Description</th>
<th>Commentary</th>
</tr>
</thead>
</table>
| N95 Respirator      | • Disposable, tight fitting                                                | • CDC and WHO recommend that general public do not use N95 respirators; reserve for healthcare professionals.  
                        • Creates seal on face to limit particle inhalation                        | • Effective at blocking transmission, but does not completely eliminate risk of infection.  
                        • Filters at least 95% of very small particulates                         | • Many studies and a recent Lancet meta-analysis of 172 studies conclude with at least a moderate level of confidence that N95 respirators are the most effective protection against infection with SARS-CoV-2, relative to surgical masks or cloth face coverings.  
                        |                                                                              | • Other evidence suggests for non-aerosol generating care, N95s and surgical masks are roughly similar in efficacy. |
| Surgical/Medical mask | • Disposable, loosely fitted                                                | Use of medical masks by symptomatic individuals may reduce transmission; WHO recommends medical masks when symptomatic.  
                        • Creates physical barrier between contaminants and wearer; does not create seal around nose/mouth | • Evidence suggests significant efficacy in reducing transmission.  
                        |                                                                              | – Some studies showed that surgical masks (worn by the healthy) can reduce the risk of infection through respiratory droplets, but not in aerosols (particles floating in air for up to three hours).  
                        |                                                                              | – However, others showed no evidence that surgical masks worn by sick individuals reduced transmission.  
                        |                                                                              | – A large meta-study suggests that while surgical masks are not as effective as N95 masks in reducing the risk of infection they remain more effective than no protection.  
                        |                                                                              | • Speculation that masks may lead to increased touching of the face, use of uncleaned, contaminated masks, or otherwise increase spread through a sense of false security may make logical sense but have not been borne out in the data. |
| Cloth face coverings | • Reusable face coverings, often homemade                                   | CDC recommends use of cloth face coverings in public settings where other social distancing guidelines are difficult to maintain as both a transmission and infection guard.  
                        • Creates physical barrier between nose/mouth and air                     | • Evidence is varied, but overall suggests significant reduction of infection rates.  
                        |                                                                              | – Variation in findings are at least partially driven by variation in the design of “cloth masks.” Multilayer cotton masks have been found to be somewhat effective, while other types of masks are less protective.  
                        |                                                                              | – Others suggest broad population benefits, with limited harm.  
                        |                                                                              | – A broad review of literature suggested fabric masks may reduce the transmission or larger respiratory droplets, but have little effect on small aerosoles. |
| Eye coverings       | • Clear plastic barriers, goggles, or other elements that shield the eyes   | Eye coverings have been shown to be effective in reducing infections for wearers across many studies but remain relatively underused. |

Sources: 8. The Lancet (link); 2. CDC (link), (link); 3. WHO (link), (link); 4. Nature (link); 5. Annals of internal medicine (link); 6. Lancet (link); 7. BMJ Nutrition, Prevention and Health (link); 8. Influenza and Other Respiratory Viruses (link); 9. National Academies of Engineering, Science, Medicine (link); 10. The Lancet (link).
HEALTH SCREENING BY EMPLOYERS

EEOC has released guidance that employers are allowed to perform temperature checks on employees and test them for presence of COVID-19 prior to return to work; some local governments have urged or required employers to do so.

CONSIDERATIONS FOR BEST PRACTICE\(^1,2\)

- **Clear communication**: Advance notice to the workforce regarding any health screening and related implications (e.g., being sent home).
- **Temperature threshold**: The CDC considers a person to have a fever when he or she has a temperature of at least 100.4°F; many employers are using a threshold in the 100-100.4°F range.
- **Facilitate testing in least invasive way**: As much as possible, utilize approaches that register temperature without exposure to bodily fluids (e.g., no-contact thermometers).
- **Appoint someone with proper training**: Ideally an on-site medical staff person or other medical professional (e.g., R.N., M.A.) will facilitate or administer on-site temperature checks and health screening.
- **Maintain physical safety during screening**: Minimize crowding and enforce social distancing at stations, provide PPE for testing personnel, clean and disinfect equipment, etc.

EXAMPLE HEALTH SCREENING

1. All health screens and temperature checks must be performed in a non-discriminatory manner and all medical information treated as private.
2. Health screens and temperature checks will not completely mitigate risk of contagion since it has been established that up to 50% of infected are asymptomatic.

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THERE IS A SPECTRUM OF STANCES EMPLOYERS COULD TAKE ON HEALTH SCREENING AND TESTING DEPENDING ON COST, FEASIBILITY AND SPECIFIC NEEDS

Any devised strategy needs to comply with local requirements and should strongly consider any recommendations from the CDC and local government.

<table>
<thead>
<tr>
<th>Likely impractical for most employers</th>
<th>Illustrative ‘Medium’ Example</th>
<th>Minimum necessary</th>
</tr>
</thead>
</table>

**TEST (nearly) EVERYONE**
- Require a negative PCR test or a positive serology test for all employees returning to work
- Set up a protocol of regular testing of entire at work population
  - Use PCR-based tests as the primary diagnostic mechanism to identify any exposed individuals
  - Test frequently to ensure any infections are identified as soon as possible
  - Use health screening, temperature checks and self-reporting of potential exposures to supplement regular testing
  - Require negative status to return to work post illness
- Use serology testing to supplement PCR testing

**STRATIFY THE POPULATION**
- Follow all local guidance as described in most conservative option
- Assess the employee base and identify any groups where preventing infection and / or having immunity is crucial
- Set up a protocol of regular PCR-based testing for the appropriate portion of the population
- Use serology tests to supplement, e.g.:
  - Guide deployment of employee base where possible based on results
  - Shuffle people into teams such that immune and susceptible individuals are evenly distributed

**FOLLOW LOCAL GUIDANCE**
- Institute only the policies required or strongly recommended by local health authorities (e.g., temperature checks and health screens)
- Run a strong internal education campaign on appropriate behavior (e.g., mask wearing, hand washing, social distancing)
- Instill a culture of social responsibility (i.e. not coming to work if symptomatic) and put in place policies that will encourage honesty
- Coordinate closely with local health authorities conducting tracing and selective quarantine to proactively identify individuals or locations that may be high risk
PRIVATE SECTOR TESTING IS AN IMPORTANT EMERGING COMPLEMENT TO PUBLIC TESTING, BUT IS OPERATIONALLY CHALLENGING AND EXPENSIVE

Some private institutions are currently or planning to regularly and broadly test their workforce...

- **Universities are among the most common organizations planning to ramp up private testing**
  - Boston area schools (including Harvard, MIT, Emerson, and Tufts) have partnered with the Broad Institute to process up to 100K tests/day with a 24 hour turnaround
  - Other schools, like Williams, Texas A&M, or Yale are outsourcing or developing in-house testing capabilities
- **Scope, frequency, and optionality all differ by school**, leading to patchwork of strategy across the country
- **Experts suggest that private sector testing will be highly industry specific**, with vulnerable employers like airlines implementing earlier
- **Companies with large workforces in confined spaces have tended to be at the forefront of private sector testing**
  - After numerous high-profile outbreaks at plants, Tyson Foods is attempting to test 100% of their workforce
  - Ceasars Entertainment recently introduced mandatory testing for their employees at casinos
  - However, the frequency of this testing is unclear – **due to the workforce size in large companies, regular testing of all employees may not be feasible**
- **Legislators have indicated a desire to fund regular testing at key locations**, including schools, nursing homes, and prisons, **though funding is still to be secured**

...Though operational and cost considerations have limited wider adoption

- A survey of 40 large US employers found that as of late June, **only 6% were definitely planning to implement onsite workplace testing**, with only 11% saying that regular testing was required for employees
- **Cost and frequency of testing are biggest prohibitors**
  - Testing should occur multiple times a week, preferably daily, to ensure cautious behavior. E.g., a negative result on Monday morning may lead to employees acting with false confidence throughout the week, even if the disease is contracted Monday night
  - At $100-150 USD per test, **cost quickly becomes substantial for any company with multiple employees tested multiple times a week**.
  - Some emerging tech offers to address this pain point with tests <$10, but these tests are not yet widely available at scale
- **Testing capacity is severely strained throughout the US, with multiple labs warning of increased turnaround times**
  - Some large organizations, like the NBA or NFL are “cutting the line”, and paying more for faster turnaround times
  - This strain will either reduce efficacy through increased turnaround times or increase costs for organizations that “cut the line”
It is far more valuable to test more frequently and less accurately than accurately and less frequently when surveying general population.

---

**Public Medical Infrastructure**

*In these use cases, employees go to medical professional or hospital for testing; in some cases, employers have partnerships with providers to guarantee access.*

- **Use Case**
  - Symptomatic individuals
  - Asymptomatic contacts of confirmed positive cases

- **Accuracy**
  - Critical to have certainty around test result for treatment and tracing / quarantine

- **Turnaround Time**
  - Timeliness of results improves treatment timeline and transmission prevention

- **Applicable test types**
  - PCR, LAMP, CRISPR, Next Gen Sequencing

**Employer-led Rapid Testing**

*Public testing infrastructure not sufficient; employer deployment of rapid testing solutions for specific use cases*

- **Use Case**
  - Asymptomatic individuals with expected significant contacts (e.g., travel, return-to-work)
  - Regular surveillance testing of asymptomatic individuals

- **Accuracy**
  - Critical to have certainty to prevent transmission; false positives more acceptable than false negatives

- **Turnaround Time**
  - Critical to have rapid turnaround time to enable activity day of (or sooner)

- **Applicable test types**
  - Currently a gap, but growing accuracy of emerging technologies

  - Antigen, saliva-based PCR, other new emerging, less accurate tests
CASE STUDY: VIETNAM’S SWIFT, PROACTIVE MEASURES INITIALLY RESULTED IN
EXEMPLARY LIMITED OUTBREAKS, THOUGH RECENT SPIKES THREATEN THEIR SUCCESS

Timeline of key actions

<table>
<thead>
<tr>
<th>Date</th>
<th>Active Cases</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 23</td>
<td>2</td>
<td>First confirmed cases found in Chinese travelers</td>
</tr>
<tr>
<td>Jan 29 –</td>
<td>2</td>
<td>Schools closed indefinitely; Govt. establishes mobile emergency response teams; National steering committee established</td>
</tr>
<tr>
<td>Feb 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feb 13</td>
<td>9</td>
<td>First regional lockdown; Son Loi Commune (pop. ~10k) locked down, two field hospitals established</td>
</tr>
<tr>
<td>Mar 4</td>
<td>0</td>
<td>Son Loi lockdown lifted after 20 days of no new cases</td>
</tr>
<tr>
<td>Mar 21</td>
<td>77</td>
<td>Borders closed to most foreign visitors; Mandatory quarantine for all incoming visitors</td>
</tr>
<tr>
<td>Apr 23</td>
<td>44</td>
<td>Reopening begins; schools start staged reopening, non-essential businesses reopen</td>
</tr>
<tr>
<td>Jul 21</td>
<td>43</td>
<td>Outbreak in factory begins</td>
</tr>
</tbody>
</table>

Observations & Lessons Learned

Early, aggressive measures can effectively prevent outbreaks
- As opposed to other individual quarantine-focused strategies that Asian countries utilized, Vietnam focused on proactive measures meant to cut down on community spread and imported cases
- Early regional lockdowns (after as few as five confirmed cases) limited country-wide spread
- Early travel bans on China and other hotspots combined with strict incoming quarantine mandates limited imported cases
- As a result, total cases (369) and deaths (0) are among the strongest worldwide, enabling earlier reopening

A well prepared and organized governance structure allows for effective response and mitigation
- The Communist party communication apparatus allowed for consistent and widespread messaging and effective contact tracing
- Vietnam was then able to institute the sweeping, area-wide lockdowns in part due to the authoritarian nature of the government
- Public health experts were integrated into decisioning at the highest level, and local authorities were expected to defer to Ministry of Health guidelines

Reopening is successful if proper preventative measures are still in place and complied with
- Despite reopening much of the country, Vietnam has kept border closures and border control in place to limit imported cases, allowing domestic travel
- The country has also kept strict incoming quarantine measures in place, allowing for repatriation of abroad citizens and entrance of skilled workers
- Vietnam is successfully engaging the population in social distancing through nationalist rhetoric and propaganda, and has maintained high support and trust in part due to strong government transparency regarding COVID

CASE STUDY: SINGAPORE SAW EARLY SUCCESS DRIVEN BY INDIVIDUAL TRACING AND QUARANTINE, BUT FAILED TO ACCOUNT FOR NON-PERMANENT RESIDENTS

Timeline of key actions

<table>
<thead>
<tr>
<th>Date</th>
<th>Active Cases</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 23</td>
<td>1</td>
<td>First confirmed case, tourist from Wuhan</td>
</tr>
<tr>
<td>Mar 16</td>
<td>135</td>
<td>Case growth accelerates due to repatriation of residents – 70% of new cases are imported</td>
</tr>
<tr>
<td>Mar 23</td>
<td>359</td>
<td>Borders closed to tourists and short term visitors</td>
</tr>
<tr>
<td>Apr 5</td>
<td>854</td>
<td>By early April, most new cases are temporary migrant workers; Govt. quarantines 20,000 workers in response</td>
</tr>
<tr>
<td>Apr 7</td>
<td>923</td>
<td>Government announces “circuit breaker” measures, including closures of schools and most non-essential businesses</td>
</tr>
<tr>
<td>Apr 21</td>
<td>7,644</td>
<td>Circuit breaker extended through June, additional businesses subject to closure</td>
</tr>
<tr>
<td>Jun 2</td>
<td>7,042</td>
<td>Phased reopening begins</td>
</tr>
</tbody>
</table>

Observations & Lessons Learned

Extremely strict testing, tracing, and quarantine protocols may effectively manage outbreaks...

- Post-SARS, Singapore expanded isolation capacity and testing infrastructure for future pandemics, enabling them to quickly scale up a COVID response
- Singapore had extremely strong quarantine measures: isolation of infected/suspected individuals and close contacts was strictly enforced
- These measures allowed the public at large to enjoy relatively few restrictions on daily life

...as long as the testing and quarantine is truly comprehensive

- Cases spread undetected at cramped migrant worker dormitories; Migrant workers are a “cognitive blind spot” for the Singaporean government, as pre-pandemic policy segregated workers to the outskirts of society
- Initially, stringent quarantining approach was not applied within this group

Digital contact tracing alone is not enough to adequately identify outbreaks

- Despite international praise for Singapore’s voluntary TraceTogether app, only ~20% of the public has downloaded it
- Government officials warn against an overreliance on digital tools, maintaining that manual tracing and outreach should be the cornerstone of policy

Governments should be prepared to adapt to changing information and circumstances

- Singapore’s “rational and incremental” approach to suppression allowed the country to respond to changing circumstances (e.g., closing borders as imported cases rose), but delays may have caused increased transmission (e.g., initial hesitancy to impose lockdown)
- Singapore is addressing migrant worker cases with parallel but differentiated measures, including widespread quarantine and free, accessible healthcare

## Timeline of key actions

<table>
<thead>
<tr>
<th>Date</th>
<th>Active Cases</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 27</td>
<td>1</td>
<td>First confirmed case discovered in Munich</td>
</tr>
<tr>
<td>Feb 16</td>
<td>6</td>
<td>First regional closures begin (govt. buildings)</td>
</tr>
<tr>
<td>Mar 20</td>
<td>19,178</td>
<td>First regional lockdown begins in Bavaria</td>
</tr>
<tr>
<td>Mar 22</td>
<td>23,833</td>
<td>National bans on gatherings of &gt;2 people and non-essential businesses; regions are allowed to impose stricter measures</td>
</tr>
<tr>
<td>Apr 20</td>
<td>43,691</td>
<td>Low traffic businesses and retail shops &lt;800 sqm allowed to reopen nationally</td>
</tr>
<tr>
<td>May 6</td>
<td>18,716</td>
<td>Reopening roadmap released; States are given autonomy to determine future reopening plans, but with “emergency brake” restrictions to be applied if state passes daily case threshold</td>
</tr>
<tr>
<td>Jun 23</td>
<td>2,286</td>
<td>First regional re-lockdowns begin</td>
</tr>
</tbody>
</table>

## Observations & Lessons Learned

**Strong federal leadership with local autonomy allows for flexible response**

- Various local leaders (at the city or state level) were given autonomy to levy stricter measures on residents than the federal government mandated, allowing for more stringent responses in hard hit areas
- Reopening guidance is primarily up to local leaders, allowing various states to adjust their reopening plans based on key industries and population dynamics
- However, the federal government has established a mandatory baseline for social distancing requirements, limiting risk from reopened businesses
- Additionally, Germany has stipulated that additional restrictions will be reimposed if any region sees acute infections reach 50/100k

**Robust public healthcare system limits negative impact**

- Germany had a high rate of ICU and hospital beds per capita, reducing strain on system and enabling them to accept overflow patients from neighboring countries
- Additionally, they built up a stockpile of test kits by the time the outbreak began in earnest in February
- Widespread testing (~350,000 per week by April) allowed for rapid detection of cases, enabling early, impactful treatment that lowered death rate
- Adequate supply of tests for medical professionals limited spread and reduced strain on workforce
- However, manual contact tracers were quickly overwhelmed at the beginning of the pandemic, necessitating stringent, country-wide lockdowns

**Trust in public leaders encourages social distancing compliance**

- Public is generally deferential to expert advice and followed social distancing guidance during the severe lockdowns in March and April
- Decentralized nature of response allows for local authorities to provide transparent, relevant updates, leading to a high degree of trust and popular support
CASE STUDY: SWEDEN’S STRATEGY HAS DIFFERED SIGNIFICANTLY FROM THAT OF OTHER COUNTRIES – EFFICACY OF SUCH IS STILL BEING DETERMINED

Timeline of key actions

<table>
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<tr>
<th>Date</th>
<th>Active Cases</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 31</td>
<td>1</td>
<td>First confirmed case in traveler from Wuhan</td>
</tr>
<tr>
<td>Mar 11</td>
<td>498</td>
<td>Ban on public gatherings &gt;500 people</td>
</tr>
<tr>
<td>Mar 16</td>
<td>1,088</td>
<td>Public Health Agency publishes set of social distancing guidelines, recommending limited travel and work from home</td>
</tr>
<tr>
<td>Mar 17</td>
<td>1,169</td>
<td>Public Health Agency recommends secondary schools and universities shift to distance learning (not primary/kindergarten); evidence suggests recommendations have been followed</td>
</tr>
<tr>
<td>Mar 27</td>
<td>2,255</td>
<td>Public gathering limit lowered to 50 people</td>
</tr>
<tr>
<td>Apr 1</td>
<td>3,668</td>
<td>Ban on nursing home visitation enacted</td>
</tr>
<tr>
<td>May 13</td>
<td>7,607</td>
<td>Guidance on domestic travel eased</td>
</tr>
</tbody>
</table>

Observations & Lessons Learned

Swedish relied on adequate social distancing and PPE compliance from its populace to limit spread of COVID

- Sweden has some of the most liberal COVID restrictions of any country, instead relying on public compliance
- Sweden has maintained adequate health system capacity thus far, but this required the doubling of ICU beds from pre-pandemic levels and emergency resupply of medication and PPE in March
- Sweden has several population dynamics that limit the risk from COVID, including an extremely high (57%) rate of single-person households, very low population density, and an overall healthy population
- However, absolute confirmed cases (~81k), cases per capita (~.008), case fatality rates (~7%), and excess mortality (+27%) are all above Sweden’s Scandinavian neighbors across all age groups
- Impact to the elderly population was very high, with nearly half of all deaths tied to care homes; the Swedish Prime Minister later admitted that the country did no go far enough in protecting the vulnerable
- Trust in both the Swedish government and the Public Health Agency was initially very high, but after the scientist spearheading the response admitted further action should have been taken, support plunged to less than half the population, though this decline does not seem to have affected compliance

Sweden appears to have managed the curve without strict intervention; Though there is not yet expert consensus on why, some ideas include:

- Adequate behavioral compliance from the Swedish population, especially in light of rising case counts in June, resulting from widespread cooperation between government, businesses, and the public
- Widespread enough immunity to result in slowed transmission (hypothesis floated by Swedish Public Health Agency)
- May be partially explained by rapid expansion of testing capacity: Testing for non-essential, non-critically ill members of the public opened up significantly in late June, potentially creating the impression of a sharp spike without a corresponding increase in true infection rates

© Oliver Wyman

Source: BBC, Foreign Affairs, NYT, Gotesborgs-Posten, Dagens Nyheter

Information as of 8/13/20
CASE STUDY: NEW YORK SUFFERED DUE TO DELAYED ACTION, BUT HAS SINCE MANAGED CASE GROWTH EFFECTIVELY WITH A CAUTIOUS REOPENING AND MASKS

Timeline of key actions

<table>
<thead>
<tr>
<th>Date</th>
<th>Active Cases</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/1</td>
<td>2</td>
<td>Second confirmed case in Westchester – beginning of first cluster in NY state</td>
</tr>
<tr>
<td>3/22</td>
<td>15,694</td>
<td>Statewide shelter-in-place order begins; non-essential businesses close</td>
</tr>
<tr>
<td>4/15</td>
<td>130,506</td>
<td>Mandate issued requiring masks in public spaces</td>
</tr>
<tr>
<td>5/15</td>
<td>37,499</td>
<td>First counties begin Phase 1 reopening: curbside retail, construction. Manufacturing reopens</td>
</tr>
<tr>
<td>6/8</td>
<td>16,035</td>
<td>NYC begins phase 1 reopening</td>
</tr>
<tr>
<td>7/1</td>
<td>8,937</td>
<td>NYC delays further reopening (inc. indoor dining) in response to rising cases across the country</td>
</tr>
<tr>
<td>7/13</td>
<td>9,333</td>
<td>Governor announces school reopening policy, with regional thresholds of infection rates used to determine which schools to reopen</td>
</tr>
</tbody>
</table>

Observations & Lessons Learned

Suppression measures should be taken before case rates are unmanageable

- Compared to other nations that saw early case imports (e.g., Vietnam, South Korea, Hong Kong), the US and NY were fairly late in instituting travel checks or mandatory lockdowns, allowing for unseen spread
- Evidence suggests nearly 10k undetected cases in NY by early March, implying case rates were already surging well before the lockdown; limited testing capacity reduced ability to see full scope of outbreak

Health system capacity is a significant indicator of risk and a key determinant of total mortality

- Due to exponential growth in late March, NYC’s hospital system was quickly overwhelmed, straining resources including PPE, ventilators, beds, and personnel
- Overcrowding lead to poor isolation protocols, increasing infection, as well as enhanced triage and turning away of less critical patients

Reopening processes should be cautious, phased, and flexible

- NY has an extremely strong reopening plan, including regional variation, clearly defined phases, and defined criteria to determine progression through phases
- This plan is enhanced by officials willingness to pause or adjust reopening plans, e.g., Indoor dining was paused due to rising outbreaks across the US, and NYC is now proceeding through additional phases without incurring additional risk from indoor spaces

Compliance with mask mandates is effective at suppressing growth

- Masks and mandates are highly correlated to declining case growth, and NY instituted one of the earliest mandates in the country (4/15)
- On the whole, NYC has some of the highest compliance nationwide with these mandates, reaching nearly 90% usage rates in some areas

1. NYT; 2. NYT; 3. NYT; 4. Advisory; 5. Time Out; 6. PNAS; 7. NYT
CASE STUDY: FLORIDA OPENED BEFORE ITS PEAK AND DID NOT HAVE SUFFICIENT TIME BETWEEN PHASES, LEADING TO SIGNIFICANT OUTBREAK AND LOW SOCIAL DISTANCING

Timeline of key actions

<table>
<thead>
<tr>
<th>Date</th>
<th>Active Cases</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/1</td>
<td>1</td>
<td>1st COVID cases confirmed; returning travelers from Italy</td>
</tr>
<tr>
<td>3/17</td>
<td>188</td>
<td>1st closures: bars, nightclubs, gyms</td>
</tr>
<tr>
<td>4/1</td>
<td>6,650</td>
<td>Governor issues statewide stay-at-home order</td>
</tr>
<tr>
<td>4/17</td>
<td>14,491</td>
<td>Beaches begin reopening</td>
</tr>
<tr>
<td>5/4</td>
<td>9,838</td>
<td>Most counties begin reopening, including dine-in restaurants and in-store retail</td>
</tr>
<tr>
<td>6/3</td>
<td>11,293</td>
<td>Bars reopen across Florida at 50% capacity</td>
</tr>
<tr>
<td>6/26</td>
<td>51,989</td>
<td>Bars prohibited from selling alcohol on premises, but can continue to sell food on-premise and alcohol for off-premise consumption</td>
</tr>
<tr>
<td>7/12</td>
<td>128,736</td>
<td>Florida sets US record for new cases at 15,300</td>
</tr>
</tbody>
</table>

Observations & Lessons Learned

Reopening should not begin until case declines are evidenced across the entire state

- Despite a decline in new cases over the first ~4 weeks of lockdown, Florida’s cases remained in a plateau through late April/early May, suggesting case growth was not fully under control
- Over 40% of FL counties (mostly rural) had a 2 week increase in new cases as of reopening on May 4th; declines in populous counties like Duval or Broward masked rising outbreaks elsewhere in the state

Reopening risky businesses too quickly will likely lead to outbreak

- Florida’s first phase of reopening included in-store retail and dining (higher risk than curbside pickup or outside dining), and phases were clustered within 2 weeks of each other, making it difficult to ascertain the impact of each phase
- Gyms began opening 2 weeks after phase one, and bars within a month, opening up the riskiest venues to the public without allowing sufficient time for cases to decline

Reopening safely requires public compliance and clear messaging from leadership

- Data suggests Floridians were among the most mobile and least socially distant populations within the US throughout May, particularly younger adults
- Messaging was inconsistent at various levels of the govt., possibly leading to limited compliance with social distancing and other public health guidance
- Additionally, antipathy towards mask mandates from the government and public likely limited mask wearing rates, exacerbating the outbreak
  - As of late June, roughly ~40% of residents “always” wore a mask when in public

Information as of 8/13/20

1. Tallahassee Democrat; 2. OpenTable; 3. BBC; 4. Vox; 5. Click Orlando; 6. TCPalm; 7. Tampa Bay Times; 8. 1Q market research
CASE STUDY: AFTER EXPERIENCING A TROUBLING INCREASE IN NEW CASES AND HOSPITALIZATIONS, ARIZONA HAS BEEN FORCED TO RECLOSE SOME BUSINESSES

Timeline of key actions

<table>
<thead>
<tr>
<th>Date</th>
<th>Active Cases</th>
<th>Notes</th>
</tr>
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<tbody>
<tr>
<td>Mar 6</td>
<td>1</td>
<td>First case attributed to community spread in AZ</td>
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<tr>
<td>Mar 15-19</td>
<td>44</td>
<td>Statewide closure of schools, canceled large events, most businesses closed, electives delayed</td>
</tr>
<tr>
<td>Mar 31</td>
<td>1,269</td>
<td>Stay at home order</td>
</tr>
<tr>
<td>May 8</td>
<td>4,481</td>
<td>In-person retail and personal care reopens. Dine-in restaurant services resume May 11 with social distancing recommendations, not requirements</td>
</tr>
<tr>
<td>May 13</td>
<td>5,007</td>
<td>Pools, gyms, spas reopen. Stay at home order expires May 15.</td>
</tr>
<tr>
<td>Jun 6</td>
<td>9,398</td>
<td>Activated emergency plans to increase bed capacity, including delaying elective procedures</td>
</tr>
<tr>
<td>Jun 29</td>
<td>37,701</td>
<td>Executive order recloses bars, movie theaters, and gyms</td>
</tr>
</tbody>
</table>

Observations & Lessons Learned

Reopening should occur after a decline in cases has been clearly evidenced in all regions of the state

- When AZ reopened in mid-May, the Gov. and many others believed they were on the cusp of a decline. Instead, they plateaued
- Two weeks later, cases began to surge in several counties, including Maricopa (Phoenix), Navajo and Apache (Navajo Nation)
- After AZ’s largest health system warned that they were nearing ICU capacity, hospitals statewide were instructed to activate emergency plans to increase ICU capacity, including suspension of elective surgeries and staffing of medical volunteers

Even the strongest suppression measures cannot overcome severe SES challenges...

- Despite one of the strictest stay at home orders in the country, the Navajo Nation has one of the highest cases per capita in the country
- Housing shortages result in multiple generations living in one home
- 30-40% do not have running water for hand washing
- Food deserts mean more people shop at fewer grocery stores, making it more difficult to socially distance

Significant case growth necessitates postponement of further reopening or reclosures of risky venues

- For much of May and June, Governor Doug Ducey did not issue a statewide order for mask wearing, and limited the ability for cities or counties to mandate them locally, in addition to publicly committing to previously stated reopening timelines
- However, as cases spiked rapidly, he reversed course, reclosing risky venues and publicly urging mask wearing compliance – initial results suggest declining/plateauing case counts
**MOBILITY ‘ON THE WAY UP’ IS NOT AS STRONGLY CORRELATED WITH CASE GROWTH AS IT IS ON THE WAY DOWN; ONE REASON COULD BE LEARNED BEHAVIORS, WHICH VARY BY COUNTRY**

**Spain**
- Infection rate was highly correlated with social distancing in the early outbreak
- This is consistent with studies showing that the earlier social distancing is implemented, the less severe a given outbreak is
- Despite relatively level transmission through June, infection rates rose with increase mobility through early July, and dropped with decreased mobility during the most recent month, suggesting:
  - Monitoring social mobility is one potential tool to help forecast future case growth in Spain
  - One could infer that the Spanish population initially engaged in riskier behavior (limited PPE, substantial contact) when moving outside the home, but have recently reduced said behavior

**Germany**
- Like Spain, Germany saw substantial decreases in infection rate with corresponding decreases in mobility
- However, their infection rate has mostly remained consistent throughout the majority of the pandemic, even as mobility has increased by nearly 100% from its lowest point
- This suggests a degree of learned behavior among the German populace - adequate hygiene and social distancing practices while in public likely mitigate negative effects from social mobility
- Despite some spikes, overall transmission has remained relatively stable since the lockdown was lifted
- Strong compliance with social distancing guidance will likely reduce the need for economic disruption throughout the pandemic
### GUIDANCE BY STATE & SITUATION; STRINGENCY RANGES FROM VERY STRICT & DEFINED CLOSURE REQUIREMENTS IN NY TO CLEANING PROTOCOLS IN ME

<table>
<thead>
<tr>
<th>State</th>
<th>1 confirmed case</th>
<th>Multiple confirmed cases linked to single classroom</th>
<th>Multiple confirmed cases in multiple classrooms, linked by in-school activity</th>
<th>Multiple confirmed cases linked to out-of-school exposure</th>
<th>Case links unable to be determined</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA</td>
<td>Students and staff in close contact with case are quarantined</td>
<td>Students and staff in close contact with case are quarantined</td>
<td>School or classroom closure determined by public health dept recommendation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME</td>
<td>Classroom cleaned or closed for at least 7 days; students and staff in contact with case are quarantined</td>
<td>Classroom cleaned or closed for at least 7 days; students and staff in contact with case are quarantined</td>
<td>Entire school closed until completion of thorough cleaning and disinfection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NJ</td>
<td>Students and staff in close contact with case are quarantined</td>
<td>Students and staff in contact with case(s) are quarantined; classroom closure determined by public health dept recommendation</td>
<td>School closure determined by public health dept recommendation</td>
<td>School closes for 14 days</td>
<td></td>
</tr>
<tr>
<td>NY</td>
<td>Classroom closed for 14 days; students and staff in contact with case are quarantined</td>
<td>Classroom closed for 14 days; students and staff in contact with case(s) are quarantined</td>
<td>School closes for duration of investigation; affected classrooms closed for 14 days at end of investigation</td>
<td>School closes for 14 days</td>
<td></td>
</tr>
<tr>
<td>CT</td>
<td><em>Local education authority determines classroom and school closure protocol; guidance primarily based on community spread indicators, not in-school confirmed cases</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NH</td>
<td><em>Local education authority determines classroom and school closure protocol; guidance based on mixture of community spread indicators, in-school confirmed cases, and general capacity of staff to handle operations</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RI</td>
<td><em>Local education authority determines classroom and school closure protocol</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VT</td>
<td><em>Local education authority determines classroom and school closure protocol in consultation with VT DoH; guidance based on mixture of community spread indicators and current impact to staff and student body</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
WHAT DROVE DECLINES ACROSS THE UNITED STATES DURING THE LATE SUMMER?

Likely explanations are primarily centered on behavioral change

1. **Increased public compliance** – American attitudes towards social distancing and mask wearing have been increasing over time, leading to reductions in risky behavior

2. **Mask mandates** – Mask usage in public is now mandated in over 50% of U.S. states, including key summer hotspots (e.g., AL, CA, LA, TX) – mask wearing demonstrably lowers transmission in states with mandates

3. **Risky business closures** – Reclosures of bars, gyms, and other risky businesses in hotspots like AZ, CA, LA, and TX likely limited risky behavior and helped to limit transmission

4. **Testing capacity limits** – Alternatively, the answer may simply be driven by data integrity, as late-summer strain on testing capacity constrained our ability to diagnose true scope of outbreak; Capacity has increased materially since, lowering the risk of unseen outbreak
BEHAVIORAL CHANGES WERE EVIDENT ACROSS SUMMER HOTSPOTS, REDUCING RISK OF TRANSMISSION

Risky behavior declined among Americans, notably in currently declining hotspots

- Summer hotspots with lower mobility generally peaked earlier than their higher mobility peers
  - Previous hotspots that peaked earlier (AZ, CA, FL, TX) have seen a stronger relative decline from their highest mobility than states which took longer to peak
  - These states also have lower mobility as a whole relative to their baseline; this is likely in part due to the higher population base of those states

- On the whole, American compliance with and positive attitudes towards social distancing are growing
  - 75% of Americans were more likely to socially distance or wear a mask in July as compared to June
  - When they do go out, they’re more likely to do so safely; mask wearing compliance is currently at an all-time high
  - This compliance is extremely high in the Northeast (92%) with the South and West not far behind (86%). The Midwest still has strong compliance, albeit less than the rest of the country, at 81%

1. Increased Public Compliance

© Oliver Wyman 1. Harris Poll; 2. Gallup; 3. Gallup
HIGH MOBILITY CONTRIBUTED TO CASE GROWTH IN CURRENT HOTSPOTS, BUT INCREASING “LEARNED BEHAVIORS” MAY ACCOUNT FOR SLOWING CASE GROWTH IN THOSE STATES

Florida

- Infection rate was highly correlated with social distancing in the early outbreak
- This is consistent with studies showing that the earlier social distancing is implemented, the less severe a given outbreak is
- Transmission increased almost in lockstep with mobility through late June, but began to decrease rapidly as mobility has leveled off, suggesting:
  - “Learned behavior” was not strong in Florida through the late spring/summer, leading to high impact from mobility
  - As case growth worsened over time, more residents began following social distancing/mask guidance, decoupling mobility from transmission

New York

- Like Florida, New York saw substantial decreases in infection rate with corresponding decreases in mobility
- However, their infection rate has mostly remained consistent throughout the majority of the pandemic, even as mobility has increased by nearly 100% from its lowest point
- This suggests a degree of learned behavior among the New York populace - adequate hygiene and social distancing practices while in public likely mitigate negative effects from social mobility
- Additionally, the slow rollout of risky businesses in NY (as opposed to FL) may have limited the overall risk from increasing mobility
- Strong compliance with social distancing guidance will likely reduce the need for further economic disruption throughout the pandemic

Oliver Wyman infection rate vs. Google mobility indices

**Florida**

- [Graph showing correlation between Google Transit Index and infection rate in Florida](#)

**New York**

- [Graph showing correlation between Google Transit Index and infection rate in New York](#)
Reclosures of bars, gyms, and indoor dining may reduce risk from social mobility

- States range in their severity of reclosures, ranging from closing specific subsets of risky businesses (Florida reclosing some bars) to the closure of multiple higher-risk venues (California reclosing indoor dining, entertainment and bars)

- However, evidence suggests **even a minimal reclosure of the highest risk businesses (e.g., bars) is prudent when dealing with high active cases**; as seen at right, states tend to see a flattening/decline of case growth within 2-3 weeks of reclosure, while those who remained opened saw rising case rates for longer periods of time

- Though it is difficult to isolate the exact effects of specific measures, studies suggest that **economic shutdowns were effective in the early pandemic**, resulting in anywhere from ~3 to 300 million fewer infections in the countries studied\(^1,2\)

- Though evaluation of efficacy is still ongoing in the United States, **hotspots that reclosed in some fashion generally experienced faster case decline** (e.g., AZ, CA, NC, TX), while those that did not reclose continued to grow (e.g., MS, MO, OK, TN)

### Reclosed bars

<table>
<thead>
<tr>
<th>State</th>
<th>Bar reclosure date</th>
<th>Days after closure until peak</th>
<th>2 week case growth as of 8/9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>6/29</td>
<td>10</td>
<td>-18%</td>
</tr>
<tr>
<td>California</td>
<td>7/13</td>
<td>(peaked just before closure)</td>
<td>0%</td>
</tr>
<tr>
<td>Florida</td>
<td>6/26</td>
<td>21</td>
<td>-18%</td>
</tr>
<tr>
<td>Louisiana</td>
<td>7/13</td>
<td>13</td>
<td>-19%</td>
</tr>
<tr>
<td>Nevada</td>
<td>7/10</td>
<td>12</td>
<td>-6%</td>
</tr>
<tr>
<td>Texas</td>
<td>6/26</td>
<td>24</td>
<td>-23%</td>
</tr>
</tbody>
</table>

### Did not reclose bars

<table>
<thead>
<tr>
<th>State</th>
<th>Bar Reclosure Date</th>
<th>Days After Closure Until Peak</th>
<th>2 Week Case Growth as of 8/9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arkansas</td>
<td>N/A</td>
<td>N/A</td>
<td>6%</td>
</tr>
<tr>
<td>Missouri</td>
<td>N/A</td>
<td>N/A</td>
<td>75%</td>
</tr>
<tr>
<td>Mississippi</td>
<td>N/A</td>
<td>N/A</td>
<td>15%</td>
</tr>
<tr>
<td>Tennessee</td>
<td>N/A</td>
<td>N/A</td>
<td>3%</td>
</tr>
</tbody>
</table>

THOUGH CASE GROWTH HAS DECLINED, TRUE EXTENT IS HARD TO GAUGE; POSITIVE TEST RATES >10% INDICATE A CAPACITY ISSUE AND LIMIT ABILITY TO ASSESS GROWTH

7-day % positive testing rate
Among current top 10 states in active cases

- Though some states appear to be improving (FL, TX, CA), true understanding of outbreak scope is limited without adequate testing capacity (e.g., in FL)
- There are currently 12 states with a >10% positive rate, but only 2 of them are current hotspots:
  - WI, FL
- While declining case rates and % positives are encouraging, those case rates should be taken with a grain of salt until positive rates are well below 10% in hotspots
EPICENTERS BRAZIL AND INDIA REOPENED DESPITE LIMITED RESPONSE CAPABILITIES

<table>
<thead>
<tr>
<th>Capability</th>
<th>Brazil</th>
<th>India</th>
</tr>
</thead>
</table>
| 1: Health system capacity  
The personnel, PPE, beds, and other equipment to sustainably manage normal healthcare needs and a potential new surge | Capacity is slightly improved from mid-summer peak, but many hospitals are rationing or completely out of PPE and beds; outbreak has spread to under-resourced rural interior | Outbreak has expanded to poor, rural regions, overwhelming public health systems; healthcare workers are dying at a rate ~10x that of the national average |
| 2: Testing  
Sufficient rapid testing to screen essential workers, conduct random testing, effectively contract trace and ID new flareups | Data is limited, but as of early September testing was substantially below recommended levels resulting in >20% positivity rates | India’s testing capacity continue to improve, but as cases continue to rise unabated and a current ~8% positive rate, there is a need to expand further |
| 3: Contact tracing  
Identification, testing, and isolation of infected individuals’ contacts | Limited contact tracing infrastructure; resistance from federal government to address severity of pandemic | Most states have abandoned contact tracing efforts in light of overwhelming case numbers; rural regions especially underserviced |
| 4: Central surveillance  
Processes and infrastructure for aggregating an analyzing data to drive decision-making around suppression strategies | In early June, Brazil limited access to COVID data; Reporting, aggregation, and analysis capabilities are all extremely substandard | India has taken steps to improve surveillance capabilities, including dedicated district-level surveillance teams; however, lack of contact tracing data and limited data from poorer regions hampers response |
| 5: Social distancing  
Cultural and infrastructural changes to daily life and work | Conflicting messaging from federal leadership has lead to low compliance; packed entertainment venues (bars, beaches) have substantially worsened the outbreak | Social distancing has not been effective - public transit, retail stores, and religious services have seen little compliance; Existing transit and housing infrastructure is not built to accommodate significant personal space. Quarantine centers have been overcrowded and ineffective, and reports of citizens dodging quarantine are widespread |

1. CDC has issued guidance on these topics that should be referenced by local authorities

© Oliver Wyman
**THERE IS SUBSTANTIAL UNCERTAINTY AROUND COVID-RELATED DATA, BUT OW IS CONSTANTLY MONITORING TO ENSURE UP-TO-DATE DATA INTEGRITY**

**Limitations with existing COVID data**

- **Reporting lag makes up-to-date assessments and comparisons across geos difficult**
  - As seen on the chart at right, estimates are regularly revised a week or more after a given date, due to reporting lags from hospitals and other providers
  - These lags vary by geo, and lag time is not consistent (e.g., Dallas has a range of 0-74 days of lag time)
  - This lag, combined with the lengthy and variable asymptomatic period of COVID, makes it difficult to determine the impact of changes in a geo’s containment strategy

- **Leading indicators are a useful barometer to assess future risk of case growth, but efficacy varies by geo**
  - Generally, mobility indices were strongly correlated as infection rates decreased, but learned behavior and proper govt. management allow for mobility increases without rises in transmission, leading to lower overall correlation (~1/3rd of modelled countries have correlations of <60%)
  - Lag from seeing change in mobility to change in infection also varies by geo – mobility indices’ strongest correlation with infection rate ranges from a ~7 day to a ~21 day lag

- **Differences in data collection and case definitions increase the difficulty of comparing across geos. E.g.:**
  - Attribution of cause of death varies by country, affecting death rate: England has nearly double the excess mortality rate of France suggesting limited attribution of death to COVID
  - Serological and diagnostic test results have been variously reported combined and separately, leading to inconsistent % positive results
  - Russia has been accused of reporting false or misleading COVID information

- **Confounding variables hinder true assessment of suppression efficacy**
  - Large numbers of disparate govt. actions at overlapping periods of time limits ability to determine impact on infection rate from discrete actions
  - Success is also highly influenced by endogenous variables such as population dynamics and cultural factors

---

**Estimated number of daily new cases, by reporting day**

*New York City, 2020*

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**Correlations between Google mobility indices and OW estimated infection rate**

*Among countries modeled in OW Pandemic Navigator*

CONTINUED RURAL CASE GROWTH CARRIES SIGNIFICANT IMPLICATIONS TO OVERALL OUTCOMES AND PANDEMIC PROGRESSION

| Outbreaks in rural areas may fly under the radar |  
|-------------------------------------------------|--------------------------------------|
| • Even high per capita case rates will have low absolute numbers in rural areas |
| • Local health departments and health systems in rural areas may not have the capacity to adequately test and report on new cases |
| • Outbreaks may be out of control before they are noticed |

| Severe outbreaks in rural areas may have particularly bad outcomes |  
|---------------------------------------------------------------|--------------------------------------|
| • Demographics in rural areas skew older and with more risk factors, suggesting illnesses may be more severe  
  — The median age is 51 years in rural areas, compared to 45 in urban areas¹  
  — Adults, young and old, living in rural areas are more likely to have pre-existing conditions that put them at increased risk of serious illness due to Covid-19 (20% of adults 65+ in rural areas, 15% in urban areas; 26% of adults under 65 in rural areas; 20% in urban areas)² |
| • There are fewer hospital beds per capita in rural areas, creating greater risk of overwhelmed systems  
  — On average, rural areas have 1.7 ICU beds per 10K population, compared to 2.8 beds per 10K population in metro areas² |
| • To date, CFRs have been lower in rural areas (3% vs. 6%), but true cause remains unknown. This could be driven by reporting issues (reporting death in county of death vs residency) or potentially because per capita cases have been higher in urban areas, and more intense exposure in urban areas³ |

| Outbreaks in rural areas could reseed recovering urban areas |  
|-----------------------------------------------------------|--------------------------------------|
| • Uncontrolled case growth in rural areas creates risks of new outbreaks spreading in urban areas, especially as restrictions ease and travel between urban and rural areas expands |

1. U.S. Census Bureau  
2. Peterson-KFF Health System Tracker  
3. Science (link)
CURRENT INFRASTRUCTURE ASSUMPTIONS ARE BASED ON HISTORICAL FLU VACCINE INFRASTRUCTURE AND MAY BE OPTIMISTIC DUE TO EXTERNALITIES OR COVID-SPECIFIC IMPACTS

Manufacturing capacity
- **Vaccine nationalism:** The United States may not be able to secure any doses manufactured outside of the country, and would therefore be limited to manufacturing capacity from facilities located within the US
- **Manufacturing disruptions:** Faulty batches, facility disruptions (e.g., fire in a facility) or labor disruptions (e.g., workers must quarantine due to COVID exposure) may reduce output beyond current stated production capacity

Distribution capacity
- **Cold storage:** Frontrunner COVID vaccines require colder temperatures for storage and distribution than most existing vaccines. The United States may not have adequate equipment to store and distribute enough vaccines at the desired pace
- **Impact from Holiday season:** Holiday season (Thanksgiving – New Years Eve) may diminish supply chain capabilities through labor shortages from vacations as well as lack of production on standard work holidays in the US

Administration capacity
- **Time constraints on vaccination:**
  - Vaccines are stored in vials containing multiple doses, and will lose effectiveness after a certain period of time outside cold storage; without ability to administer vaccines quickly and effectively, doses may be “wasted”
  - Additional safety precautions for COVID (e.g., capacity limits in waiting rooms, required PPE) may increase time per vaccination beyond historical averages for other vaccines
- **Labor shortages:** Given the US is likely headed towards a winter resurgence, available labor pools may be diminished due to A) increased need to care for COVID patients, and B) increased numbers of doctors/nurses infected with COVID
- **Impact of flu season:**
  - Patients cannot be vaccinated if already sick with another illness, limiting uptake during winter months
  - Vaccines will be administered in parallel with flu vaccines, limiting administration capacity
- **Multi-dose vaccination schedule:**
  - Frontrunner COVID vaccines are all multi-dose, and we expect material number of patients to receive an initial shot without finishing the program
  - Vaccines are not interchangeable - patients who receive an initial shot of Oxford's vaccine can only receive the second shot from Oxford, increasing administrative and storage complexity
POPULATION UPTAKE IS A SIGNIFICANT LIMITING FACTOR TO OVERALL IMPACT FROM VACCINES; MANDATES MAY BE REQUIRED TO ACHIEVE ADEQUATE COVERAGE

Average flu coverage over time as % of US population
Average of 2015–2019

- Historically, uptake ramps up over the course of a year, but tends to top out at ~45% of the US population
- We expect COVID vaccination (barring a mandate) to follow a similar curve, as comfort with vaccine safety increases over time
- Overall willingness to take a COVID vaccine ranges from ~65%^1,3 to 50%^2,3, and has been falling over time
- OW’s baseline assumptions for uptake over time are not sufficient in most scenarios to achieve herd immunity, especially when considering incompletion rates of the multi-dose vaccine schedule
- Over time, conferred immunity from natural infection and voluntary vaccinations may be enough to cross the herd immunity threshold, but it is highly unlikely this would be enough before next fall
- Adequate coverage in a near-term time horizon (by September) requires:
  - Extremely favorable assumptions on approval and distribution scenarios, vaccine effectiveness, and conferred immunity from natural infection
  - Vaccine mandate(s) from either the govt. or private employers to ensure adequate uptake and follow-through on the multi-dose schedule

1 Gallup; 2. Pew Research; 3. CNN
OW’S GLOBAL MONITORING CAPABILITIES PROVIDE DEEP AND ACTIONABLE INSIGHT TO GOVERNMENTS, EXECUTIVES AND PUBLIC HEALTH AUTHORITIES

Daily updated database covering 50+ metrics and 200+ countries; access all relevant COVID information in one convenient location

Risk tracker and dashboard identifying likely hotspots and areas of resurgence with key global archetypes

In-depth profiles highlighting key lessons learned and themes from any given country

Consistently refreshed summaries of therapeutics and treatments across the globe

Global macroeconomic perspectives and recovery timelines

Holistic best practices for employers and governments looking to reopen

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## THE US HEALTHCARE INDUSTRY WILL FEEL THE IMPACT OF COVID-19 THROUGH 2021 AND BEYOND

<table>
<thead>
<tr>
<th>Type of business</th>
<th>Impact of COVID on operating revenue</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community health systems (inc. AMCs)</td>
<td>↓</td>
<td>Patient volumes will begin returning by EOY; mix shift drives lower revenue in 2021+</td>
</tr>
<tr>
<td>For-profit hospital chains</td>
<td>↓</td>
<td>Patient volumes begin returning by EOY; better mix management than NFP competitors</td>
</tr>
<tr>
<td>Independent provider groups</td>
<td>↓</td>
<td>Groups will struggle to stay afloat through 2020; those that do, survive</td>
</tr>
<tr>
<td>Pure-play telemedicine</td>
<td>↑</td>
<td>Pure-plays see a temporary volume increase, but lose differentiation or are acquired</td>
</tr>
<tr>
<td>Chain drug / retail care</td>
<td>↑</td>
<td>Stockpiling and testing drive growth; stand to gain from vaccine, but lose in-store demand</td>
</tr>
<tr>
<td>Blues / regional health plans</td>
<td>↑</td>
<td>Temporary MLR gains, offset by loss of commercial business in 2021+</td>
</tr>
<tr>
<td>National health plans</td>
<td>↑</td>
<td>On average, more gov’t business and national diversification hedge commercial losses</td>
</tr>
<tr>
<td>Health IT</td>
<td>↓</td>
<td>Providers cutting capital budgets; payers continue to invest</td>
</tr>
<tr>
<td>Pharma</td>
<td>↓</td>
<td>COVID-19 players gain, while others see short-term loss from delayed hospital demand</td>
</tr>
<tr>
<td>Medical device manufacturers</td>
<td>↓</td>
<td>Correlates with hospital revenue; increased provider cost controls hurt margins</td>
</tr>
</tbody>
</table>

A Pandemic resurgence

What’s going on in my area, and what’s the risk of COVID resurgence?

OW Assets
- Pandemic Navigator
- COVID-19 Almanac
- Pandemic Navigator Database
- Scenario Sandbox and Generator

B Economic disruption and unemployment

How will unemployment fluctuate, given the industry mix in my area?

OW Assets
- SCALE Model with economic recovery by industry
- Unemployment Model

C Payer mix shift

As unemployment rates recover and potentially fluctuate, how will payer mix change?

OW Assets
- HLS Payer Mix Model
- OWA Payer Mix Microsimulation

D Changes in healthcare consumption

How will payer mix shift change utilization?

How will consumer demand recover – and how will it be different (telehealth)?

How much capacity will be needed to test/treat COVID?

...what is the economic impact of all of the above?

OW Assets
- Demand Recovery Learnings and Calculator
- Consumer Surveys
- Provider Distress Scorecard

Existing assets are continually being refined and expanded through client engagements
**ANTICIPATED SHIFTS IN MOVEMENT**

Health insurance mix shift as a result of unemployment caused by the COVID-19 pandemic will see a significant move from Employer–based Commercial insurance to Individual/ACA Commercial insurance, Medicaid, Medicare, and Uninsured.

<table>
<thead>
<tr>
<th>Employer</th>
<th>Individual</th>
<th>Medicaid</th>
<th>Medicare</th>
<th>Uninsured</th>
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<tr>
<td>As unemployment grows, the number of consumers with employer sponsored insurance decreases substantially.</td>
<td>Some consumers shift to the individual market, driven by choice or restrictions on Medicaid eligibility.</td>
<td>Many uninsured move into Medicaid, particularly in ACA expansion states.</td>
<td>Medicaid remains largely unaffected in the near term given focus on retirees.</td>
<td>Some consumers cannot afford coverage and cannot not / choose not to enroll in Medicaid.</td>
</tr>
</tbody>
</table>
PAYER MIX SHIFT SCENARIO ESTIMATION
The OW modelling team is developing multiple unemployment scenarios and analysing their impact on payer mix shift

• Key recent updates include:
  – Fewer lives migrating out of Group
    - Updated to reflect that small business employees have significantly lower enrollment in Group insurance
    - Outsized impact to these businesses vs. larger businesses (which have higher rates of Group enrollment) due to the pandemic translate to fewer overall lives leaving Group coverage
  – Fewer lives migrating into Medicaid
    - Many of the newly uncovered would may not be eligible due to income cutoffs
MULTI-LINE CARRIERS ARE FOCUSED ON A FIGHT FOR COMMERCIAL CUSTOMERS

National carriers are working to retain their commercial business in this time of economic turmoil. It remains to be seen if these will lead to permanent policy/business changes in the future.

**Premium grace periods**

Most carriers are offering a 30 or 60 day premium grace period (note, state regulations can dictate what is permissible).

**Enrollment period extension**

Add new open enrollment periods for existing enrollees, and extend the open enrollment period for new enrollees.

**Furloughed employee coverage**

Many plans are covering furloughed employees through July 31.

**Coverage for ‘new’ employees**

Remove waiting periods for employees temporarily laid off / furloughed.

**Rate freezes**

Some carriers will not adjust rates for new coverage if coverage was dropped due to COVID-19.
THERE ARE 4 WAYS COVID IS RE-SHAPING HEALTHCARE DEMAND

A. Payer mix shift
How will patients change utilization patterns as a result of changes in employment status and health insurance coverage?

B. Recovery of demand
How fast and how far will healthcare consumption recover after the first peak?
What could be immediate and subsequent impact of future outbreaks?

C. Long-term consumer preference changes
How has COVID permanently changed consumer preferences for healthcare? (i.e., telehealth, home care, ambulatory sites of care)

D. Ongoing COVID utilization
What is the utilization impact of COVID-related services (testing, hospitalizations, management of sequelae)?
COVID IS AFFECTING HEALTHCARE CONSUMPTION ACROSS THE ENTIRE ECOSYSTEM

To date, almost half of families have put off care due to COVID-19 – while 68% of this group plans to get care in the next quarter, this represents a serious threat for payers and providers attempting to manage members’ medical conditions.

<table>
<thead>
<tr>
<th>Category</th>
<th>Percent</th>
<th>Details</th>
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<tbody>
<tr>
<td>Skipped care</td>
<td>48%</td>
<td>Percent of people who say they or a family member have skipped care due to COVID-19, though 68% of this group plans to get care within 3 months</td>
</tr>
<tr>
<td>Mental Health</td>
<td>39%</td>
<td>Percent of people who report that COVID-19 has had a negative impact on mental health</td>
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<tr>
<td>Condition Worsened</td>
<td>11%</td>
<td>Percent of people who say they or a family member skipped care due to COVID-19 and believe their condition worsened as a result (23% of those who deferred care)</td>
</tr>
<tr>
<td>Physical Health</td>
<td>8%</td>
<td>Percent of people who say their physical health has gotten worse since the COVID-19 outbreak began</td>
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Source: Kaiser Family Foundation, KFF Health Tracking Poll – May 2020 (link)
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IMPACT OF DEFERRED CARE – AN INCREASE IN NON-COVID-19 DEATHS?

While COVID-19 has caused >100K deaths in the United States, other chronic diseases are still a major danger for many people, and deaths from other diseases have spiked as hospital visits have fallen.

Excess deaths due to COVID-19 and other causes\(^1\)
New York and New Jersey, Mid-March through Mid-May, 2020

Critical care avoidance due to COVID-19

- Drop in ER visits\(^2\)
  - Nationally: 48%
  - Hotspots: 60%
- Drop in hospital admissions for heart attacks: 40-60%\(^3\)
- Drop in stroke patient treatment: 50-70%\(^4\)
- Drop in hospital endocrine visits: 25%\(^2\)

---

1. NYT, *There Has Been an Increase in Other Causes of Deaths, Not Just Coronavirus*, June 1, 2020
2. StrataDecision, *NATIONAL PATIENT AND PROCEDURE VOLUME TRACKER*, May 18, 2020
3. NYT, *Where Have All the Heart Attacks Gone?*, April 6, 2020
4. NPR, *Eerie Emptiness Of ERs Worries Doctors: Where Are The Heart Attacks And Strokes?*, May 6, 2020

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BILLING AND CLAIMS DATA SUGGEST HOSPITAL DEMAND IS RECOVERING MORE QUICKLY THAN EXPECTED

2020 utilization as a % of 2019 baseline

Week (for the week ending on each date, unless otherwise specified)

Sources: Strata Decision Technology analysis of billing encounter data for 209 hospitals from 49 health systems – data points are weekly or monthly averages; Transunion (TU) Healthcare Survey of over 500 hospitals; Tenet Health COVID-19 Operational Impact Update – data points are monthly averages or 2-week averages; Commonwealth Fund analysis of billing data from ambulatory practices, with over 50,000 providers; Surgery Partners Executives; Drug Store News; Center for Biosimilars

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OP: 110-120%
IP: 90-100%
Prof: 85-95% of baseline

IP/OP/ED data updated 7/20/20; Prof data updated 6/25/20
GOVERNMENTS, PROVIDERS, AND PAYERS WILL HAVE TO ADOPT NEW MODELS OF HEALTHCARE THROUGH THE DURATION OF THE PANDEMIC

We expect COVID to be a persistent issue for at least the next 18 months, necessitating a new model to manage COVID-19 cases until a vaccine is available; This will likely require cooperation between public health authorities and health systems

**Community Level Solutions**

1. **Co-managed Utility**
   - System A
   - System B
   - Example: LA County with KP and Dignity
   - Community partners manage and staff a publicly owned COVID facility

2. **Co-managed Capacity Pool**
   - System A
   - System B
   - System C
   - Each system provides agreed capacity. Public health authority balances demand across available supply

**System Level Solutions**

3. **Devoted Assets**
   - Hospital 1
   - Hospital 2
   - Hospital 3
   - COVID Hospital
   - System identifies asset that is destination for COVID cases across the system

4. **Segregated Assets**
   - Hospital 1
   - Hospital 2
   - Hospital 3
   - Hospital 4
   - Portions of designated hospitals are segregated as “COVID wings” with devoted staff, procedures, support

5. **Enabled Capacity**
   - Hospital 1
   - Hospital 2
   - Hospital 3
   - Hospital 4
   - Hospitals across the system have ability to scale COVID response as needed with appropriate isolation, equipment, supplies, etc.

All models require some degree of sacrifice from health systems involved, requiring trust and communication between authorities and the systems

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COVID IS EXPECTED TO ACCELERATE TRENDS IN TELEHEALTH AND ALTERNATIVE CARE

In the future, healthcare is expected to be delivered over a breadth of settings, tailored to consumer preferences and cost efficiency; COVID has accelerated the demand for non-facility based care

Location agnostic care can mean both virtual visits for people based in their homes and at work, as well as physical services delivered to people in their homes. Both will complement facility-based care

- In-home programs such as Mount Sinai Hospital at Home and Neighborhood Health@Home bring care to members in their homes.
- Wearables are growing and can compliment these services – Livongo now has 20K people on hourly home blood pressure monitoring.
- Fully virtual telehealth gives members the convenience to receive care from where they want when they want – and it will not always be at home.
- Telehealth has spiked tremendously – Teladoc is up 92% YoY while MDLive is up >100%

2. CNBC, “Digital health stocks are surging because ‘suddenly now we’re in the future’”, May 23 2020
EXECUTIVES WILL OPERATE IN THE FACE OF A PERVERSIVE RISK OF DISRUPTION AS ECONOMIES REOPEN

HALLMARKS OF THE ROAD AHEAD

1. Seemingly “random” regional shutdowns
2. 20%+ absenteeism (from illness or care giving requirements)
3. Significant mental health and wellbeing challenges for employees
4. Unequal economic impact across sectors
5. Changed customer behaviors (perhaps permanently)

Current Peak

Long Haul of Suppression

Initial period of volatility when reopening begins, before testing and monitoring mechanisms are perfected
Systematic, scaled, and sophisticated tools to enable near real-time monitoring of the disease become well-established

Case Growth per Day

~2 Months
12+ Months
<table>
<thead>
<tr>
<th>Physical work space safety</th>
<th>Functional redesigns</th>
<th>Alternative staffing models</th>
<th>Health screening/testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increased ventilation</td>
<td>• Workflow redesign to reduce hand-offs, complexity, and intensity of rare skills</td>
<td>• Formal separation of a-teams and b-teams to ensure backup availability</td>
<td>• Temperature checks or assessments at entry</td>
</tr>
<tr>
<td>• Floor layout redesigns and foot traffic guidance to reduce congestion and maintain 6 ft distance</td>
<td>• Automation of critical processes and processes with higher personnel risks</td>
<td>• “Flex pool” or “pool of pools” to plug live gaps</td>
<td>• Testing (on site or protocol for referral to local public health entity/physician)</td>
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<tr>
<td>• Comprehensive disinfection practices at appropriate intervals (particularly of high touch surfaces and restrooms)</td>
<td>• Infrastructure and IT configured for enablement of full program portfolio</td>
<td>• Reallocation of workforce across sites to mitigate undue risk in one location</td>
<td>• Policies related to health screening/testing (e.g. management of medical data and privacy, payment for testing and time required for testing, reporting of results, policy for use of results in deployment of staff)</td>
</tr>
<tr>
<td>• Bans on 10+ person meetings</td>
<td>• No sharing of equipment when possible</td>
<td>• All who can work-from-home do so</td>
<td>• Education of management about disease and control measures</td>
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<tr>
<td>• New behaviors, e.g. masks/gloves at all times in public spaces, frequent hand washing, toilet closure)</td>
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<td>• Cross-training of all critical skill sets</td>
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<td>• Cafeteria/social space closure</td>
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<th>Scalable employee support</th>
<th>Management of special people situations</th>
<th>Legal and labor agreements</th>
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<tbody>
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<td>• Elevation of centralized risk monitoring function</td>
<td>• Expanded communications, e.g. educational campaign on social responsibility</td>
<td>• Formal identification of higher risk employees (demographics, health status, rare skills)</td>
<td>• Managing responsibilities to labor unions with regards to lay offs, reduced work hours, testing, etc.</td>
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<td>• Real-time tracking and evaluation of all key risks</td>
<td>• Managing workforce concerns about returning to work</td>
<td>• Alternative work rotations and extended WFH for populations at higher health risk</td>
<td>• Appropriate compliance with wage and hour laws, anti-discrimination laws, health and safety laws, the Americans with Disabilities Act, various new (and old) paid sick and family leave rules, etc.</td>
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<td>• SWAT teams for rapid intervention</td>
<td>• Transportation burden assistance (e.g. to avoid subway use)</td>
<td>• Enhanced HR admin capacity for special employee circumstances (e.g. Sick days, PTO, furlough, alternative work arrangements)</td>
<td>• Preparation for any potential claims filed by employees as a result of measures undertaken during crisis period</td>
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<td>• Contingency plans for opening/closing/relocating operations based on evolving local risk</td>
<td>• Mental wellbeing coaching resources</td>
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<td>• Alerts and compliance monitoring</td>
<td>• Productivity training for remote collaboration</td>
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<td>• Policy &amp; technology provision for extended work-from-home for large portions of workforce</td>
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<td>• Childcare assistance</td>
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Oliver Wyman and our parent company Marsh and McLennan (MMC) have been monitoring the latest events and are putting forth our perspectives to support our clients and the industries they serve around the world. Our dedicated COVID-19 digital destination will be updated daily as the situation evolves.

Visit our dedicated COVID-19 website
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