

## MEDICAL STUDENT COVID-19 CURRICULUM

On March 15, a group of students at Harvard Medical School created a Response Team to organize their efforts against the COVID-19 pandemic. They identified two main opportunities for impact: education and activism. Education efforts have resulted in this curriculum intended for the medical community and a public-facing social media campaign (see @FutureMDvsCOVID). Activism work has involved coordinating ways that students can provide on-the-ground help in both the community and clinical settings. For inquiries about the HMS COVID-19 Student Response Team's efforts, please contact: [hmscovid19studentresponse@gmail.com](mailto:hmscovid19studentresponse@gmail.com).

This curriculum was entirely written and compiled by Harvard Medical School students. This document is not an official publication of the institution. It is provided for educational purposes only and does not constitute medical advice.

While our primary audience is our classmates, we suspect the curriculum will be of use to other medical students and health professionals around the world. We encourage you to share these materials with anyone whom you believe may benefit from them. If you are from outside the HMS community, welcome.

*We invite you to sign the [guest book](#) so we can track this material's reach.*

The contents in each module were reviewed for accuracy by expert faculty members at the time of initial publication. We thank them for their attention during this particularly demanding time. However, given our constantly changing understanding of SARS-CoV-2 and the pandemic's spread in society, the material in this curriculum will need to be updated frequently, and we cannot guarantee the accuracy of the information at any given time. A date stamp is included at the bottom right of each page to indicate how recently the material was revisited. **We plan to update content every Friday.**

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### HOW TO USE THIS CURRICULUM

We want these lessons to be as widely helpful as possible. Given the range of circumstances in which medical students may find themselves right now, we do not have a single approach in mind. For those with the time, we suggest you proceed through the modules start-to-finish, ideally spaced over two or more sittings. However, for those with more urgent needs, the modules are stand-alone, and you can selectively access content on an as-needed basis. The subsequent overarching goals, learning objectives, and table of contents may help you locate content that is most important. Many modules reference supplemental resources that may be worth accessing in the future, either in anticipation of specific patient interactions or simply to find the most current statistics of the pandemic. Also included in this sheet are one-page summaries of each module's key takeaways.

## OVERARCHING LEARNING GOALS

### Module 1: From Bench to Bedside

Evaluate how the emerging understanding of COVID-19 pathophysiology translates to evolving diagnosis, treatment, and prevention efforts.

### Module 2: Epidemiology Principles

Introduce epidemiological principles underlying the current public health interventions regarding COVID-19, and evaluate how these interventions could influence the impact of the pandemic.

### Module 3: Current Situation and Healthcare Response, in Massachusetts and Beyond

Appreciate the complex and rapidly changing landscape of the COVID-19 pandemic as it stands in Massachusetts, as well as the adapting responses of the healthcare system and society as a whole.

### Module 4: Communicating Information about COVID-19

Now that you've bolstered your COVID-19 knowledge, prepare to productively communicate that information, especially with a non-medical audience who may have varying attitudes towards the pandemic.

### *[Module 5: Clinical Role-Specific Skills]*

This forthcoming module will address some of the practical skills that students may require as they are called upon to fill new clinical roles.

## LEARNING OBJECTIVES

At the end of Module 1, medical students should be able to:

- Relate the basic virology of SARS-CoV-2 to evolving COVID-19 diagnosis and prevention approaches
- Translate knowledge of the host immune response against SARS-CoV-2 to COVID-19 risk stratification, treatment, and vaccine strategies
- Build a differential diagnosis for COVID-19 using its typical clinical manifestations, laboratory, and imaging findings
- Evaluate current triage and treatment recommendations for COVID-19, stratified by disease severity
- Appreciate how COVID-19 pathophysiology underlies ongoing research into investigational therapeutics and vaccines

At the end of Module 2, medical students should be able to:

- Define  $R_0$ ,  $R_e$ , incubation period, epidemic curve, community transmission, social distancing, and flattening the curve as they pertain to COVID-19
- Identify and access a reliable source of the latest epidemiologic information about COVID-19
- Describe how changing epidemiological parameters changes disease dynamics
- Contrast two cases that illustrate how flattening the curve saves lives in a pandemic

At the end of Module 3, medical students should be able to:

- Access useful sources on the current landscape for coronavirus infection in Massachusetts
- Illustrate how practical considerations of a healthcare system impact testing capacity and eligibility
- Describe the current landscape of clinical trials on experimental antiviral treatments and vaccine development
- Identify at least 3 different ways in which the pandemic has impacted the global economic and social climate

At the end of Module 4, medical students should be able to:

- Compare and contrast 2 different responses individuals may have to the pandemic
- Revisit 3 key conceptual frameworks for communication skills
- Recognize the tool that would be most appropriate for a given situation
- Rehearse a potentially difficult situation with someone from your life

## TABLE OF CONTENTS

If you're not familiar, learn to use Google Docs' "Document Outline" feature, which is accessible by clicking the icon at the top left margin (icon below). This will allow you to quickly jump to different sections of the document.



### Module 1: From Bench to Bedside

- Basic Virology and Immunology
  - Basic Virology
  - Pathogenesis of COVID-19 Infection
  - Immune Response in COVID-19
- Clinical Presentation of COVID-19
  - Clinical Presentation
  - Risk Stratification
  - Diagnostics
  - Ancillary Studies
- Treatment of COVID-19
  - Clinical Course
  - Triage Guidelines
  - Treatment
- Investigational Therapeutics & Vaccine Development
  - Investigational Therapeutics
  - Passive Antibody Transfer
  - Vaccine Development

### Module 2: Epidemiology Principles

- Introduction to Epidemiological Terms
- Where Are We Now?
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  - Asymptomatic Transmission
- Where Will We Be Next - Approaches to Prediction
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  - Models of Virus Spread
  - How Social Distancing Could Impact Spread
- Case Study: 1918 Influenza Pandemic and Lessons from 3 US Cities
  - How 3 US Cities Tried to Stop the Spread
- Case Study: South Korea, 2020
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- Reducing Barriers for Quarantine and Treatment
- Social Distancing
- Current Situation in South Korea
- Summary

### **Module 3: Current Situation and Healthcare Response, in Massachusetts and Beyond**

- Current Landscape of COVID-19 in Massachusetts
- Diagnostics: Testing Capacity and Eligibility
  - Testing Capacity
  - Testing Eligibility
  - Telephone Triage and Drive-Through Testing
- Ongoing Clinical Trials: Treatment and Prevention
  - Treatments
  - Vaccines
- Socioeconomic Ramifications
  - Social Isolation
  - Impact on Work
  - Financial Instability
  - What Is Being Done in Response?
  - Further Reading and Updates
- Summary and Final Thoughts

### **Module 4: Communicating Information about COVID-19**

- Reflection on Cases
- Skillset Review
  - Difficult Conversations
  - Giving Bad News
- Cultural Humility & Meeting People Where They Are
- Sustaining Constructive Behaviors Over Time
  - Prochaska's Stages of Change Model
  - Motivational Interviewing
- Activity: Putting It to Practice

## CASES

To help you link this curriculum's clinical, epidemiologic, and social principles into real-world human narratives, the modules will repeatedly reference two characters. We'd like to introduce you to them now.

### Case 1: Brian

Brian is a healthy, 22 year-old college senior in Boston who just received a 5-day notice to pack up his dorm room belongings, say goodbye to his friends, and return home. He posts on Twitter about being mad at the administration for taking such "ridiculous measures" and "ruining his senior spring." He has been looking forward to walking at graduation with his friends all year and now the school has made it "virtual." To celebrate these last few days of school, he goes out to dinner with his roommates and is surprised when the restaurant is basically empty. He is convinced the chances he'll get COVID-19 are miniscule--there's only a few dozen cases in Boston--and even if he does, he'll be asymptomatic. People are overreacting, he thinks to himself. It's just a bad cold, right?

He puts on a brave face, but inside he is really concerned. He doesn't have a place to live after graduation and was planning on staying with his grandmother, Diane, until he earned enough money to pay rent. Now he's being told he can't move in with her because of the dangers he may pose to her. On top of that, he has no earnings, student debt, and a post-grad job that is on indefinite hold.

The next day, he notices that a few people have commented on his insta-story from last night at dinner with his friends, reprimanding him for being irresponsible and not "socially distancing." Brian feels like they are acting holier-than-thou and is frustrated that they don't understand everything he is going through right now.

### Case 2: Diane

Diane is a 72 year-old woman who has COPD, heart failure, depression, and anxiety. She's proud to live on her own in an independent living facility for the elderly in the middle of the city. She was planning on housing her grandson, Brian, after graduation from college until he could find a place to live but she doesn't think that is a good idea anymore given everything that is going on with the coronavirus madness. Over the last few weeks, she's watched the news carefully, becoming more and more alarmed as the case numbers are rising. In particular, she's heard that people who are older and have other health conditions are more at risk, and she is reminded of her late husband, who passed away last year of complications from the flu. Making things worse are her concerned children, who live across the country. They call her and plead that she isolate herself at home. But she can't--she doesn't have any help, so Diane walks to her local supermarket to stock her pantry and purchase what she has heard to be necessities, including cleaning wipes, masks, and soap. At the store, her heart pounds. The home supply shelf is completely empty.

## ONE-PAGE SUMMARY - MODULE 1: FROM BENCH TO BEDSIDE

### LEARNING GOAL

- Evaluate how the emerging understanding of the pathophysiology of COVID-19 translates to evolving diagnosis, treatment, and prevention efforts

### BASIC VIROLOGY, IMMUNOLOGY, AND PATHOGENESIS:

- SARS-CoV-2 is a new virus belonging to the Coronavirus family, which includes less pathogenic strains responsible for the common cold, as well as the viruses responsible for SARS and MERS. It is genetically related to the coronavirus responsible for the SARS outbreak in 2003; the closest identified relative was isolated from bats.
- SARS-CoV-2 is spread primarily via droplet, though it can be aerosolized and can persist on plastic and stainless steel surfaces for up to 72 hours. Disinfectants with commercial concentrations of EtOH or H<sub>2</sub>O<sub>2</sub> are effective.
- Microscopically, the virus is a ssRNA<sup>+</sup> enveloped virus with a helical capsid, coated with S protein ‘studs,’ which facilitate receptor binding and membrane fusion. S protein binds to the ACE2 receptor of type 2 pneumocytes.
- People with severe COVID-19 have a cytokine storm and increased neutrophil migration to the lungs. Protection against reinfection is unclear; CD4<sup>+</sup> Th1 and CD8<sup>+</sup> cells both are part of the immune response to the virus.
- Lymphopenia is seen in COVID-19, presumably due to bone marrow suppression by the antiviral response.

### CLINICAL PRESENTATION OF COVID-19

- Common symptoms: cough, fever, and fatigue; however, sputum, shortness of breath, myalgias, sore throat, headache, nasal congestion, and nausea/vomiting/diarrhea have also been reported.
- The elderly and those with comorbid conditions (most clearly cardiovascular disease, respiratory conditions, and cancer) are at higher risk for a more severe disease course and death.
- RT-PCR on respiratory samples is the current gold standard. Serologic antibody tests are undergoing FDA approval.
- Common lab findings: ↓lymphocytes, ↓platelets, ↑CRP. Higher inflammatory markers seen in more severe disease.
- Common chest CT findings: bilateral ground glass opacities, consolidations, and “crazy paving” patterns.

### TREATMENT OF COVID-19

- Clinical outcomes include mild disease, pneumonia, severe pneumonia, ARDS, and septic shock.
- Case fatality rate estimated to be ~2%, but many cases likely remain undiagnosed.
- Triage: Mild symptoms - ~14-day home quarantine. Only admit if there is significant risk of decompensation. Moderate to severe symptoms - admit to the hospital in an airborne isolation room. ICU level care necessary for advanced ventilatory support or support for 2+ organ systems.
- Standard supportive measures: isolation, conservative fluid management; Possible supportive measures if comorbid conditions: empiric antibiotics, oseltamivir, bronchodilators; Advanced supportive measures: ventilatory support.

### INVESTIGATIONAL THERAPIES AND VACCINE DEVELOPMENT

- There are currently no FDA-approved treatments directed against COVID-19 at this time (3/18/20). A variety of therapies are under investigation, however. These include repurposing of antivirals (remdesivir, lopinavir/ritonavir), antimalarials (chloroquine/hydroxychloroquine), and immunosuppressive medications (tocilizumab), or transfusing antibodies against SARS-CoV-2 analogs/SARS-CoV.
- It is expected that COVID-19 vaccine development will take a minimum of one year.

## ONE-PAGE SUMMARY - MODULE 2: EPIDEMIOLOGY PRINCIPLES

### LEARNING GOAL

- Introduce epidemiological principles used to describe the spread of COVID-19, and evaluate the potential impact of public health interventions via modeling and historical and contemporary examples.

### CORE MATERIALS

- Pueyo, T. [Coronavirus: Why You Must Act Now](#). Medium, 3.10.20
- Sanderson, G. [Exponential Growth and Epidemics](#). Youtube, 3.8.20
- Stevens, H. [Why outbreaks like coronavirus spread exponentially, and how to “flatten the curve”](#). WaPo, 3.14.20
- Bitton, A. [Social Distancing: This Is Not a Snow Day](#). Ariadne Labs, 3.20.20
- Barry, J. [The Single Most Important Lesson From the 1918 Influenza](#). New York Times, 3.17.20

### INTRODUCTION TO EPIDEMIOLOGICAL TERMS

- **R<sub>0</sub>** refers to the average number of people an infectious person is expected to infect in an entirely susceptible population. **Re** is similar but without the assumption that everyone is susceptible.
- **Incubation period** is the time between exposure and symptom onset; **latent period** is the time between exposure and infectiousness. A difference between these periods can lead to **pre- or asymptomatic transmission**.
- **Serial interval** is the time period between symptom onsets in an infector-infectee pair and is often used as a surrogate for **generation interval**.

### WHERE ARE WE NOW?

- Latest case number and geography are available for the [U.S.](#) and the [globe](#).
- Current estimates for the U.S. indicate a caseload of [10-50x](#) what is currently recognized.
- Wuhan data indicate **asymptomatic** and **mildly symptomatic cases** are responsible for the [majority](#) of new transmission.

### WHERE ARE WE GOING?

- Common modeling assumptions include that nearly everyone is **susceptible** to SARS-CoV-2; that the **R<sub>0</sub>** is 2-4; that the **doubling time** is 5-7 days; and that patients cannot become **reinfected** in the short term (months-years).
- **Re** and **serial interval** (estimated 4-5 days) are two factors that influence the [exponential growth](#) of the pandemic.
- Small modifications to the parameters of this growth can “[flatten the curve](#),” which lengthens the time over which severely ill people present, buys the healthcare system more time to prepare to treat such patients, and buys scientists time to test and optimize new treatment strategies to reduce mortality from the virus.
- At this phase the U.S. is primarily attempting to flatten the curve by “[social distancing](#).”
- The impact of interventions undertaken today may not be clear for 1-2 weeks due to the viral incubation period.
- Social distancing may be required for months. Modeling is ongoing to determine how to transition to the post-pandemic phase safely while lessening disruptions to societies and economies.

### CASE STUDIES

- The influenza pandemic of [1918](#) prompted different responses from three U.S. cities, with three dramatically different outcomes for morbidity and mortality.
- South Korea presents a contemporary example of a country that rapidly scaled up testing, contact tracing, and social distancing without nationwide lockdown, which has greatly decreased the recent number of new cases.



## ONE-PAGE SUMMARY - MODULE 3: CURRENT SITUATION AND HEALTHCARE RESPONSE

### LEARNING GOAL

- Appreciate the complex and rapidly changing landscape of the COVID-19 pandemic as it stands in Massachusetts, as well as the adapting responses of the healthcare system and society as a whole.

### CURRENT LANDSCAPE OF COVID-19 IN MASSACHUSETTS

- The SARS-CoV-2 pandemic is an ever changing entity. To further understand the extent of the virus's impact locally in Massachusetts, the first part of this module provides valuable resources to understand the number of cases, the current travel restrictions, and current local policies. This information will be frequently updated.

### DIAGNOSTICS: TESTING CAPACITY AND ELIGIBILITY

- Testing capacity within the United States has been limited due to regulatory requirements, initial faulty test kits, and limitations of the healthcare infrastructure (including laboratory personnel, supplies, testing facilities, etc.), though is now beginning to ramp up with the emergence of FDA-approved commercial testing kits.
- Though the state of Massachusetts previously ran all tests through the Mass. Dept. of Public Health Laboratory, which is capable of running 400 tests a day (as of 3/18), individual hospitals are now live with their own in-house tests.
- Testing guidelines for Persons Under Investigation (PUI) for COVID-19 vary and are likely to change. However, a graphic of the current algorithm from the Mass. Dept. of Public Health can be found in this module.
- Testing risks transmission to other patients and healthcare workers; telephone triage and drive-through centers mitigate this.

### ONGOING CLINICAL TRIALS: TREATMENT AND PREVENTION

- For the time being, the WHO and the CDC recommend supportive care only. No controlled clinical data exists to support the efficacy of any agent for the treatment of COVID-19. There are, however, ongoing investigations evaluating the potential repurposing of various medications: Chloroquine/ Hydroxychloroquine, Remdesivir, Lopinavir/ritonavir, and Tocilizumab.
- Vaccine development (see Module 1 for background information) is ongoing. There are several studies evaluating mRNA, DNA, killed/inactivated pathogen, and whole pathogen vaccines. Ongoing clinical trials will be updated.

### SOCIOECONOMIC RAMIFICATIONS

- The pandemic clearly has far reaching implications for the society's physical well-being, but so too are its implications for society's social and financial well-being.
- Those disproportionately affected by the pandemic include people experiencing: housing insecurity, incarceration, insecure immigration status, lack of paid sick leave/ability to take time off work, financial instability, lack of childcare in light of school closings, among many others.
- Social distancing poses a unique risk for increased social isolation and loneliness that may contribute to negative health outcomes.
- The call for social distancing, working from home, and recent volatility of the global financial market have brought about unique questions regarding the impact of the pandemic on the economy. At the current moment, we cannot say for sure whether or not the pandemic will trigger a policy or structure related recession, but it will certainly incite a disruption in the supply-demand chain.

## ONE-PAGE SUMMARY - MODULE 4: COMMUNICATING INFORMATION ABOUT COVID-19

### LEARNING GOAL

- Review and rehearse communication strategies for engaging a non-medical audience

### COMMUNICATION SKILL SET

- Review [overarching principles](#) for physician/medical student communication and the [CDC Crisis + Emergency Risk Communication](#) framework for public messaging.
- Having Difficult Conversations
  - Do not focus on facts at the expense of feelings. To anticipate feelings, think about one's identity and how the situation may relate to their most important values.
  - Recognize that each conversation engages fact, feelings, and identity conversation.
- Delivery Serious or Bad News
  - Review SPIKES and REMAP mnemonics and apply to clinical and non-clinical scenarios
- NURSE/Expressing Empathy
  - Name the emotion, express understanding, demonstrate respect, provide support, explore the emotion further, use "I wish" and "I wonder" statements.

### CULTURAL HUMILITY & MEETING PEOPLE WHERE THEY ARE

- Recognize the [differential impact](#) that coronavirus has on people based on their past experiences or their current circumstances and [adopt an equity framework](#).
- Practice cultural humility: recognize the unique elements of someone's experience based on background and culture; acknowledge the authority that each person has over their experiences and story.
- Utilize [a framework](#) to respond to microaggressions or macroaggressions.
- Communicate with kids by honestly discussing facts using age-appropriate language and resources, listening to concerns, empathizing, and maintaining a sense of social connectedness ([Basu and Koenen](#), [Haelle](#)).

### SUSTAINING CONSTRUCTIVE BEHAVIORS OVER TIME

- Review Prochaska's Stages of Change model
  - The most effective approach to addressing a change in behavior should take into account the person's willingness to change, motivating factors towards change, and barriers standing in the way
- Motivational Interviewing
  - Review technique for engaging people in conversations about behavior changes

### ACTIVITY: PUTTING IT TO PRACTICE

- Identify opportunities to impact other people/networks from your life, and implement one of these ideas in your real life by the end of the week.

### HELPFUL RESOURCES

- Infographic: [COVID-19: What you need to know: a 1-page guide](#)
- Twitter: [@FutureMDvsCOVID](#)
- Instagram: [futuremdvs covid](#)

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To continue in our COVID-19 curriculum, please click here: [Module 1: From Bench to Bedside](#).

We welcome your feedback on the curriculum. Please share it [here](#).