COVID AMP
ANALYSIS AND MAPPING OF POLICIES

Overview

The COVID Analysis and Mapping of Policies (AMP) is part of the COVID-Local suite of free resources developed for local decision-makers. The COVID AMP Policy and Plan Database includes a library of polices from US states and the District of Columbia, US local governments (counties, cities) and national governments globally.

COVID AMP is an on-going research effort with data collection performed by researchers at the Georgetown University Center for Global Health Science and Security and Talus Analytics. As of July 2020, data are most complete for US states. Additional work is in progress to expand both to county-level data collection across the US and country-level data globally. In addition, a dataset of COVID-19-related plans published by US states and other organizations is also being collated and is available on the site.

The site includes:

1. A searchable, filterable database of all policies and plans in the dataset, including legal and regulatory analysis. The complete dataset can be downloaded in an Excel file format directly from the site. If you are interested in establishing an API or other direct access, please contact us at outbreak@georgetown.edu or info@talusanalytics.com
2. An interactive policy map providing geospatial visualization of the policies implemented over time. Policies can be viewed by "Distancing level" (see Methods below for detailed information about these categories) and by key policy types. All policy maps include reference COVID-19 case counts, over time, either as new cases in the last 7 days or cumulative cases.
3. An interactive tool to explore the intersection between policies and caseload for each US state. The tool also provides the ability to:
    a. Compare the effect of not having implemented any policies
    b. Evaluate new policy options given conditions in a state

In addition to direct download from the site, we are happy to work with your team to provide automated access via API or other data sharing method. Please contact us at info@talusanalytics.com for more information.

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Annotated Policy Library

Data coding process

To collect the data, the team first developed a custom data taxonomy and data dictionary to define key metadata and organize the dataset. These data are populated directly by the policy coding team into Airtable and transferred *via* API into a database on Amazon Web Services. These data may be accessed directly from the backend database *via* API upon request. The data dictionary with complete description of all metadata fields can be downloaded as an Excel file here. The complete dataset can be downloaded from the Policy data page from covidamp.org/data.

For the purpose of this effort, policies are defined as government-issued and backed by legal authority or precedent. Plans included in the dataset are documents issued by a government, non-profit, for-profit, or higher education institution that provide recommended actions or guidelines, but do not necessarily have legal basis or authority.

Policies are coded and tagged with the relevant metadata manually. Each policy is tagged with a series of descriptive attributes based on a review of the policy language, including (see data dictionary for complete description of data fields):

- Policy name and description
- Policy type (e.g., executive order, emergency declaration, statute, etc.)
- Categorical description of the scope of policy actions (e.g., social distancing, travel restrictions, enabling and relief measures, support for public health and clinical capacity) as well as more granular subcategory tagging (e.g., face coverings, quarantine, private sector closures, school closures, etc.)
- Authorizing role enacting the policy (e.g., governor, mayor, health official, president, city council, etc.)
- Start/end dates, including anticipated end dates for those policies still in effect but with declarative expirations
- Information about the geographic regions where the policy applies (if different from the level at which the policy was enacted)

Researchers review public sources to identify policies, with the most common sources including government websites that collate policy announcements, either COVID-19-specific or more generally. If a documented policy is not available or where there are questions about the policy, researchers contact local public communications or other offices to confirm. A static copy (PDF or screen capture) of each policy is stored with links to any sites with associated policy announcements in the dataset.

Legal experts review each policy following entry into the dataset to identify and code relevant authorities underlying the policy. This review is ongoing and data from the legal review are continually added to policies in the dataset. In addition, for policies in the US, this data collection includes capturing attributes of the US state with respect to how legal authority is allocated between the local and state government (see definitions for Dillon's Rule and Home Rule states in the data dictionary available from the AMP documentation page).

Plans are recorded and coded using separate data given the nature of plans is different from that of policies and because plans, as included in AMP, do not have a requirement for being government-issued and or backed by legal authority or precedent. In addition to providing the pdf for the plan itself, data captured for plans includes (representative subset – see data dictionary for full description of data fields):

- Plan name a description
- Name and type of the organization that authored the plan
- Information about topics covered in the plan, based on the plan type (e.g., what aspects of school operations are addressed in a government plan; what aspects of operations are addressed in a private sector plan; etc.)
- Whether the plan was authored by an entity with authority to enact the plan elements

Policy Map

The policy map visualizes the policies in effect over time as well as a distancing level determined by analyzing policies in place on a given day (see below). A date slider at the top of the map page provides the ability to select a date or date range over which to compare the policies in effect in a given category, or view distancing level over time. State-level data are available for 50 US states and the District of Columbia (US only view) and currently includes country-level polices for select countries globally (sub-national polices are not included for locations other than the US). Expansion of coverage to additional countries is ongoing and are added to the map and policy library as policies are coded by the research team.

Visualizing distancing level, as analyzed from policies

Distancing level reflects major categories of status of the overall approach to COVID-19-related policies that address measures related to social distancing at a given time, including: Lockdown (Phase I), Stay-at-home (Phase II), Safer-at-home (Phase III), and New normal (Phase IV). Each phase is intended to reflect the approaches and phases that have emerged across the approach to COVID-19 response, including as aligned to the frameworks of the COVID Local Frontline Guide for Local Decision-Makers.

The distancing status of each location is captured based on a day-by-day analysis of policies in effect for each state, over time, that address school closures, private sector closures, and mass gatherings. To determine distancing level, explicit policies are considered first and that status is used (e.g., stay-at-home policy for stay-at-home distancing level) so long as it addresses the defined combinations of school closures, private sector closures, and mass gathering restrictions listed for each distancing level below. In cases where an explicit policy is in place, but subsequent policies related to social distancing counteract key elements used in the definition of distancing level considered here, the distancing level is determined using the rules below. For example, a stay-at-home order that subsequently relaxes (lifts) private sector closures prior to the end of the stay-at-home order is considered in a safer-at-home status for the purposes of distancing level in COVID AMP. Finally, the rules also serve as the basis for determining distancing level when no explicit policy is in place, but policies addressing school closures, private sector closures, and mass gatherings exist. The definition for each distancing level is included and the bullets that follow reflect the conditions used to capture each status *via* and/or logic.

Lockdown (Phase I): Policies do not allow residents to leave their place of residence unless explicitly permitted to do so.

- Lockdown order in place (e.g., includes provisions requiring no movement outside or limits those leaving home for essential functions to specific household members or to only some days of the week)

Stay-at-home (Phase II): Policies limit most in-person activities and social events

For the purposes of determining distancing level in AMP, stay-at-home is defined by simultaneous closure of schools, private sector businesses, and restrictions on mass gatherings and events, as captured by the policy tagging completed by the research team. Stay-at-home distancing level is captured from one or more policies, as follows.

- Stay-at-home order that includes all of the following:
    - School closures
    - Private sector closures
    - Mass gathering and/or event restrictions
- OR Combination of policies that includes all of the following:
    - School closure AND
    - Private sector closures AND
    - Mass gathering and/or event restrictions

Safer-at-home (Phase III): Policies limit activities to those specifically permitted, encouraging extra precautions and retaining limits on mass gatherings

For the purposes of determining distancing level in AMP, safer-at-home is defined as continuing school closures, reopening of the private sector (either as specified in a safer-at-home order or through a combination of stay-at-home order plus relaxed private sector restrictions), and ongoing mass gathering restrictions (though they may be relaxed relative to stay-at-home conditions)

- Safer-at-home order in place

- OR Stay-at-home order in place with simultaneous policies that relax restrictions on (reopen) the private sector

- OR Combination of policies that includes all of the following:
  - School closure AND
  - Private sector closure with some relaxation from prior, most restrictive policies AND
  - Mass gathering and/or event restrictions with some relaxation from initial, most restrictive policies

New normal (Phase IV): A majority of public restrictions on mass gatherings and non-essential businesses are lifted or expired, with some encouraging of safeguards such as face coverings

New normal distancing level is defined as:

- No stay-at-home or safer-at-home order in place (including by expiration)
- No private sector closures
- No mass gathering restrictions

Visualizing policies in place, by category, over time

To visualize policies in effect of different types over time, the map queries the policy dataset by date and location. Policies can be viewed by category on the map:

- Social distancing
- Emergency declarations
- Travel restrictions
- Enabling and relief measures
- Support for public health capacity

Policies can be viewed by multi-selected categories or sub-categories to view the status of each location based on polices in effect/not in effect related specifically to private sector closures, school closures, mass gatherings, and others.

COVID caseload data

US map and social distancing policy model

US state-level COVID-19 caseload data, new cases in the last 7 days and cumulative cases, are sourced from the New York Times Coronavirus (Covid-19) Data in the United States (https://github.com/nytimes/covid-19-data). These data include confirmed cases and, where captured by public health agencies, probable cases. Data are updated daily. These data are collated by the New York Times on the basis of data from state and local health agencies and licensed under the Creative Commons Attribution-Non Commercial 4.0 International license.

Global map

Global COVID-19 caseload data, new cases in the last 7 days and cumulative cases, are sourced from the COVID-19 Data Repository by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University which holds the copyright to all data (https://github.com/CSSEGISandData/COVID-19). These data include only confirmed cases and are updated daily. Additional information about the collation of the data by the Johns Hopkins University is available from the GitHub repository linked above.

Social distancing policy model

The COVID AMP policy model supports users in evaluating the impact of policies on the outbreak – a visualization of when (1) policies were implemented in each state relative to their actual caseload and fatalities, (2) predictive analysis for how future policy implementation will impact caseload, and (3) an analysis of what would have been had no mitigation policies been implemented. The social distancing policy model includes actual and modeled data for COVID-19 cases, COVID-related hospitalizations, ICU patient count (specifically for COVID complications), and deaths at daily resolution. These data about the dynamics of COVID outbreaks are accompanied by key designations of policies related to social distancing (i.e., stay-at-home, safer-at-home, new normal) captured from policies in place at different points in the outbreak (see "Visualizing distancing level," above). For points in the future, users can add new social distancing policies and evaluate their relative impact on the modeled outcome. The AMP social distancing policy model is currently available for US states at state scale.

For past dates, cases are sourced from confirmed and probable cases (see 'COVID caseload data' above) data from March 1 to the most recent data update. Because case data is cumulative, we calculate "active" cases by assuming patients recover 13 days after their case is confirmed by testing and deriving deaths from those cases. We assume approximately 25% of total confirmed cases are hospitalized with equates to ~7% of total cases (symptomatic and asymptomatic.) For all dates past the most recent case update, all data for cases, hospitalizations, ICU patient counts, and deaths are modeled using the approach below as seeded with the current case counts from reported actual cases (from the New York Times Coronavirus (Covid-19) Data in the United States, as described above).

Future cases, hospitalizations, ICU patient counts, and deaths are predicted on the basis of a modified SEIR (susceptible, exposed, infectious, recovered) model adding multiple levels of infections and an asymptomatic class (see Figure 1 below). The COVID-19 SEIR model used here was developed in collaboration with COVID Act Now, originally adapted from the original work of Dr. Allison Hill[i], Research Fellow at the Harvard Program on Evolutionary Dynamics. In this model, susceptible (S) individuals may become exposed (E) to the virus, then infected (I) at varying levels of disease severity (asymptomatic, mild, moderate, or severe, captured as rates A, I_1, I_2, and I_3 respectively. Infected individuals then either recover (R) or die (D). Figure 1, below, is adapted from Hill et al., and describes the process underling the COVID-19 SEIR model that calculated cases, hospitalizations, ICU patient count, and deaths in the social distancing policy model.

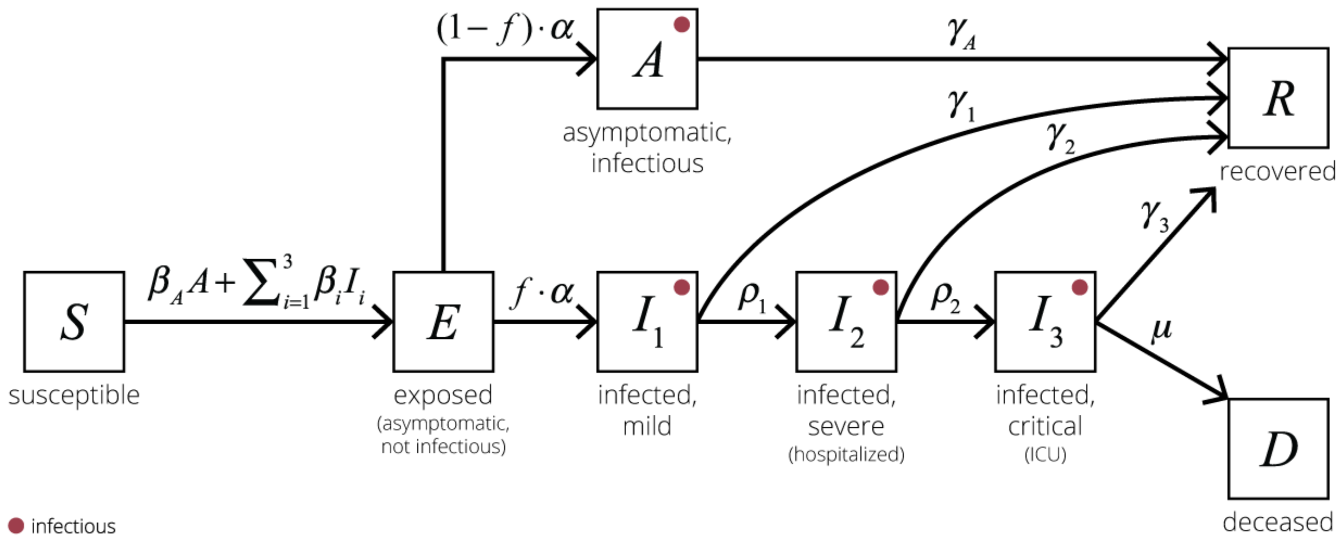

Figure 1: State diagram depicting the transitions between states included in the model and variables corresponding to the rate of each transition. Parameter values are included and described below.

State descriptions

The following bullets summarize the states of the SEIR model and how individuals progress through them (see tables below for details on each parameter):

- **Susceptible**: Starting state for all individuals in a fully predictive run and, in cases where the model run is initiated base on prior cases, the susceptible group includes the proportion of individuals not previously sick.
- **Exposed**: People move from Susceptible to Exposed when they come in contact with other infectious individuals with a rate that is determined by the number of contacts individuals have with one another (providing basis for susceptible individuals to come into contact with infected individuals and get exposed). In this model, Exposed individuals are not yet infectious to other and do not have symptoms (pre-symptomatic). All exposed individuals transition to mild cases (Infected$_1$) after 6 days.
- **Asymptomatic**: These cases have no symptoms and will not know they are infected unless tested. They can, however, infect other people. We assume 30% of infected people in the model are asymptomatic and infected for a total of 12 days with the final 6 of those being infectious to others.
- **Infected$_1$**: These are mild cases. After approximately a week, 7% of these cases worsen, and require hospitalization (the Infected$_2$ state), and the remaining 93% progress to the Recovered state.
- **Infected$_2$**: These are severe, hospitalized cases, requiring non-ICU treatment. After approximately a week, 13% of these cases worsen, thus requiring ICU/ventilation (Infected$_3$), while the remaining 87% progress to the Recovered state.
- **Infected$_3$**: These are critical cases requiring ICU treatment. This model assumes all deaths must first pass through this category. After approximately a week, 40% of these cases lead to death, while the remaining 60% progress to Recovered.

- **Recovered**: Includes all individuals who have already had the disease (excluding those who died). For the purposes of the model, recovered individuals are considered to be immune from future infection.
- **Dead**: Those that have died from the disease. All of these come from ICU cases and make up approximately 1% of all cases.

Modeling disease characteristics

Values for the epidemiological model parameters are based on the best available data and academic consensus, wherever possible. Changes in parameters related to policy implementation are based on the expected changes in contact rate and transmission anticipated corresponding to policy status under each category of social distancing (lockdown, stay-at-home, safer-at-home, and new normal; see above for definitions). These estimates are calculated as a difference in contact rate and transmission based on reproductive rate (R), the number of new cases that result from one individual infecting others. Reproductive rate is an inferred model outcome and is not an input of the SEIR model, but is used to calibrate the model state to produce a transmission rate (β) for the given conditions in the table below. The probability of transmission (β), representing the likelihood that a susceptible individual is exposed to someone who is infectious (and the likelihood of infection given exposure, which is not adjusted directly in the model), is set dynamically based on the policies in place at a given time. Thus, the distancing level captured from policies is considered in the transmission dynamics for future COVID spread (e.g., stay-at-home more stringently restricts contacts between individuals and suppresses transmission more than a safer-at-home condition).

What if we had done nothing? (Counterfactual)

As the outbreak has unfolded, we have added a counterfactual analysis to assess how the event would have unfolded had states not implemented any policies. The counterfactual scenario is modeled assuming contact rate remained elevated throughout the Spring and early Summer of 2020, as those states had not implemented social distancing policies. We start from the caseload data on either the day of first distancing policy or March 12th, whichever comes first. (Note: March 12 was the day the US saw a significant decline in mobility regardless of policy).[ii, iii] We then project forward assuming using a R value of 2.1, slightly lower than that before the event to account for changes in behavior as would be expected with only reports of disease threat (as seen in states without social distancing policies, but that still showed a reduction in mobility.) Notably, variations in actual contact rate both between and within states especially in the early months of the outbreak, the model does not necessarily capture behavior early in the event, especially in states with small or later outbreaks. In these cases, the comparison to today's actual caseload or deaths can suggest that doing nothing could lead to fewer cases today, but all suggest that there will be far more cases in the near future due to the exponential nature of growth with an R greater than one. The implication is not that doing nothing would be a better strategy because the number is lower today, but that this lack of action puts the state on a dangerous trajectory.

R-values by distancing level			
Distancing level (phase)	**Effective R value**	**Corresponding Beta value**[iv]	**Percentage reduction (relative to early event)**
Early event (prior to any policy interventions)	2.47	.04	N/A
Lockdown (Phase I)	0.79	.012	68%
Stay-at-home (Phase II)	0.90	0.14	64%
Safer-at-home (Phase III)	1.21	0.19	49%
New normal (Phase IV)	1.78	0.29	28%

The following parameters are drawn from the best available clinical information for COVID-19, and effects of non-pharmaceutical interventions manifested through policies, in order to populate the model.

Model Parameters		
Parameter	Description, as used in model	Value(s)
Transmission rate (non-hospitalized)	Rate at which susceptible individuals are infected, which is dependent upon distancing level resulting from policies in place	Based on distancing level: • Prior to any policy interventions = 0.4 • Lockdown = 0.12 • Stay-at-home = 0.1375 • Safer-at-home = 0.19 • New open = 0.285
Transmission rate (hospitalized, ICU)	Rate at which susceptible individuals are infected by patients in the hospital setting, which is independent of distancing level resulting from policies	0.1
Pre-symptomatic period	3-day pre-symptomatic period used to calculate alpha (α = 1/pre-symptomatic period)	6 days[v]
Duration of mild infections	6-day mild infection period sets the rate at which cases move from mildly infected to	6 days[vi]

	either severely infected (7%) or recovered (93%) (g_1 = 1/mild infection period)	
% infections requiring hospitalization	Proportion of mild infections that progress to severe infections	7.27%[vii]
Duration of hospitalization, pre-ICU admittance	11-day period sets the rate at which cases move hospitalized to either ICU (~14%) or recovered (~85%%) (g_2 = 1/pre-ICU admittance period)	11 days[viii]
% hospitalizations requiring ICU care	Proportion of severe infections that progress to ICU admission	22%[ix]
Case fatality rate (CFR)	Fraction of all cases resulting in death	1.09%[x]
Time in ICU until death	Time a patient spends in the ICU setting before death or recovering	8 days[xi]

Policies (distancing level)

The AMP Policy Model includes policies implemented historically, as captured by the 'Distancing level', and allows users to add policies in the future. Future policy interventions update model parameters (specifically the transmission level, or Beta) to reflect the increase or decrease in intra-personal contact level as a result of policies that change the level of social distancing. This feature provides the ability to analyze relative, future impact of policy implementation on caseload.

[i] Hill, Alison, et al. "Modeling COVID-19 Spread vs Healthcare Capacity" https://alhill.shinyapps.io/COVID19seir/

[ii] https://www.apple.com/covid19/mobility

[iii] https://visualization.covid19mobility.org/?date=2020-07-09&dates=2020-04-09_2020-07-09&region=WORLD

[iv] Calculated based on a consideration of literature-reported R values, estimated reduction of transmission by non-pharmaceutical interventions, and bounded by estimated effective R values developed by the R_t COVID-19 project (https://rt.live/).

[v] Wei, Yongyue, et al. "A systematic review and meta-analysis reveals long and dispersive incubation period of COVID-19" https://www.medrxiv.org/content/10.1101/2020.06.20.20134387v1
[vi] Koehler, Matt, et al. "Modeling COVID-19 for lifting non-pharmaceutical interventions" https://www.medrxiv.org/content/10.1101/2020.07.02.20145052v1
[vii] Ferguson, Neil, et al. "Report 9: Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand" https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-NPI-modelling-16-03-2020.pdf
Note: As implemented in the model, the reported values in this reference are weighted by US population demographics.
[viii] US Centers for Disease Control and Prevention. "Interim Clinical Guidance for Management of Patients with Confirmed Coronavirus Disease (COVID-19)" https://www.cdc.gov/coronavirus/2019-ncov/hcp/clinical-guidance-management-patients.html
[ix] Cummings, Matthew, et al. "Epidemiology, clinical course, and outcomes of critically ill adults with COVID-19 in New York City: a prospective cohort study" https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)31189-2/fulltext
[x] Ferguson, Neil, et al. "Report 9: Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand" https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-NPI-modelling-16-03-2020.pdf
Note: As implemented in the model, the reported values in this reference are weighted by US population demographics.
[xi] European Centre for Disease Prevention and Control. "Clinical characteristics of COVID-19" https://www.ecdc.europa.eu/en/covid-19/latest-evidence/clinical