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Have assembled a team of experts to help operationalize the White House “Opening America” framework
Executive Summary: The War on COVID-19

- Global cases & deaths continue to rise. Mitigation efforts have led to some level of “flattening”, but with severe economic consequences
  - The US new daily cases are beginning to decline, but still account for 1/3 of global daily new cases
  - MA new daily cases still high, but are seeing frequent periods of declining. Hospital ICU beds only ~50% filled
  - JP Morgan estimating Q2 GDP down ~40% QoQ. MA unemployment ~2x the GFC, with low income workers particularly hard hit

- Determining when to re-open is dependent on modeling out “supply and demand”
  - Key supply considerations include availability of beds and healthcare workers (taking into account burden of other illness/need) and therapeutic availability and effectiveness
  - Key demand considerations include a manageable current new case trajectory (“flattened curve”), confidence in ability to track case counts, and anticipated effectiveness of segmentation & worker safeguards

- If reopening causes a demand imbalance, risk a rolling lockdown scenario
  - 1918 Spanish Flu data warns of opening too early or with too little preparation – could result in a second, larger spike in cases than the first
  - Spain re-opened once COVID-19 cases reached 20% of their prior peak, but was still too soon – cases rapidly rose and Spain was forced to shut again

- Critical to design a “back-to-work” plan that does not overload hospitals and keeps people safe

We can defeat COVID-19 by implementing: (1) strategic population segmentation, (2) effective therapeutic treatments and longer term a vaccine, (3) full adoption of R_T reduction protocols
Contents

• Summary COVID-19 History & Economic Impact

• Timing: *When* to Return to Work

• The Key Three Steps: *How* to Return to Work
Global COVID-19 Cases Update

As of 4/30/20
Sources: WHO situation reports, Johns Hopkins University, press search, McKinsey

Global cases and deaths continue to rise. The US may be in early stages of “flattening” & Europe cases declining, but the rest of the world is still experiencing growth
Why is COVID-19 so serious?

- Fundamental issue: COVID-19 has a high fatality rate and a high $R_0$ (high rate of infection)

- Additionally, COVID-19 has a high rate of hospitalization (~10%+), which combined with high rate of spread creates large tax on hospital capacity

- Finally, COVID-19 is indiscriminate, causing serious long term health consequences in all ages

- In order to return to work, need to adopt policies & procedures to reduce $R_T$

COVID-19 has a high spread & high rate of hospitalization / death – to return to work, need to adopt policies & procedures to reduce spread ($R_T$)

*Note: Infection fatality rate used where available, otherwise case fatality rate used to approximate IFR
Sources: NY Times (https://www.nytimes.com/2020/02/18/learning/whats-going-on-in-this-graph-coronavirus-outbreak.html), World Health Organization, Institute for Disease Modeling, BMC Infectious Diseases
Today, MA’s $R_T$ has fallen below 1.0 – the virus is being contained. However, mitigation efforts are having a dramatic impact on the economy and thus are unsustainable.

Sources: rt.live, Kevin Systrom, Thomas Vladeck, Mike Krieger, Ryan O’Rourke, Robby Stein, Thomas Dimson, Frank Dellaert, Adam Lerer. Data last updated 4/30
Economic Impact of Shutdowns

JP Morgan projecting US GDP to be down 40% QoQ in Q2; EU GDP to be down 45-55% QoQ

Source: 4/17/20 JP Morgan Economic Outlook, US Department of Labor, LaborCUBE; BLS OES, Moody’s, McKinsey Global Institute analysis

Note: Analysis determines vulnerable jobs as a function of physical distancing policies and their immediate knock-on economic consequences – assumes maximum physical distancing (defined by shelter-in-place policy)

Mitigation efforts are having a significant impact on the economy, and impact is most severe in low income workers
COVID-19 History & Economic Impact: Summary

- Global cases and deaths continue to rise, but the US & Europe may be in the early stage of “flattening”

- COVID-19 is particularly serious because of its high hospitalization & death rate and high rate of spread ($R_0$). Unmitigated spread can quickly overwhelm hospitals

- While mitigation efforts are contributing to the early curve “flattening,” they will have a dramatic economic impact in the U.S., with some analysts forecasting Q2 GDP declines 2-3x that of the great depression

- Workers earning less than $40K/year and employed by small businesses are most vulnerable

Mitigation efforts are aiding in the fight against the virus, but are also having a significant impact on the economy, and impact is most severe in low income workers

Source: Bain Capital Partners Analysis
Contents

• Summary COVID-19 History & Economic Impact

• **Timing:** *When to Return to Work*

• The Key Three Steps: *How to Return to Work*
Determining When to Reopen

Supply
• Availability of supply inputs: beds, HC workers
• Timeline & supply of therapeutic options
• System readiness for policies to reduce $R_T$ (e.g., testing, tracing, PPE capacity)

Demand
• Current new case trajectory manageable / “curve flattening”
• Confidence in ability to track cases
• Model projecting anticipated hospital burden based on # ppl returning to work & projected spread

Case Studies

China Return to Work
• Waited until new cases practically eradicated. Since then, new cases returned, but at much lower rates
• Firm workplace rules, rigorous testing, travel restrictions
• Comprehensive smartphone tracking

Spain Return to Work
• Waited until new cases ~20% of peak
• Handed out 10M masks and 1M+ testing kits
• Allowing non-essential construction, manufacturing to return to work
• New cases since rose to ~80% peak levels, requiring immediate scale back – opened too soon

Need to model out supply and demand and reopen with a buffer on total capacity utilization

Massachusetts COVID-19 Cases

# of new cases showing signs of flattening; growth rate has slowed since people movement slowed

[Graph showing new cases and 2 Day Avg Growth Rate]

MA growth rate has dramatically slowed since stay-at-home mitigation efforts, and new cases / day may be in early stages of declining

Note: There is day-to-day variability in cases reported by testing laboratories and no single day change in indicative of overall cases trends
Source: Mass.gov; as of 4/30/20

62,205 total cases
3,803 in hospital
1,001 in ICU
3,562 total deaths
MA Hospitalization Rate & Capacity Data

Approximately ~10% of positive cases in MA hospitalized
~21% of hospital beds and ~50% of ICU beds are currently filled by COVID-19 patients

*Hospitalization rate does not include patients previously hospitalized but since discharged, so likely higher than demonstrated by existing data
Source: Mass.gov
Critical to “Avoid the W”

What we need to prevent:

- Actual new cases (10x reported, could be 3x-50x)
- Vaccine rollout
- Relaxes
- Lockdown
- Unmitigated spread

Sub-optimal public health approach creates the bad/bad box of ineffective lockdowns and high burden on healthcare systems – creating wider, deeper “U” or “W” that only ends with vaccine

Source: Bain Capital Partners analysis
1918 Spanish Flu Precedent

Philadelphia – too late to shut, overwhelmed

- Philadelphia acted too late to curb the death rate – after waiting until after a massive parade to close the city, the virus overwhelmed hospitals
- But because initial rate so high, no second peak

St. Louis – reopened too early

- St. Louis acted early to curb the death rate – but opened too soon, causing a second spike much higher than the first

Denver – reopened with too little public guidance

- Denver acted early to curb the death rate – but opened with too little public guidance, causing a second spike with similar magnitude as first
  - After initial closure was lifted, the public thronged the streets by the thousands, and new cases rapidly spiked to rates higher than previous

City closures & social distancing highly effective if instituted early – but second waves are likely and can be worse than the first if proper measures not taken before re-opening

Source: Proceedings of the National Academy of Sciences, InfluenzaArchive.org, Markel et. al., Journal of the American Medical Association (2007), Bain Capital Analysis
When to Return to Work: Summary

• **Building a dynamic hospital capacity / demand model** based on current infection rate and system readiness for reopening critical to determining when to return to work.

• MA new daily cases still trending **around peak**, although have shown signs of “flattening.” Managing hospital capacity well so far, with **ICU beds only ~50% filled** with COVID-19 patients.

• However, **critical to not reopen too soon** – a demand imbalance could lead to a second peak more severe than the first, as evidenced by St. Louis’ re-opening during the 1918 Spanish Flu.

Need to focus on developing policies and protocols to keep hospital capacity balanced with demand and minimize the risk of another lockdown.
Contents

• Summary COVID-19 History & Economic Impact

• Timing: When to Return to Work

  • The Key Three Steps: How to Return to Work
The Key 3 Steps to Achieve Hospital Balance & Worker Safety

**Segmentation:** Sequence segments returning to work according to risk to lower hospitalization rate

**Effective Therapeutics:** While waiting for vaccine, implement effective treatments to curb hospitalization rate & fatality rate

**Reduce $R_T$:** Implement policies & procedures to reduce the rate of spread

Source: Bain Capital Partners analysis
Excluding those aged 60+ from initial return to work segment may greatly reduce the hospital burden without affecting a large portion of the working population.

Source: mass.gov COVID-19 dashboard; U.S. Census, BCP Analysis, data as of 4/27/20
Industry Segmentation

Ability to Work From Home

<table>
<thead>
<tr>
<th>Easier</th>
<th>Harder</th>
<th>Hardest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government</td>
<td>Social services &amp; healthcare</td>
<td></td>
</tr>
<tr>
<td>Utilities</td>
<td>Retail (food, grocery, pharmacy)</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>Transportation (public)</td>
<td></td>
</tr>
<tr>
<td>Information</td>
<td>Agriculture</td>
<td></td>
</tr>
<tr>
<td>Finance, Real</td>
<td>Mining</td>
<td></td>
</tr>
<tr>
<td>estate</td>
<td>Construction</td>
<td></td>
</tr>
<tr>
<td>Professional</td>
<td>Manufacturing</td>
<td></td>
</tr>
<tr>
<td>services</td>
<td>Administrative</td>
<td></td>
</tr>
<tr>
<td>Management</td>
<td>Recreation</td>
<td></td>
</tr>
<tr>
<td>Wholesale</td>
<td>Food &amp; accommodation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Retail (discretionary)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transportation (private)</td>
<td></td>
</tr>
</tbody>
</table>

Typically considered critical by states

<table>
<thead>
<tr>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical</td>
<td>Critical sectors with some ability to WFH</td>
</tr>
<tr>
<td>sectors that</td>
<td>may be able to encourage portions to</td>
</tr>
<tr>
<td>cannot work from</td>
<td>continue remote work</td>
</tr>
<tr>
<td>home</td>
<td></td>
</tr>
<tr>
<td>sectors that</td>
<td>Less critical sectors that cannot work</td>
</tr>
<tr>
<td>cannot work from</td>
<td>from home – Less critical, so possible</td>
</tr>
<tr>
<td>home</td>
<td>to delay, but may need to be part of initial</td>
</tr>
<tr>
<td></td>
<td>wave</td>
</tr>
<tr>
<td></td>
<td>Less critical sectors able to work from</td>
</tr>
<tr>
<td></td>
<td>home - - encourage these sectors to continue</td>
</tr>
<tr>
<td></td>
<td>working from home where possible</td>
</tr>
</tbody>
</table>

% of US GDP\(^1\)

<table>
<thead>
<tr>
<th>Easier</th>
<th>Harder</th>
<th>Hardest</th>
</tr>
</thead>
<tbody>
<tr>
<td>41%</td>
<td>20%</td>
<td>19%</td>
</tr>
<tr>
<td>% of US GDP(^1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36%</td>
<td>37%</td>
<td>19%</td>
</tr>
<tr>
<td>% of US employment(^1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20%</td>
<td>39%</td>
<td>37%</td>
</tr>
</tbody>
</table>

Possible to phase industries returning to work by criticality and ability to continue working from home

1. Sum is less than 100%, due to other minor sectors not depicted

Comprehensive “Funnel Framework”

A handful of key segmentation decisions can greatly reduce the hospitalization rate while still enabling large portions of the economy to restart.

Other Considerations

- Returning population’s exposure to excluded population: how many excluded ppl will still be exposed by household members returning to work?
- Nursing Homes: how to deal with isolated high-risk populations interacting with workers?
- Workforce enablers: (childcare / education) – need enough capacity to support segment returning to work

Source: Bain Capital Partners analysis
Other Considerations: Families with At-Risk Relatives

Up to ~40% of 65+ population could be living with individuals returning to work. To manage these at-risk populations, may need to set up alternative living arrangements in hot spots.

**MA 65+ Population Living Situation**

- Lives Alone: 10%
- Lives w/ Spouse: 40%
- Lives w/ Youner Relatives: 50%
  - Lives w/ Younger Non Relatives: 20%
  - Lives w/ Parent: 30%

**Strategies for At-Risk Individuals with Family Members Returning to Work**

- Encourage workers living with at-risk individuals to strictly adhere to all policies and procedures
- In hot spots, could consider setting up alternative housing for at-risk individuals

Source: 2018 American Community Survey Living Arrangements of Adults 18 Years and Over By Age
Other Considerations: Education

## Reopening Schools

<table>
<thead>
<tr>
<th>Earliest to Open</th>
<th>Latest to Open</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reopened schools in low-risk areas outside Tokyo</td>
<td>Schools opening potentially next school year</td>
</tr>
<tr>
<td>Reopening kindergartens and primary schools</td>
<td></td>
</tr>
<tr>
<td>Considering reopening schools to graduating students</td>
<td></td>
</tr>
</tbody>
</table>

### Action

- Reopened schools in low-risk areas outside Tokyo
- Reopening kindergartens and primary schools
- Considering reopening schools to graduating students
- Schools opening potentially next school year

### Risks / Mitigation

- Many regions with low case count, but limited risk for children themselves
- Opening after a month in lockdown, disinfecting schools twice a day
- Oldest students can keep masks on, but still risk of asymptomatic transmission
- Opening after bars, cinemas, and restaurants

### Key Considerations

- Schools should consider risk to children themselves (likely low) and their transmission to others (higher)
- Criticality for economic activity a concern, school reopening often a prerequisite to parents returning to work
- Transpiration and child care also necessary preconditions to allowing people to return to work, will need mitigating safety measures

Reopening schools and child care precondition to returning to work, but carries key risks. Will also need plan for other key enablers (e.g., transportation)

The Key 3 Steps to Achieve Hospital Balance & Worker Safety

**Segmentation:** Sequence segments returning to work according to risk to lower hospitalization rate

**Effective Therapeutics:** While waiting for vaccine, implement effective treatments to curb hospitalization rate & fatality rate

**Reduce R<sub>T</sub>:** Implement policies & procedures to reduce the rate of spread

Source: Bain Capital Partners analysis
# Types of Solutions & Timeline

<table>
<thead>
<tr>
<th>Use Case</th>
<th>First Wave “Repurposed” Therapeutics</th>
<th>Second Wave New Therapeutics</th>
<th>Third Wave Vaccines</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acute remediation</strong></td>
<td>• Remdesivir</td>
<td>• Human antibodies – Monoclonal and polyclonal</td>
<td>• Inactivated virus particles</td>
</tr>
<tr>
<td><strong>Drug Candidates</strong></td>
<td>• Niclosamide</td>
<td>• New compounds targeting essential viral proteins</td>
<td>• Live-hybrid viruses</td>
</tr>
<tr>
<td>• Favipiravir</td>
<td>• Human antibodies</td>
<td>• RNA-based vaccines – Moderna, CureVac, BioNTech</td>
<td>• Unknown if vaccines will need to be seasonal (like influenza) or durable long-term (like measles)</td>
</tr>
</tbody>
</table>

| Challenges | **FDA approval timelines** are usually 30 days for testing, 3-6 months for approval | **Dose** likely higher than existing use cases, **supply** limited |

| April-June 2020 | July-September 2020 | April 2021-April 2022+ |

**Therapeutics in development, but vaccine 18+ months away**

Source: Scientists to Stop COVID-19, Newpath Partners, Nature, Bain Capital Partners analysis
First Wave – “Repurposed” Therapeutics

Repurposed Therapeutic Development Timeline

<table>
<thead>
<tr>
<th>Remdesivir Trial Results</th>
<th>Example Early Candidates Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remdesivir Production</td>
<td>GILEAD Under development (Ebola, SARS)</td>
</tr>
<tr>
<td>Niclosamide</td>
<td>FUJIFILM Investigational (influenza) *approved in Japan</td>
</tr>
<tr>
<td>Favipiravir</td>
<td>Use Case Treatment</td>
</tr>
<tr>
<td>Camostat</td>
<td>Earliest Trial May 2020</td>
</tr>
<tr>
<td>Trials, Results</td>
<td>Initial Clinical Evidence Positive outcomes on clinical improvement in global program</td>
</tr>
<tr>
<td>Continued Production, combined with second wave therapies</td>
<td>Positive results on viral load and clinical recovery in Chinese trials</td>
</tr>
<tr>
<td>April 2020</td>
<td></td>
</tr>
<tr>
<td>May 2020</td>
<td></td>
</tr>
<tr>
<td>June 2020+</td>
<td></td>
</tr>
</tbody>
</table>

With rapid FDA approval and ramped production will be available in next six to nine weeks, but limited to acute remediation

## Second Wave – New Therapeutics

### New Therapeutic Development Timeline

<table>
<thead>
<tr>
<th>Stage</th>
<th>Time Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>IND Application, FDA Approval</td>
<td>April-June 2020</td>
</tr>
<tr>
<td>Clinical Trials</td>
<td>June-August 2020</td>
</tr>
<tr>
<td>Large Efficacy Trials</td>
<td>August-Sept 2020+</td>
</tr>
<tr>
<td>Scale Production</td>
<td></td>
</tr>
<tr>
<td>NDA, FDA Approval</td>
<td></td>
</tr>
<tr>
<td>Broad Administration</td>
<td></td>
</tr>
</tbody>
</table>

### Example Early Candidates Progress

<table>
<thead>
<tr>
<th>Compound</th>
<th>Developers</th>
<th>Description</th>
<th>Target Trial Start Date</th>
<th>Additional Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monoclonal antibodies</td>
<td>Vir Biogen</td>
<td>Isolated antibodies from SARS survivors, GE mice</td>
<td>June-August 2020</td>
<td>Can prevent short-term and treat COVID-19 patients</td>
</tr>
<tr>
<td>Polyclonal antibodies</td>
<td>Regeneron</td>
<td>Hyperimmune globulin isolated from survivor plasma</td>
<td>September 2020</td>
<td>9 candidates profiled already</td>
</tr>
</tbody>
</table>

With regulatory flexibility and ramped production, may be available by late summer 2020, but still not a cure

Source: Scientists to Stop COVID-19, Newpath Partners, Milken Institute, BioCentury, FiercePharma, FierceBiotech, Bain Capital Partners analysis
Third Wave - Vaccines

Vaccine Development Timeline

- Preclinical Animal Studies
- Phase I/II Clinical Trials
- Additional Clinical Trials
- Dead Virus Vaccines
- DNA/viral Protein-based Vaccines

Vaccine likely to take 18+ months to develop

Example Early Candidates Progress

<table>
<thead>
<tr>
<th>Type</th>
<th>RNA</th>
<th>DNA/Viral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developers</td>
<td>Moderna, Biontech, StemRxRNA</td>
<td>Inovio, The Jenner Institute</td>
</tr>
<tr>
<td>Country</td>
<td>USA, Germany, China</td>
<td>USA, England, China</td>
</tr>
<tr>
<td>Development Phase</td>
<td>Preclinical - Clinical Phase I</td>
<td>Preclinical - Clinical Phase II</td>
</tr>
<tr>
<td>Clinical Trial Dates</td>
<td>March 2020 – June 2021</td>
<td>April 2020 – November 2020</td>
</tr>
</tbody>
</table>

**VACCINES**

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Company</th>
<th>Platform</th>
<th>Stage</th>
<th>Description</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. mRNA-1273</td>
<td>Moderna</td>
<td>RNA</td>
<td>(Phase 1)</td>
<td>First to date a human in the U.S. Vaccines consist of an mRNA strand of SARS-CoV-2 designed to elicit an immune response to produce antibodies against SARS-CoV-2</td>
<td></td>
</tr>
<tr>
<td>2. Ad5-nCoV</td>
<td>CanSino Biotech</td>
<td>Non-replicating</td>
<td>Phase I</td>
<td>Benefits from previous success in the Ebola virus (time to market: ~3 years). The vaccine is based on viral vectors that have been modified to deliver antigens to express the SARS-CoV-2 spike protein.</td>
<td></td>
</tr>
<tr>
<td>3. ChAdOx1 nCoV-a</td>
<td>University of Oxford</td>
<td>Non-replicating</td>
<td>Phase I/II</td>
<td>Enrolling phase I/II candidates to test vaccine candidates that use a non-replicating virus to deliver RNA proteins.</td>
<td></td>
</tr>
<tr>
<td>4. ChAdOx1 nCoV-b</td>
<td>University of Oxford</td>
<td>Non-replicating</td>
<td>Phase I/II</td>
<td>Enrolling phase I/II candidates to test vaccine candidates that use a non-replicating virus to deliver RNA proteins.</td>
<td></td>
</tr>
<tr>
<td>5. BCG Vaccine</td>
<td>Research Group, Netherlands</td>
<td>Live Attenuated</td>
<td>Phase I/III</td>
<td>Figuratively speaking, the BCG vaccine, originally for TB, is being studied for SARS-CoV-2 in healthcare workers at high risk of infection. Vaccinated individuals will be enrolled in a trial to receive the vaccine or placebo.</td>
<td></td>
</tr>
<tr>
<td>6. BCG Vaccine</td>
<td>Measles Vaccine Research Institute</td>
<td>Live Attenuated</td>
<td>Phase I/III</td>
<td>The BCG vaccine will be given to healthcare workers in a randomized, multi-center study to evaluate its safety and efficacy.</td>
<td></td>
</tr>
</tbody>
</table>

**SARS-CoV-2 vaccines currently in clinical trials**

<table>
<thead>
<tr>
<th>Entity</th>
<th>Vaccine</th>
<th>Clinicaltrials.gov#</th>
<th>Stage</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Oxford</td>
<td>ChAdOx1 nCoV-a</td>
<td>NCT04324606</td>
<td>Recruiting</td>
<td>Phase I</td>
</tr>
<tr>
<td>CanSino Biologics Inc.</td>
<td>Ad5 Vectors</td>
<td>NCT04313127</td>
<td>Active, not recruiting</td>
<td>Phase I</td>
</tr>
<tr>
<td>CanSino Biologics Inc.</td>
<td>Ad5 Vectors</td>
<td>NCT04341389</td>
<td>Recruiting</td>
<td>Phase II</td>
</tr>
<tr>
<td>Sinovac</td>
<td>Inactivated virus vaccine</td>
<td>NCT04352608</td>
<td>Recruiting</td>
<td>Phase I/II</td>
</tr>
<tr>
<td>Symvivo Corporation</td>
<td>Bifidobacterium vector</td>
<td>NCT04334980</td>
<td>Not yet recruiting</td>
<td>Phase I</td>
</tr>
<tr>
<td>NIAID</td>
<td>mRNA-1273</td>
<td>NCT04283461</td>
<td>Recruiting</td>
<td>Phase I</td>
</tr>
<tr>
<td>Inovio</td>
<td>DNA</td>
<td>NCT04336410</td>
<td>Recruiting</td>
<td>Phase I</td>
</tr>
</tbody>
</table>

Source: Visual Capitalist, FDA, WHO, company websites, Professor Florian Krammer
How to Accelerate Therapeutic Development

<table>
<thead>
<tr>
<th>Rapid FDA Approval</th>
<th>Commentary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Investigational New Drug Review</strong></td>
<td><strong>Government action</strong> can turbo charge vaccine and therapeutic development &amp; deployment</td>
</tr>
<tr>
<td>• <strong>Issue:</strong> Companies must wait 30 days after submission to implement trials</td>
<td></td>
</tr>
<tr>
<td>• <strong>Solution:</strong> FDA should ask relevant questions before receiving IND, allow trial initiation immediately</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>New Drug Application (NDA)</strong></td>
<td></td>
</tr>
<tr>
<td>• <strong>Issue:</strong> FDA review of an NDA typically takes 3-6 months</td>
<td></td>
</tr>
<tr>
<td>• <strong>Solution:</strong> FDA communicate daily with relevant companies, complete NDA review within 1 week</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Purchase Guarantees</strong></td>
<td></td>
</tr>
<tr>
<td>• <strong>Issue:</strong> Insufficient PPE including gloves, gowns, masks, and N95s</td>
<td></td>
</tr>
<tr>
<td>• <strong>Solution:</strong> Provide companies financial guarantees above market prices, regulatory relief</td>
<td></td>
</tr>
<tr>
<td><strong>Scaling Existing Production</strong></td>
<td></td>
</tr>
<tr>
<td>• <strong>Issue:</strong> Individual companies cannot produce enough of emerging therapies</td>
<td></td>
</tr>
<tr>
<td>• <strong>Solution:</strong> Facilitate manuf. of promising candidates by other U.S. drug cos</td>
<td></td>
</tr>
<tr>
<td><strong>Test and Trace Funding</strong></td>
<td></td>
</tr>
<tr>
<td>• <strong>Issue:</strong> Hospitals, others lack supplies to conduct fastest tests</td>
<td></td>
</tr>
<tr>
<td>• <strong>Solution:</strong> Provide funding guarantees for viral testing and serological test to detect antibodies</td>
<td></td>
</tr>
<tr>
<td><strong>Free Up U.S. Plant Capacity</strong></td>
<td></td>
</tr>
<tr>
<td>• <strong>Issue:</strong> Need capacity to scale treatments prior to approval</td>
<td></td>
</tr>
<tr>
<td>• <strong>Solution:</strong> FDA should approve new plants for the production of other medicines</td>
<td></td>
</tr>
</tbody>
</table>

New therapies and vaccines months to years off, but targeted government action can accelerate development

Source: Scientists to Stop COVID-19
The Key 3 Steps to Achieve Hospital Balance & Worker Safety

**Segmentation:** Sequence segments returning to work according to risk to lower hospitalization rate

**Effective Therapeutics:** While waiting for vaccine, implement effective treatments to curb hospitalization rate & fatality rate

**Reduce $R_T$:** Implement policies & procedures to reduce the rate of spread

Source: Bain Capital Partners analysis
Reducing $R_T$: Why It Matters

**MA New Cases Under Different $R_T$**

<table>
<thead>
<tr>
<th>$R_T$</th>
<th>New Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.4</td>
<td>Increasing</td>
</tr>
<tr>
<td>1.0</td>
<td>Flat</td>
</tr>
<tr>
<td>0.8</td>
<td>Decreasing</td>
</tr>
</tbody>
</table>

Lower spread can significantly reduce the number of daily new cases, despite greater population exposure.

Source: Prof. Uri Alon, Prof. Ron Milo, Prof. Nadav Davidovich, Prof. Amos Zahavi, Dr. Hagit Ulanovsky; Intermittent Work: A feasible strategy for a return to economic activity that can prevent a second wave of COVID-19; Weizman Institute of Science; Business Insider; WSJ.com
Potential Policies to Reduce $R_T$

<table>
<thead>
<tr>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPE / Masks</td>
<td>Mandated mask &amp; PPE use</td>
</tr>
<tr>
<td>Personal Hygiene</td>
<td>Frequent hand washing or sanitizing. Avoid touching eyes, nose and mouth. Good respiratory hygiene</td>
</tr>
<tr>
<td>Self-Diagnosis</td>
<td>Comprehensive check-list of symptoms each worker considers before leaving home</td>
</tr>
<tr>
<td>Distancing / No Large Groups</td>
<td>Social distancing at work where possible. Staggered shifts and lunch times</td>
</tr>
<tr>
<td>Workspace Cleaning</td>
<td>Frequent workplace deep cleaning. Hygiene zones with mandatory sanitization checkpoints in between</td>
</tr>
<tr>
<td>Employer Screening</td>
<td>Temperature measurement and symptom screening upon entry</td>
</tr>
<tr>
<td>Re-designing Workspace</td>
<td>Re-modeling of workspace to ensure greater spacing between employees. Improved air filtration and ventilation. Touch-free handles and interfaces</td>
</tr>
<tr>
<td>Telework</td>
<td>Encourage telework where possible</td>
</tr>
<tr>
<td>Travel limitations</td>
<td>Discourage travel unless absolutely necessary. Before traveling, ensure virus levels low at home &amp; destination</td>
</tr>
<tr>
<td>Smaller Transport Methods</td>
<td>Limit use of mass transit when possible. Encourage carpooling or deploy corporate vans where hygiene easier</td>
</tr>
<tr>
<td>Tracing</td>
<td>Team of ~5,000 tracers in MA conducting manual interviews with positive cases and alerting and quarantining those who were in contact with a positive case</td>
</tr>
<tr>
<td>Testing</td>
<td>6-10 centralized testing centers in MA performing 100K tests a day</td>
</tr>
</tbody>
</table>

Large variety of possible strategies to help reduce $R_T$ – should begin with most effective & lowest cost, but will likely need higher cost effective measures as well (testing, tracing)

Source: Bain Capital Partners Analysis, Scientists to Stop COVID-19, McKinsey: Coronavirus COVID-19: Securing the workplace
Framework for Possible Workplace Norm Policies

Large variety of possible strategies to help reduce $R_T$ – should begin with most effective & lowest cost, but will likely need higher cost effective measures as well (testing, tracing)

Source: Bain Capital Partners Analysis
Potential Policies to Reduce $R_T$

- **Group A**: Masks, Self-Diagnosis and Employer Screening

- **Group B**: Testing & Tracing
Theoretical Effectiveness of Masks & PPE

Source: The Atlantic, L. Tian et al., "Calibrated Intervention and Containment of the COVID-19 Pandemic" (2020); "Testing the Efficacy of Homemade Masks: Would They Protect in an Influenza Pandemic?", Anna Davies, Katy-Anne Thompson, Karthika Giri, George Kafatos, Jimmy Walker, Allan Bennett

Theoretical Mask Use Impact on $R_T$

- **Adherence:** Higher adherence, even with less effective masks, can greatly reduce $R_T$. Consider making PPE **mandatory**

- **Supply & Efficacy:** Is there adequate supply of the necessary level of efficacy? (i.e., easy to supply cloth masks but lower efficacy)

**Key Considerations**

**Mean % Filtration Efficiency of Various Masks**

<table>
<thead>
<tr>
<th>Scarf</th>
<th>100% Cotton Masks</th>
<th>Tea Towel</th>
<th>Surgical Masks</th>
<th>N95</th>
</tr>
</thead>
<tbody>
<tr>
<td>49%</td>
<td>51%</td>
<td>72%</td>
<td>89%</td>
<td>95%+</td>
</tr>
</tbody>
</table>

Note: Data based on Bacteriophage MS2 (23 nm in diameter) - COVID-19 virus particles are ~125 nm in diameter
Self-Diagnosis

Daily Symptom Checklist

<table>
<thead>
<tr>
<th>Symptom</th>
<th>% of Cases w/ Symptom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fever</td>
<td>64%</td>
</tr>
<tr>
<td>Sinus Pain</td>
<td>50%</td>
</tr>
<tr>
<td>Cough</td>
<td>46%</td>
</tr>
<tr>
<td>Altered sense of smell</td>
<td>44%</td>
</tr>
<tr>
<td>Expectoration</td>
<td>32%</td>
</tr>
<tr>
<td>Stuffy nose</td>
<td>25%</td>
</tr>
<tr>
<td>Chills</td>
<td>18%</td>
</tr>
<tr>
<td>Fatigue</td>
<td>18%</td>
</tr>
<tr>
<td>Sore throat</td>
<td>13%</td>
</tr>
<tr>
<td>Headache</td>
<td>13%</td>
</tr>
<tr>
<td>Difficulty breathing</td>
<td>11%</td>
</tr>
<tr>
<td>Joint or muscle pain</td>
<td>10%</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>6%</td>
</tr>
<tr>
<td>Vomiting</td>
<td>3%</td>
</tr>
</tbody>
</table>

Potential Policy & Considerations

- **Mandate employees / students certify** (via smartphone app / website for example) they are not experiencing any of the listed symptoms
- **Incentivize adherence** with paid sick leave policies
- Provided adherence is high, **self-certification could detect a significant amount of symptomatic cases**, including mildly symptomatic cases
- Recent studies suggest **true number of asymptomatic cases quite rare (2-6%)**, suggesting **meticulous and accurate daily symptom surveying** and self-reporting can be highly effective in lowering $R_T$

Meticulous and accurate daily symptom surveying and self-reporting can be highly effective in lowering $R_T$

Source: Scientists to Stop COVID-19
## Employer Screening

### Example Employer Screening Case Studies

- **Wuhan, China** – all arriving employees must submit to at least four temperature checks daily.

- **Amazon** – using *thermal cameras* at its operations facilities to screen workers for fevers.

- **Some grocery stores** are using *non-contact forehead infrared thermometers* to temperature test associates as they arrive for work.

- **Colorado** – governor announced *temperature checks at workplaces* will be part of reopening plan.

### Potential Considerations

- **Not effective at reducing $R_T$ on its own:** only 64% of cases present with fever, and carriers are contagious in the period of time before fever manifests. Will need to be combined with other norms & screening measures.

- **Implementation could be challenging:** will require additional PPE and thermometers that could be difficult to acquire.

- **Medical information will have to be safely stored:** all temperatures taken should be treated as confidential medical information and stored as such.

Temperature checks and other employer screening are useful tools when used in combination with other policies.

Source: Scientists to Stop COVID-19, Bloomberg, CNN, supermarketnews.com, CPR.org, Bain Capital Partners analysis
Potential Policies to Reduce $R_T$

- **Group A**: Masks, Self-Diagnosis and Employer Screening
- **Group B**: Testing & Tracing
Combined Testing & Tracing Program Effectiveness

Impact of Testing & Manual Tracing

Impact of Testing & App-Based Tracing

Study Conclusions

• **Self-isolation** of symptomatic cases alone: reduces $R_T$ by 32%
• Household quarantine + self-isolation reduces $R_T$ by 37%
• Self-isolation + app-based tracing reduced $R_T$ by 44%
• Self-isolation + manual tracing of all known contacts reduces $R_T$ by 57%
• Self-isolation + manual tracing of all contacts reduces $R_T$ by 67%

Testing and tracing strategies can *more than double* the impact on $R_T$ of self-isolation alone

Three important factors to a testing & tracing strategy: (1) how many infected are ID’d and isolated, (2) how many contacts are traced and quarantined, and (3) how quickly each is done

Source: Adam Kucharski, Petra Klepac, Andrew Conlan, Stephen Kissler, Maria Tang, Hannah Fry, Julia Gog, John Edmunds, Centre for Mathematical Modelling of Infectious Diseases COVID-19 working group
The Importance of Prolific Testing

Countries that are overwhelmed have very high rates of positive tests – likely are not testing enough

Countries that have controlled the epidemic test enough such that only ~3% of tests come back positive

The countries that have contained the pandemic only find ~1-3% positive cases during testing ~20% of MA cases come back positive – need to significantly increase level of testing

Source: Tomas Pueyo and Genevieve Gee analysis, based on data from worldometers: https://www.worldometers.info/coronavirus/#countries
The Importance of Tracing

Recent research suggests ~45% of infections are caught from pre-symptomatic carriers. If only test symptomatic individuals, can only reduce $R_T$ by 40%. But a combined testing & tracing program that catches asymptomatic carriers can reduce $R_T$ by up to 85%.

Recent research suggests ~45% of infections are caught from pre-symptomatic carriers. If only test symptomatic individuals, can only reduce $R_T$ by 40%. But a combined testing & tracing program that catches asymptomatic carriers can reduce $R_T$ by up to 85%.

Source: "Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing" by Luca Ferretti, Chris Wymant, Michelle Kendall, Lele Zhao, Anel Nurtay, Lucie Abeler-Domer, Michael Parker, David Bonsall, Christophe Fraser, Oxford University, Tomas Pueyo
The Importance of Speed

How Quickly Infections Happen

- 50% of presymptomatic infections happen within 5 days
- 50% of symptomatic infections happen within 6 days

If contact tracing & testing take too long, will limit the impact such a program can have on $R_0$

Speed is vital – the larger the delay between onset and successfully testing & tracing, the lower the impact on $R_T$. Need a program that can successfully test & trace 70-80% of contacts within 2 days

Testing & Tracing Speed v. Impact on $R_T$

If testing & tracing happens within 1 day, only need to successfully isolate 70% of cases & 60% of infected contacts to reduce $R_T$ below 1

But if takes 2 days to test & trace, will need to successfully isolate 80% of cases & 75% of infected contacts to reduce $R_T$ below 1

Source: Tomas Pueyo, adapted from “Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing” by Luca Feretti, Chris Wymant, Michelle Kendall, Lele Zhao, Anel Nurtay, Lucie Abeler-Domer, Michael Parker, David Bonsall, Christophe Fraser, Oxford University
Testing: Who to Test

Possible Testing Plans

<table>
<thead>
<tr>
<th>MA Today</th>
<th>Bare Bones</th>
<th>Minimal</th>
<th>Moderate</th>
<th>Expansive</th>
<th>Universal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population Tested</td>
<td>Those with strong symptoms, other causes ruled out in hot spots</td>
<td>Those with strong symptoms</td>
<td>Those with mild symptoms</td>
<td>Those with mild symptoms + contacts traced</td>
<td>Everyone every week</td>
</tr>
<tr>
<td># Tests Required / day in MA</td>
<td>~10K / day</td>
<td>~20K / day</td>
<td>~50K / day</td>
<td>~100K / day</td>
<td>~1M / day</td>
</tr>
<tr>
<td>Current testing capacity</td>
<td>~1,500 positives @ 8% detection rate</td>
<td>~1,500 positives @ 3% detection rate</td>
<td>~1,500 positives @ 3% detection rate + 30 contacts/positive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost¹</td>
<td>~$6M / month</td>
<td>~$12M / month</td>
<td>~$30M / month</td>
<td>~$60M / month</td>
<td>~$600M / month</td>
</tr>
<tr>
<td>% Pop. Tested</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Example Countries

Need to prioritize who to test today and make testing as efficient as possible, while working to increase capacity to ~100K/day

Source: Edmond J. Safra Center for Ethics at Harvard University: Roadmap to Pandemic Resilience, Worldometer, Tomas Pueyo

¹ Assumes $20 / test
Current Testing Capacity

New Tests Per Day

MA Testing capacity higher than rest of the US on a per capita basis, but both need to expand dramatically to reach goals of 30M national tests / week

Source: https://covidtracking.com/data/us-daily, Mass.gov
Building the Necessary Testing Capability

Proposed Rapid Centralized Solution

• **MA contracts directly** with a large/multiple large diagnostics company(s) who can handle 100K+ tests/day

• Provider sets up **6-10 centralized testing centers** to take advantage of scale and ramps up ability to perform **100K tests/day**

• In addition to centralized facilities, **utilize current healthcare infrastructure** and local facilities (hospitals, urgent care clinics, pharmacies, etc.)

• Diagnostics companies require **6-8 weeks** to ramp production – vital to set up contracts **as soon as possible**

Given shortage of testing capacity, Massachusetts should **rapidly** explore avenues to secure capacity

Source: Discussions with Industry Experts, Bain Capital Partners Analysis
Testing: Timeline of Solutions

**More expensive & difficult**

**Short-Term**
- Centralized testing through a handful of large diagnostic companies
- 6-10 centralized testing centers
- Existing HC infrastructure used whenever possible
- Production ramped to ~100K/day

**Medium-Term**
- Frequent saliva-based testing administered once a week
- 10 centralized testing centers continue to process tests, each able to process ~100K/day
- Production ramped to ~1M tests/day

**Long-Term**
- Universal at-home testing kits
- Saliva-based
- Cheap & easy to administer

**Less expensive & easy**

Should work towards a more universal at-home testing program (infeasible today given technology and capacity constraints)

Source: Bain Capital Partners Analysis
Contact Tracing: Five Key Questions

**1. Who Qualifies as a Contact?**
Identifying who should be traced and their risk category

**2. What Procedures Should Contacts Follow?**
Isolation and self-assessment based on risk level

**3. How Many Contacts Do We Need to Trace?**
Extensive tracing of 70-90% of contacts needed to slow spread

**4. How Many Investigators Do We Need?**
Thousands of investigators needed to trace 70-90% of contacts

**5. How Do We Use Technology to Help?**
Digital tracing can increase efficacy considerably

Contact tracing necessary to slow spread and will require large manual and digital effort

Source: Bain Capital Partners Analysis, Tomas Pueyo
Who Qualifies as a Contact?

How Far Back to Trace

- Median incubation period is 5-6 days, full range up to 14 days
- Need to track all contacts from previous two weeks

Example Case Study: Canadian Classification System

<table>
<thead>
<tr>
<th>High</th>
<th>Medium</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Close contact</strong></td>
<td><strong>Non-close contact</strong></td>
<td><strong>Transient interactions</strong></td>
</tr>
<tr>
<td>• Provided direct care</td>
<td>• Provided direct care</td>
<td>• Walking by the case</td>
</tr>
<tr>
<td>without PPE</td>
<td>without PPE</td>
<td>• Briefly in same room</td>
</tr>
<tr>
<td>• Lived with infected</td>
<td>• Prolonged contact but not within 6 feet</td>
<td>• Exposure for less than</td>
</tr>
<tr>
<td>person (e.g., family)</td>
<td>of person</td>
<td>15 minutes</td>
</tr>
<tr>
<td>• Prolonged contact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>within 6 feet of person</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Direct contact (e.g.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sneezed on)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Need to isolate and test family members, those in contact >15 minutes closer than 6 feet

Sources: Annals of Internal Medicine: “The Incubation Period of Coronavirus Disease 2019 (COVID-19) From Publicly Reported Confirmed Cases: Estimation and Application”, Stephen A. Lauer, MS, PhD; Kyra H. Grantz, BA; Qifang Bi, MHS; Forrest K. Jones, MPH; Qulu Zheng, MHS; Hannah R. Meredith, PhD; Andrew S. Azman, PhD; Nicholas G. Reich, PhD; Justin Lessler, PhD; Government of Canada: Public health management of cases and contacts associated with coronavirus disease 2019 (COVID-19)
What Procedures Should Contacts Follow?

**Example Case Study: Canadian Guidelines**

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Example</th>
<th>Procedures</th>
</tr>
</thead>
</table>
| High Risk  | Family Member | • Quarantine at home for 14 days after exposure  
• Practice good hand hygiene and respiratory etiquette  
• Self-monitor for symptoms such as fever or cough  
• Record temperature daily  
| Medium Risk | Provided direct care while wearing PPE | • Self-monitor for symptoms such as fever or cough  
• Avoid close contact with individuals at higher risk for severe illness  
• Follow actions recommended for entire population |
| Low Risk   | Walked by on street | • Follow actions recommended for entire population |

Need to determine policies & procedures for contacts to follow based on risk level. Should only high risk contacts be self quarantined, or should medium risk contacts be quarantined as well?

Sources: Government of Canada Public health management of cases and contacts associated with coronavirus disease 2019
How Many Contacts Do We Need to Trace?

Impact of Tracing on Reproduction Rate ($R_T$)

Key Considerations

- Tracing required varies depending on basic reproduction number ($R_0$) of COVID-19 without remediating efforts
- If $R_0$ is 2.5, need to trace 70% of contacts to control epidemic – studies estimate 20 people per case
- If $R_0$ is 3.5, need to trace 90% of contacts to control epidemic – studies estimate 30 people per case
- Additional measures taken to help lower $R_T$ will reduce burden on exactness in contact tracing

At initial $R_0 = 2.5$-$3.5$, need to trace 70-90% of contacts to get $R_n$ below 1

$R_n=1$. Below this, epidemic is controlled

Will likely need to trace and isolate 20-30 closest contacts of each positive case as fast as possible

How Many Investigators Do We Need?

### Case-Based Manual Tracers Estimate

<table>
<thead>
<tr>
<th>Tracers Needed Per Case</th>
<th># of tracers needed to clear one case per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wuhan Success</td>
<td>5</td>
</tr>
<tr>
<td>CMS Estimate</td>
<td>12-15</td>
</tr>
</tbody>
</table>

### Framing Equations

- **# of new cases per day**
- **# of tracers to clear one case**
- **Tracers Needed**

### MA Tracers Required

- ~1,000-2,000 (x)
- ~5 (=)
- ~5-10K tracers

### Scale of Manual Tracers Needed in MA

<table>
<thead>
<tr>
<th></th>
<th>MA Today</th>
<th>Johns Hopkins Plan</th>
<th>Case-Based Build</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracers Needed</td>
<td>1,000</td>
<td>~2,000</td>
<td>~5,000-10,000</td>
</tr>
</tbody>
</table>

MA may need up to ~5-10K contact tracers

Sources: Tomas Pueyo, ProPublica, Johns Hopkins Bloomberg School of Public Health: A National Plan to Enable Comprehensive COVID-19 Case Finding and Contact Tracing in the US
How Do We Use Technology to Help?

Illustrative Contacts Identified through Manual Interview and Digital Tracing

Will be difficult to identify 70-90% of contacts with manual tracing alone. Digital tracing can help manual tracers identify far more contacts, particularly with opt-out Bluetooth apps.

Sources: Tomas Pueyo
Workplace Digital Tracing: Example Case Study

Exposure Heat Map – Locix App

![Exposure Heat Map](image)

- Locix building a tool designed to track where people have been at work within a few centimeters
- Other proposed solutions (e.g., Microshare) may involve workers wearing badges, key rings or wristwatches embedded with inexpensive Bluetooth beacons to effectively trace populations without universal smartphone adoption

<table>
<thead>
<tr>
<th>Example Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Devices Used</strong></td>
</tr>
<tr>
<td>Smartphone app</td>
</tr>
<tr>
<td>Badges, key rings, and wristbands</td>
</tr>
<tr>
<td>Smartphones, IoT sensors, asset trackers, appliances</td>
</tr>
<tr>
<td><strong>Technology Used</strong></td>
</tr>
<tr>
<td>📱</td>
</tr>
</tbody>
</table>

Companies are building surveillance tools to monitor spread of coronavirus inside offices

Sources: Financial Times, company websites
Testing & Tracing: Summary

• Testing and tracing can have a large impact on reducing $R_T$ (up to ~2x more effective than self-isolating alone)

• In order to be effective, testing & tracing programs need to capture ~70% of contacts within 1-2 days. MA leading the way in the US on tracing (have already assembled a team of ~1000 tracers), but will likely need ~5-10x more tracers to accomplish this

• To accurately capture all cases & test contacts, will need ~100K tests/day. MA capacity slowly ramping (achieving ~10-15K / day currently). Need to rapidly explore avenues to performing ~100K tests / day, as ramping will likely take ~6-8 weeks post-contract

Although testing / tracing can have a significant impact on reducing $R_T$, that impact will be constrained by the time it takes to build up capacity, and the cost associated with large-scale efforts

Source: Bain Capital Partners Analysis
Legal Feasibility of New Workplace Norms

Key Legal Questions & Considerations

- How to make sure on-site temperature testing, symptom screening, and storing information are compliant with HIPAA and the ADA?
- Can compliance with health & safety guidelines be conditions of employment? How to deal with employees that refuse to comply?
- How to ensure a non-discriminatory implementation of policies and protocols?
- How to implement changes and protocols with a unionized workforce?
- How to deal with potential negligence & lawsuit risk related to new outbreaks and/or deaths?

Ropes & Gray Emerging Principles

- Afford employees a safe working environment by adopting and enforcing scientifically-based work rules & providing appropriate supplies & support
- Align work rules & practices with guidelines from the cognizant federal, state, and local authorities
- Comply with federal, state, and local laws and regulations
- Respect the special requirements of disability rights laws, including as they apply to comorbidity
- Cooperate with state and local public health departments
- To the greatest extent possible, keep private the health and social information of individual employees

Several legal considerations to implementing new workplace norms. Key questions are (1) what the state should mandate, (2) consistent implementation, and (3) how to provide legal guidance for SMBs

Source: Ropes & Gray. Does not constitute legal advice
Reducing $R_T$ Summary Thought Model

**Impact of Workplace Norms**

- **Workplace norms** such as universal mask wearing, distancing and self-diagnosis can significantly reduce $R_T$

**Impact of Testing & Tracing**

- A robust testing & tracing program (~100K tests/day, 5-10K tracers + digital tracing) can have a similar impact on reducing $R_T$ as workplace norms

Source: Bain Capital Partners analysis
The War on COVID-19

Timing & Hospital Capacity Constraint Model
Build a dynamic hospital capacity / demand model based on current infection rate and system readiness

Segmentation
Implement segmentation model, sequencing segments returning to work according to risk and ability to safeguard

Treatment
Identify and rapidly deploy effective therapeutic treatments and longer-term a vaccine

Reduce $R_T$
Implement policies & procedures to reduce the rate of spread

Co-living
Develop guidelines for high risk segments living with segments returning to work

Enablers
Develop guidelines for back-to-school (including childcare) and transportation

Therapeutics
While waiting for vaccine, implement effective treatments to curb hosp. rate

Vaccine
Accelerate vaccine development & prepare for deployment at-scale

Workplace Norms
Develop workplace norms to minimize reoccurrence

Testing & Tracing
Develop massive testing & tracing plan to be used to identify & contain virus spread

United we will win the war against COVID-19

Source: Bain Capital Partners analysis
Appendix
Testing Companies and Organizations, References

- 3D Medicines
- Abbott
- Acurals, Inc.
- Anatolia Geneworks
- ARUP Laboratories
- A*STAR, Tan Tock Seng Hospital of Singapore
- Assure Tech
- Atla BioSystems
- AusDiagnostics
- Autobio Diagnostics
- Avellino Lab
- Bako Diagnostics
- Baptist Hospital Miami Pathology/Laboratory Medicine Lab
- Becton Dickinson
- Becton Dickinson, BioGx
- Beijing Decombio Biotechnology
- Beijing Diagreat Biotechnology
- Beijing Kewei Clinical Diagnostic Reagent
- Beijing O&D Biotech
- Beroni Group
- BGI
- Biodexis
- BioMedics
- BioMérieux
- BioMérieux/BioFire Defense
- Bioneer
- BioReference Laboratories
- Boston Children’s Hospital Infectious Diseases Diagnostic Laboratory (IDDL)
- BTNX
- Cellex
- Centers for Disease Control and Prevention
- Cepheid
- CepTest BioTec
- Chembio Diagnostics
- Children’s Hospital of Philadelphia Infectious Disease Diagnostics Laboratory
- CirrusDx Laboratories
- Co-Diagnostics
- Core Technology
- Credo Diagnostics Biomedical
- DiaCarta
- Diagnostic Solutions Laboratory
- DiaSorin Molecular
- Diatherix Eurofins
- Dizyme Laboratories
- Echips Biopharmaceuticals
- Euroimmun/PerkinElmer
- Exact Sciences
- Fosun Pharma USA
- Fulgent Genetics/MedScan Laboratory
- Genetic Signatures
- Genetron
- GenMark Diagnostics
- Genomica/PharmMar Group
- Genosensor
- Genomen
- Gold Standard Diagnostics
- Guangzhou Wondfo Biotech
- Hackensack University Medical Center (HUMC)
- Molecular Pathology Laboratory
- Hangzhou Biotest Biotech
- Hangzhou Cleongene Biotech
- Hangzhou Testealabs Biotechnology
- Hellenic Scientific
- Hologic
- InBio International
- Innova (Tangshan) Biological Technology
- Integrated DNA Biotech
- Integrity Laboratories
- Ipsum Diagnostics
- Jiangsu Macro & Micro-Test Med-Tech
- Jin Medsys
- Kogene Biotech
- Korvalabs
- Laboratory Corporation of America
- LGC, Biosearch Technologies
- Lifeassay Diagnostics
- LumineX
- Maccura Biotechnology
- Massachusetts General Hospital
- Mayo Clinic Laboratories
- Medical Systems Biotechnology
- Mesa Biotech
- Mount Sinai Labs
- Nanjing Liming Bio-products
- Nanoresearch
- Nantong Diagnos Biotechnology
- NeuMoDx Molecular
- Nirnidas Biotech
- Northwestern Medicine Diagnostic Molecular Laboratory
- Novacyst/Primerdesign
- NY State Department of Health (performed at Wadsworth Center and New York City Department of Health and Mental Hygiene, Public Health Laboratories)
- OrigIn
- Ortho Clinical Diagnostics
- Osang Healthcare
- PathoFinder
- PCL
- PerkinElmer
- Phamatech
- Promedical
- Qiagen
- Quest Diagnostics
- Quidel
- Rendi Biotechnology
- Roche
- Rutgers University Clinical Genomics Laboratory
- ScienCell Research Laboratories
- SD Biosensor
- Seegene
- Sentinel Diagnostics
- Shanghai Fosun Long March Medical Science/Shanghai Fosun Pharmaceutical
- Shenzhen Landwind Medical
- Snibe Diagnostics
- SolGenT
- Sonic Healthcare
- Specialty Diagnostic (SDI) Laboratories
- Stanford Health Care Clinical Virology Laboratory
- SureScreen Diagnostics
- Sushou Kangsheshun Medical Technology
- TIB Molbiol Syntheselabor
- United Biomedical
- University of North Carolina Medical Center
- Vela Diagnostics
- Viracor Eurofins
- Vision Medicals
- VivaChek Biotech (Hangzhou)
- Yale New Haven Hospital Clinical Virology Laboratory
- YD Diagnostics
- Zhejiang Orient Gene Biotech
- Zhengzhou Fortune Bioscience
- Zhongshan Bio-Tech
- Zhuhai Encode Medical Engineering
- Zhuhai Livzon Diagnostics

Source: 360dx.com, CDC, FDA, company websites

# White House Return to Work Framework

## Gating Criteria

### Symptoms
- Downward trajectory of flu and COVID-19 like illnesses reported within a 14-day period

### Cases
- Downward trajectory of positive test rates or documented cases within a 14-day period

### Hospitals
- All patients treated without crisis care
- Testing program for healthcare workers in place

## Phase One
- **Individuals**
  - Vulnerable individuals shelter in place
  - Others should maximize distance in public, avoid groups of >10 people, wear PPE in public

- **Employers**
  - Encourage telework
  - Close common areas
  - Minimize non-essential travel
  - Certain venues (bars, schools) should remain closed

## Phase Two
- **Individuals**
  - Vulnerable individuals shelter in place
  - Others should maximize distance in public, wear PPE
  - Can resume non-essential travel

- **Employers**
  - Encourage telework
  - Close common areas
  - Provide accommodations for vulnerable populations
  - Restricted venues (bars, schools) can reopen with limited capacity

## Phase Three
- **Individuals**
  - Vulnerable individuals can resume public interactions
  - Others should minimize time spent in crowded environments, wear PPE in public

- **Employers**
  - Visits to senior care facilities and hospitals can resume
  - Large venues can operate under limited distancing protocols
  - Bars may operate with increased occupancy

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Source: whitehouse.gov
Intermittent Work Phasing Option

To reduce risk of second wave, could begin by phasing groups in cycles of 4 work days and 10 lockdown days

Those infected at work reach peak infectiousness during lockdown days

Could explore alternative back-to-work phasing to help reduce healthcare burden while allowing groups to return part-time earlier, potentially before system fully ready

Source: Prof. Uri Alon, Prof. Ron Milo, Prof. Nadav Davidovich, Prof. Amos Zahavi, Dr. Hagit Ulanovsky; Intermittent Work: A feasible strategy for a return to economic activity that can prevent a second wave of COVID-19; Weizman Institute Science
European countries are starting to ease, but containment strategies appear limited, risking acceleration of the virus. This may mean a return to lockdown.

Source: Tony Blair Institute for Global Change: A Sustainable Exit Strategy Managing Uncertainty Minimizing Harm
East Asia countries are strongly emphasizing containment (masks, testing and tracing), which has enabled most countries to avoid full lockdowns and keep infection spikes below western peers.

Source: Tony Blair Institute for Global Change: A Sustainable Exit Strategy Managing Uncertainty Minimizing Harm
Testing: How to Test

Case Study: Drive-Thru Testing

• South Korea has set up drive-through testing centers. Tests take 10 minutes and results texted to you the next day. Able to test ~10 ppl/hour

• At this point, all 50 U.S. states have also adopted drive-through testing centers. However, currently can take up to a week to get results

Other Potential Testing Locations

Drive-Thru, Pharmacy, At Work, Hospital / Urgent Care Center

Should utilize current healthcare infrastructure to make testing widely available and easy to access

Goal is to make testing easy and quick, in order to test & track as many individuals as possible within the first 2 days of exposure

Source: NPR.org, Bain Capital Partners Analysis
Making Testing More Efficient: Test Pooling Case Study

Stanford's Test Pooling

- In early testing, Stanford pooled samples into groups of 9-10 and tested the group.

- Of the 292 groups pooled, only two came back positive – further analysis showed that one person in each group was positive.

- Concluded pooling can make mass testing far more efficient, but only works when prevalence is low.

Recent COVID-19 Sample Pooling Study

- A recent study showed pooling samples in groups up to 48 samples/group preserved accuracy (all positives identified, with no false negatives).

- Group recommends pooling methods for asymptomatic carriers (e.g., in expected low prevalence groups) – can make such testing far more efficient.

Research still emerging, but may be possible to pool samples in groups of 10-50, significantly increasing testing efficiency (able to run 100K pooled tests in the same time as 10K individual tests).

What Tests to Use: Viral Testing Overview

**Key Considerations**

**How it works:** Viral genetic information extracted using swab and amplified in a machine using PCR

**What it detects:** If you **currently** have COVID-19

**Average cost:** TBD

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detects current infection</td>
<td>Slow results</td>
</tr>
<tr>
<td>High throughput</td>
<td>Requires many swabs, limited reagents</td>
</tr>
<tr>
<td>Inexpensive</td>
<td>High throughput machines require trained technicians</td>
</tr>
<tr>
<td>Can collect at home</td>
<td></td>
</tr>
</tbody>
</table>

**Testing Companies & Capacity**

- Abbott Molecular
- BD
- BioGX
- Cepheid
- DiaSorin Molecular
- Hologic
- LabCorp
- NeuMoDx
- PerkinElmer
- Quest Diagnostics
- Quidel Corporation
- Roche Molecular Systems
- Thermo Fisher Scientific

**Key Companies**

**Sample High Throughput Machines / Products**

<table>
<thead>
<tr>
<th>Company</th>
<th>Machine / Product</th>
<th>Daily Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbott</td>
<td>m2000</td>
<td>470</td>
</tr>
<tr>
<td>BD / BioGX</td>
<td>BDMax</td>
<td>360</td>
</tr>
<tr>
<td>Cepheid</td>
<td>GeneXpert Infinity</td>
<td>&gt;2,000</td>
</tr>
<tr>
<td>Hologic</td>
<td>Panther Fusion</td>
<td>1,150</td>
</tr>
<tr>
<td>NeuMoDx</td>
<td>288 Molecular</td>
<td>864</td>
</tr>
<tr>
<td>Roche</td>
<td>COBAS 8800</td>
<td>4,128</td>
</tr>
<tr>
<td>Thermo Fisher</td>
<td>TaqPath</td>
<td>&gt;1,500</td>
</tr>
<tr>
<td>Labs incl. Quest, LabCorp, etc.</td>
<td>Lab Developed Tests</td>
<td>&gt;200</td>
</tr>
</tbody>
</table>

**Ideal for combination testing and tracing program because of ability to detect infection in real time**

Sources: Company websites, FDA, Centers for Medicare & Medicaid Services
What Tests to Use: Antibody Testing Overview

Key Considerations

How it works: Samples blood, test device detects antibodies created by body to fight virus

What it detects: If you previously had COVID-19

Average cost: TBD

Pros
• Can identify previous infections
• Takes seconds to test
• Doesn’t require swabs
• Can detect previous asymptomatic cases

Cons
• Antibodies slow to develop
• Unclear how protected those with antibodies are
• Program based on antibody testing could encourage ppl to catch virus
• False positives

Companies
• Abbott
• BioMedomics Inc
• Bioperfectus Technologies
• Cellex
• Decombio

Biotechnology
• DeepBlue Medical
• Innovita
• Premier Biotech
• Sure Biotech
• UCP biosciences

Testing Companies & Accuracy

<table>
<thead>
<tr>
<th>Company</th>
<th>BioMedomics</th>
<th>Bioperfectus</th>
<th>DecomBio</th>
<th>DeepBlue</th>
<th>Innovita</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specificity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Premier Biotech</td>
<td>87%</td>
<td>95%</td>
<td>90%</td>
<td>84%</td>
<td>96%</td>
</tr>
<tr>
<td>Sure Biotech</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UCP Biosciences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VivaChek Biotech</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wandfo Biotech</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SD Biosensor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biolids Limited</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomedomics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epitope Diagnostics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sample Test Specificity

<table>
<thead>
<tr>
<th>Company</th>
<th>Premier</th>
<th>Sure</th>
<th>UCP</th>
<th>VivaChek</th>
<th>Wandfo</th>
<th>Epitope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specificity</td>
<td>97%</td>
<td>100%</td>
<td>98%</td>
<td>95%</td>
<td>99%</td>
<td>90%</td>
</tr>
</tbody>
</table>

Note: FDA allowed self-validation for first kits without data validation. The above data is self-declared and may not be accurate

Ideal for identifying percentage of population that has been infected, but less ideal for testing/tracing

Sources: Company websites, FDA, Johns Hopkins Centers for Health Security, “Test performance evaluation of SARS-CoV-2 serological assays” – Whitman et. al, UC San Francisco, MGH
What Tests to Use: Saliva v. Nasal Testing

<table>
<thead>
<tr>
<th>Nasal or Throat Swabs</th>
<th>Saliva Tests</th>
<th>Other Emerging Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Currently <strong>most broadly administered</strong> test</td>
<td>• <strong>Recently received FDA</strong> emergency use authorization</td>
<td>• <strong>DNA test</strong> that can deliver results in 40 minutes using CRISPR</td>
</tr>
<tr>
<td>• <strong>Recommended by the CDC</strong></td>
<td>• <strong>Minimally invasive</strong> (simply spit into vial)</td>
<td>• <strong>Take-home test</strong> – FDA recently authorized the first take-home kit; receive kit with doctor approval and mail back</td>
</tr>
<tr>
<td>• <strong>Invasive</strong> (involves a long Q-tip-like swab stuck up the nose or into the back of the throat)</td>
<td>• Can be <strong>reliably self-administered</strong></td>
<td></td>
</tr>
<tr>
<td>• Can take <strong>1-5 hours</strong> to run the test</td>
<td>• Requires <strong>less PPE and personnel</strong> to administer</td>
<td></td>
</tr>
<tr>
<td>• Requires a <strong>trained professional to administer</strong></td>
<td>• Not enough information to determine accuracy, but recent studies estimate ~90% to ~95% as effective as nasal or throat swabs</td>
<td></td>
</tr>
<tr>
<td>• Can have a <strong>false-negative rate of ~30%+</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Should keep track of emerging testing technologies and focus on options that make the testing process as easy and quick as possible while retaining accuracy**

Sources: Scientists to Stop COVID-19, “Saliva is More Sensitive for SARS-COV-2 detection in COVID-19 patients than nasopharyngeal swabs”, medRxiv, Yale (study has not yet been peer reviewed), cnet.com
## Range of Digital Tracing Options

<table>
<thead>
<tr>
<th>Description</th>
<th>Policy</th>
<th>Google and Facebook</th>
<th>Europe</th>
<th>South Korea</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alerts users if they’ve been in contact with a positive case</td>
<td>Google and Facebook</td>
<td>App that uses central servers to alert contacts of positive cases</td>
<td>Government publishes detailed reports about confirmed cases</td>
<td>Traced residents who left Wuhan, involuntary quarantine</td>
<td></td>
</tr>
<tr>
<td>Technology Used</td>
<td>iPhones and Android devices, Bluetooth</td>
<td>Bluetooth, central servers, cellphone data</td>
<td>Cellphone data, credit-card transactions, security footage</td>
<td>Phone and location data, travel history, drones, security footage</td>
<td></td>
</tr>
<tr>
<td>Date Deployed</td>
<td>In development</td>
<td>In development by consortium of institutions &amp; companies</td>
<td>Traced residents in February, gave access to local officials March 4th</td>
<td>Lockdown of Wuhan January 23rd, traced residents soon after</td>
<td></td>
</tr>
<tr>
<td>Success</td>
<td>NA</td>
<td>N/A</td>
<td>Average of 30 cases a day</td>
<td>0 reported new cases</td>
<td></td>
</tr>
<tr>
<td>Opt-In/Voluntary?</td>
<td>✅</td>
<td>✅</td>
<td>✗</td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>Information Disclosed</td>
<td>Age and gender</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>Travel history</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>Address &amp; location</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>Contacted persons</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>

Digital tracing can be highly effective, but privacy concerns a key issue

Reimagining Support Services: Workforce Redeployment

New Jersey State Platform Example

How it works

Job posting platform, featuring postings by employers whose labor needs are spiking due to COVID-19, hosted by NJ Economic Development Authority

No matching service, purely ’bulletin board’ style.

Outcomes so far

Job posts: 540+ employers posted 46,000+ jobs on the site as of 2 April

Visitors and clicks: Site had ~340K unique visits in its first 10 days, with ~20K aggregate clicks on “Apply Now” buttons

New Jersey has set up a ‘bulletin-board’ style platform to help match unemployed with new labor needs

Sources: New Jersey Covid-19 Jobs Portal