Impact of COVID-19 on Digital Health and Health Informatics

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References

"A Visual Guide to the SARS-CoV-2 Coronavirus - Scientific American." n.d. Accessed September 1, 2020. https://www.scientificamerican.com/article/a-visual-guide-to-the-sars-cov-2-coronavirus/.

Alexander, G. Caleb, Matthew Tajanlangit, James Heyward, Omar Mansour, Dima M. Qato, and Randall S. Stafford. 2020. "Use and Content of Primary Care Office-Based vs Telemedicine Care Visits During the COVID-19 Pandemic in the US." *JAMA Network Open* 3 (10): e2021476. https://doi.org/10.1001/jamanetworkopen.2020.21476.

Alexander, Gregory L., Kimberly R. Powell, and Chelsea B. Deroche. 2020. "An Evaluation of Telehealth Expansion in U.S. Nursing Homes." *Journal of the American Medical Informatics Association: JAMIA*, November. https://doi.org/10.1093/jamia/ocaa253.

Allen, Marshall. 2020. "'Immune to Evidence': How Dangerous Coronavirus Conspiracies Spread." ProPublica. May 17, 2020. https://www.propublica.org/article/immune-to-evidence-how-dangerous-coronavirus-conspiracies-spread?token=YxUntiDH12MOMHz5OD1yLBRth4wTzdEG.

Andoni, Anna. 2020. "Artificial Intelligence Can't Help with the COVID Pandemic. Or Can It?" *NODE.Health* (blog). July 8, 2020. https://nodehealth.org/2020/07/08/artificial-intelligence-cant-help-with-the-covid-pandemic-or-can-it/.

Azzopardi-Muscat, Natasha, Hans Henri P Kluge, Samira Asma, and David Novillo-Ortiz. 2020. "A Call to Strengthen Data in Response to COVID-19 and Beyond." *Journal of the American Medical Informatics Association*, no. ocaa308 (December). https://doi.org/10.1093/jamia/ocaa308.

Baker, Michael G., Nick Wilson, and Andrew Anglemyer. 2020. "Successful Elimination of Covid-19 Transmission in New Zealand." *New England Journal of Medicine* 0 (0): e56. https://doi.org/10.1056/NEJMc2025203.

Balwani, Manisha, Eliane Sardh, Paolo Ventura, Paula Aguilera Peiró, David C. Rees, Ulrich Stölzel, D. Montgomery Bissell, et al. 2020. "Phase 3 Trial of RNAi Therapeutic Givosiran for Acute

Intermittent Porphyria." *The New England Journal of Medicine* 382 (24): 2289–2301. https://doi.org/10.1056/NEJMoa1913147.
Beall, Jeffrey. 2018. "Predatory Journals Exploit Structural Weaknesses in Scholarly Publishing." *4open* 1: 1. https://doi.org/10.1051/fopen/2018001.
Bello, Walden. 2020. "How Thailand Contained COVID-19 - FPIF." *Foreign Policy In Focus* (blog). June 3, 2020. https://fpif.org/how-thailand-contained-covid-19/.
Benaich, Nathan. 2020. "AI Has Disappointed on Covid." *Financial Times*, September 20, 2020. https://www.ft.com/content/0aafc2de-f46d-4646-acfd-4ed7a7f6feaa.
Bhaskar, M. Emmanuel, and Santhanam Arun. 2020. "SARS-CoV-2 Infection Among Community Health Workers in India Before and After Use of Face Shields." *JAMA*, August. https://doi.org/10.1001/jama.2020.15586.
Bosworth, A, J Ruhter, LW Samson, C Taplin, W Tarazi, and R Zuckerman. 2020. "ASPE Issue Brief: Medicare Beneficiary Use of Telehealth Visits: Early Data From the Start of the COVID-19 Pandemic." ASPE. July 28, 2020. https://aspe.hhs.gov/pdf-report/medicare-beneficiary-use-telehealth.
Bramstedt, Katrina A. 2020. "The Carnage of Substandard Research during the COVID-19 Pandemic: A Call for Quality." *Journal of Medical Ethics* 46 (12): 803–7. https://doi.org/10.1136/medethics-2020-106494.
Brat, Gabriel A., Griffin M. Weber, Nils Gehlenborg, Paul Avillach, Nathan P. Palmer, Luca Chiovato, James Cimino, et al. 2020. "International Electronic Health Record-Derived COVID-19 Clinical Course Profiles: The 4CE Consortium." *Npj Digital Medicine* 3 (1): 1–9. https://doi.org/10.1038/s41746-020-00308-0.
Brody, Jane E. 2020. "A Pandemic Benefit: The Expansion of Telemedicine." *The New York Times*, May 11, 2020, sec. Well. https://www.nytimes.com/2020/05/11/well/live/coronavirus-telemedicine-telehealth.html.
Budd, Jobie, Benjamin S. Miller, Erin M. Manning, Vasileios Lampos, Mengdie Zhuang, Michael Edelstein, Geraint Rees, et al. 2020. "Digital Technologies in the Public-Health Response to COVID-19." *Nature Medicine* 26 (8): 1183–92. https://doi.org/10.1038/s41591-020-1011-4.
Califf, Robert M., Adrian F. Hernandez, and Martin Landray. 2020. "Weighing the Benefits and Risks of Proliferating Observational Treatment Assessments: Observational Cacophony, Randomized Harmony." *JAMA*, July. https://doi.org/10.1001/jama.2020.13319.
Campanella, Gabriele, Matthew G. Hanna, Luke Geneslaw, Allen Miraflor, Vitor Werneck Krauss Silva, Klaus J. Busam, Edi Brogi, Victor E. Reuter, David S. Klimstra, and Thomas J. Fuchs. 2019. "Clinical-Grade Computational Pathology Using Weakly Supervised Deep Learning on Whole Slide Images." *Nature Medicine* 25 (8): 1301–9. https://doi.org/10.1038/s41591-019-0508-1.
Caulfield, Timothy. 2020. "Pseudoscience and COVID-19 — We've Had Enough Already." *Nature*, April. https://doi.org/10.1038/d41586-020-01266-z.
Cohen, Aaron M., Steven Chamberlin, Thomas Deloughery, Michelle Nguyen, Steven Bedrick, Stephen Meninger, John J. Ko, Jigar J. Amin, Alex J. Wei, and William Hersh. 2020. "Detecting Rare Diseases in Electronic Health Records Using Machine Learning and Knowledge Engineering: Case Study of Acute Hepatic Porphyria." *PloS One* 15 (7): e0235574. https://doi.org/10.1371/journal.pone.0235574.
Crabb, Brendan T., Ann Lyons, Margaret Bale, Valerie Martin, Ben Berger, Sara Mann, William B. West, et al. 2020. "Comparison of International Classification of Diseases and Related Health Problems, Tenth Revision Codes With Electronic Medical Records Among Patients With

Symptoms of Coronavirus Disease 2019." *JAMA Network Open* 3 (8): e2017703–e2017703. https://doi.org/10.1001/jamanetworkopen.2020.17703.

Cuan-Baltazar, Jose Yunam, Maria José Muñoz-Perez, Carolina Robledo-Vega, Maria Fernanda Pérez-Zepeda, and Elena Soto-Vega. 2020. "Misinformation of COVID-19 on the Internet: Infodemiology Study." *JMIR Public Health and Surveillance* 6 (2): e18444. https://doi.org/10.2196/18444.

Dabla-Norris, Era, Anne-Marie Gulde-Wolf, and Francois Painchaud. n.d. "Vietnam's Success in Containing COVID-19 Offers Roadmap for Other Developing Countries." *IMF* (blog). Accessed September 1, 2020. https://www.imf.org/en/News/Articles/2020/06/29/na062920-vietnams-success-in-containing-covid19-offers-roadmap-for-other-developing-countries.

Db, Larremore, Wilder B, Lester E, Shehata S, Burke Jm, Hay Ja, Tambe M, Mina Mj, and Parker R. 2020. "Test Sensitivity Is Secondary to Frequency and Turnaround Time for COVID-19 Screening." Science Advances. Sci Adv. November 20, 2020. https://doi.org/10.1126/sciadv.abd5393.

Desai, Sheena, Arash Mostaghimi, and Vinod E. Nambudiri. 2020. "Clinical Informatics Subspecialists: Characterizing a Novel Evolving Workforce." *Journal of the American Medical Informatics Association: JAMIA*, September. https://doi.org/10.1093/jamia/ocaa173.

Dolgin, Elie. 2020. "Core Concept: The Pandemic Is Prompting Widespread Use—and Misuse—of Real-World Data." *Proceedings of the National Academy of Sciences* 117 (45): 27754–58. https://doi.org/10.1073/pnas.2020930117.

Evanega, Sarah, Mark Lynas, Jordan Adams, and Karinne Smolenyak. 2020. "Coronavirus Misinformation: Quantifying Sources and Themes in the COVID-19 'Infodemic.'" https://allianceforscience.cornell.edu/wp-content/uploads/2020/10/Evanega-et-al-Coronavirus-misinformation-submitted_07_23_20-1.pdf.

Flanagin, Annette, Phil B. Fontanarosa, and Howard Bauchner. 2020. "Preprints Involving Medical Research-Do the Benefits Outweigh the Challenges?" *JAMA* 324 (18): 1840–43. https://doi.org/10.1001/jama.2020.20674.

Ford, Dee, Jillian B. Harvey, James McElligott, Kathryn King, Kit N. Simpson, Shawn Valenta, Emily H. Warr, et al. 2020. "Leveraging Health System Telehealth and Informatics Infrastructure to Create a Continuum of Services for COVID-19 Screening, Testing, and Treatment." *Journal of the American Medical Informatics Association: JAMIA*, June. https://doi.org/10.1093/jamia/ocaa157.

Fozouni, Parinaz, Sungmin Son, María Díaz de León Derby, Gavin J. Knott, Carley N. Gray, Michael V. D'Ambrosio, Chunyu Zhao, et al. 2020. "Amplification-Free Detection of SARS-CoV-2 with CRISPR-Cas13a and Mobile Phone Microscopy." *Cell* 0 (0). https://doi.org/10.1016/j.cell.2020.12.001.

Fraser, Nicholas, Liam Brierley, Gautam Dey, Jessica K. Polka, Máté Pálfy, and Jonathon Alexis Coates. 2020. "Preprinting a Pandemic: The Role of Preprints in the COVID-19 Pandemic." *BioRxiv*, May, 2020.05.22.111294. https://doi.org/10.1101/2020.05.22.111294.

Glasziou, Paul P., Sharon Sanders, and Tammy Hoffmann. 2020. "Waste in Covid-19 Research." *BMJ* 369 (May). https://doi.org/10.1136/bmj.m1847.

Grange, Elisha S., Eric J. Neil, Michelle Stoffel, Angad P. Singh, Ethan Tseng, Kelly Resco-Summers, B. Jane Fellner, et al. 2020. "Responding to COVID-19: The UW Medicine Information Technology Services Experience." *Applied Clinical Informatics* 11 (2): 265–75. https://doi.org/10.1055/s-0040-1709715.

Greenhalgh, Trisha, Matthew Knight, Christine A'Court, Maria Buxton, and Laiba Husain. 2020. "Management of Post-Acute Covid-19 in Primary Care." *BMJ* 370 (August). https://doi.org/10.1136/bmj.m3026.

Gupta, Shruti, Salim S. Hayek, Wei Wang, Lili Chan, Kusum S. Mathews, Michal L. Melamed, Samantha K. Brenner, et al. 2020. "Factors Associated With Death in Critically Ill Patients With Coronavirus Disease 2019 in the US." *JAMA Internal Medicine*, July. https://doi.org/10.1001/jamainternmed.2020.3596.

Haendel, Melissa, Christopher Chute, and Kenneth Gersing. 2020. "The National COVID Cohort Collaborative (N3C): Rationale, Design, Infrastructure, and Deployment." *Journal of the American Medical Informatics Association*. https://doi.org/10.1093/jamia/ocaa196.

Havers, Fiona P., Carrie Reed, Travis Lim, Joel M. Montgomery, John D. Klena, Aron J. Hall, Alicia M. Fry, et al. 2020. "Seroprevalence of Antibodies to SARS-CoV-2 in 10 Sites in the United States, March 23-May 12, 2020." *JAMA Internal Medicine*, July. https://doi.org/10.1001/jamainternmed.2020.4130.

Herper, Matthew. 2020. "Data Show Panic, Disorganization Dominate the Study of Covid-19 Drugs." *STAT* (blog). July 6, 2020. https://www.statnews.com/2020/07/06/data-show-panic-and-disorganization-dominate-the-study-of-covid-19-drugs/.

Hsu, Hanson, Peter W. Greenwald, Matthew R. Laghezza, Peter Steel, Richard Trepp, and Rahul Sharma. 2020. "Clinical Informatics during the COVID-19 Pandemic: Lessons Learned and Implications for Emergency Department and Inpatient Operations." *Journal of the American Medical Informatics Association: JAMIA*, November. https://doi.org/10.1093/jamia/ocaa311.

Jain, Snigdha, Rohan Khera, Zhenqiu Lin, Joseph S. Ross, and Harlan M. Krumholz. 2020. "Availability of Telemedicine Services Across Hospitals in the United States in 2018: A Cross-Sectional Study." *Annals of Internal Medicine*, April. https://doi.org/10.7326/M20-1201.

Jefferies, Sarah, Nigel French, Charlotte Gilkison, Giles Graham, Virginia Hope, Jonathan Marshall, Caroline McElnay, et al. 2020. "COVID-19 in New Zealand and the Impact of the National Response: A Descriptive Epidemiological Study." *The Lancet Public Health* 5 (11): e612–23. https://doi.org/10.1016/S2468-2667(20)30225-5.

Joshi, Ashish, Fnu Kajal, Soumitra S. Bhuyan, Priya Sharma, Ashruti Bhatt, Kanishk Kumar, Mahima Kaur, and Arushi Arora. 2020. "Quality of Novel Coronavirus Related Health Information over the Internet: An Evaluation Study." Research Article. The Scientific World Journal. Hindawi. August 6, 2020. https://doi.org/10.1155/2020/1562028.

Kakani, Pragya, Amitabh Chandra, Sendhil Mullainathan, and Ziad Obermeyer. 2020. "Allocation of COVID-19 Relief Funding to Disproportionately Black Counties." *JAMA*, August. https://doi.org/10.1001/jama.2020.14978.

Kane, Carol K., and Kurt Gillis. 2018. "The Use Of Telemedicine By Physicians: Still The Exception Rather Than The Rule." *Health Affairs (Project Hope)* 37 (12): 1923–30. https://doi.org/10.1377/hlthaff.2018.05077.

Kannampallil, Thomas G., Randi E. Foraker, Albert M. Lai, Keith F. Woeltje, and Philip R. O. Payne. 2020. "When Past Is Not a Prologue: Adapting Informatics Practice during a Pandemic." *Journal of the American Medical Informatics Association: JAMIA* 27 (7): 1142–46. https://doi.org/10.1093/jamia/ocaa073.

Keesara, Sirina, Andrea Jonas, and Kevin Schulman. 2020. "Covid-19 and Health Care's Digital Revolution." *New England Journal of Medicine* 382 (23): e82. https://doi.org/10.1056/NEJMp2005835.

Laguarta, J., F. Hueto, and B. Subirana. 2020. "COVID-19 Artificial Intelligence Diagnosis Using Only Cough Recordings." *IEEE Open Journal of Engineering in Medicine and Biology*, 1–1. https://doi.org/10.1109/OJEMB.2020.3026928.

Lam, Kenneth, Amy D. Lu, Ying Shi, and Kenneth E. Covinsky. 2020. "Assessing Telemedicine Unreadiness Among Older Adults in the United States During the COVID-19 Pandemic." *JAMA Internal Medicine* 180 (10): 1389–91. https://doi.org/10.1001/jamainternmed.2020.2671.

Larremore, Daniel B., Bryan Wilder, Evan Lester, Soraya Shehata, James M. Burke, James A. Hay, Milind Tambe, Michael J. Mina, and Roy Parker. 2020. "Test Sensitivity Is Secondary to Frequency and Turnaround Time for COVID-19 Screening." *Science Advances*, November. https://doi.org/10.1126/sciadv.abd5393.

Lenert, Leslie, and Brooke Yeager McSwain. 2020. "Balancing Health Privacy, Health Information Exchange, and Research in the Context of the COVID-19 Pandemic." *Journal of the American Medical Informatics Association* 27 (6): 963–66. https://doi.org/10.1093/jamia/ocaa039.

Lenzer, Jeanne, and Shannon Brownlee. 2020. "Pandemic Science Out of Control | Issues in Science and Technology." April 28, 2020. https://issues.org/pandemic-science-out-of-control/.

Liang, Wenhua, Hengrui Liang, Limin Ou, Binfeng Chen, Ailan Chen, Caichen Li, Yimin Li, et al. 2020. "Development and Validation of a Clinical Risk Score to Predict the Occurrence of Critical Illness in Hospitalized Patients With COVID-19." *JAMA Internal Medicine* 180 (8): 1081–89. https://doi.org/10.1001/jamainternmed.2020.2033.

Lowe, Derek. 2020. "AI, Machine Learning and the Pandemic." In the Pipeline. July 23, 2020. https://blogs.sciencemag.org/pipeline/archives/2020/07/23/ai-machine-learning-and-the-pandemic.

Majumder, Maimuna S., and Kenneth D. Mandl. 2020. "Early in the Epidemic: Impact of Preprints on Global Discourse about COVID-19 Transmissibility." *The Lancet Global Health* 8 (5): e627–30. https://doi.org/10.1016/S2214-109X(20)30113-3.

Mandel, Joshua C., David A. Kreda, Kenneth D. Mandl, Isaac S. Kohane, and Rachel B. Ramoni. 2016. "SMART on FHIR: A Standards-Based, Interoperable Apps Platform for Electronic Health Records." *Journal of the American Medical Informatics Association: JAMIA* 23 (5): 899–908. https://doi.org/10.1093/jamia/ocv189.

Mann, Devin M., Ji Chen, Rumi Chunara, Paul A. Testa, and Oded Nov. 2020. "COVID-19 Transforms Health Care through Telemedicine: Evidence from the Field." *Journal of the American Medical Informatics Association* 27 (7): 1132–35. https://doi.org/10.1093/jamia/ocaa072.

Meyer, Robinson, and Alexis Madrigal. 2020. "The Plan That Could Give Us Our Lives Back." *The Atlantic*, August 14, 2020. https://www.theatlantic.com/health/archive/2020/08/how-to-test-every-american-for-covid-19-every-day/615217/?fbclid=IwAR0NBulrfq5a5nIaLUEEoKMNehNql4Dp6m_co82Kd8SWaLmiYZOHbGIZjHc.

Mina, Michael J., Roy Parker, and Daniel B. Larremore. 2020. "Rethinking Covid-19 Test Sensitivity — A Strategy for Containment." *New England Journal of Medicine*, September. https://doi.org/10.1056/NEJMp2025631.

Mishra, Tejaswini, Meng Wang, Ahmed A. Metwally, Gireesh K. Bogu, Andrew W. Brooks, Amir Bahmani, Arash Alavi, et al. 2020. "Pre-Symptomatic Detection of COVID-19 from Smartwatch Data." *Nature Biomedical Engineering*, November, 1–13. https://doi.org/10.1038/s41551-020-00640-6.

Mj, Mina, Parker R, and Larremore Db. 2020. "Rethinking Covid-19 Test Sensitivity - A Strategy for Containment." The New England Journal of Medicine. N Engl J Med. November 26, 2020. https://doi.org/10.1056/NEJMp2025631.

National Academies of Sciences, Engineering. 2018. *Open Science by Design: Realizing a Vision for 21st Century Research*. https://doi.org/10.17226/25116.

Neil, Stuart J.D., and Edward M. Campbell. 2020. "Fake Science: XMRV, COVID-19, and the Toxic Legacy of Dr. Judy Mikovits." *AIDS Research and Human Retroviruses* 36 (7): 545–49. https://doi.org/10.1089/aid.2020.0095.

Nishimura, Yasutoshi. 2020. "Opinion | How Japan Beat Coronavirus Without Lockdowns." *Wall Street Journal*, July 7, 2020, sec. Opinion. https://www.wsj.com/articles/how-japan-beat-coronavirus-without-lockdowns-11594163172.

Quer, Giorgio, Jennifer M. Radin, Matteo Gadaleta, Katie Baca-Motes, Lauren Ariniello, Edward Ramos, Vik Kheterpal, Eric J. Topol, and Steven R. Steinhubl. 2020. "Wearable Sensor Data and Self-Reported Symptoms for COVID-19 Detection." *Nature Medicine*, October. https://doi.org/10.1038/s41591-020-1123-x.

Rae, Matthew, Cynthia Cox, and Gary Claxton. 2020. "Coverage and Utilization of Telemedicine Services by Enrollees in Large Employer Plans." *Peterson-KFF Health System Tracker* (blog). March 3, 2020. https://www.healthsystemtracker.org/brief/coverage-and-utilization-of-telemedicine-services-by-enrollees-in-large-employer-plans/.

Rajkomar, Alvin, Anjuli Kannan, Kai Chen, Laura Vardoulakis, Katherine Chou, Claire Cui, and Jeffrey Dean. 2019. "Automatically Charting Symptoms From Patient-Physician Conversations Using Machine Learning." *JAMA Internal Medicine* 179 (6): 836–38. https://doi.org/10.1001/jamainternmed.2018.8558.

Rajkomar, Alvin, Eyal Oren, Kai Chen, Andrew M. Dai, Nissan Hajaj, Michaela Hardt, Peter J. Liu, et al. 2018. "Scalable and Accurate Deep Learning with Electronic Health Records." *Npj Digital Medicine* 1 (1): 1–10. https://doi.org/10.1038/s41746-018-0029-1.

Razzaghi, Hilda. 2020. "Estimated County-Level Prevalence of Selected Underlying Medical Conditions Associated with Increased Risk for Severe COVID-19 Illness — United States, 2018." *MMWR. Morbidity and Mortality Weekly Report* 69. https://doi.org/10.15585/mmwr.mm6929a1.

Reeves, J. Jeffery, Hannah M. Hollandsworth, Francesca J. Torriani, Randy Taplitz, Shira Abeles, Ming Tai-Seale, Marlene Millen, Brian J. Clay, and Christopher A. Longhurst. 2020. "Rapid Response to COVID-19: Health Informatics Support for Outbreak Management in an Academic Health System." *Journal of the American Medical Informatics Association: JAMIA* 27 (6): 853–59. https://doi.org/10.1093/jamia/ocaa037.

"Retracted Coronavirus (COVID-19) Papers." 2020. *Retraction Watch* (blog). April 29, 2020. https://retractionwatch.com/retracted-coronavirus-covid-19-papers/.

Rosenthal, Marjorie S. 2020. "The New Language of Telehealth." *The New York Times*, May 5, 2020, sec. Well. https://www.nytimes.com/2020/05/05/well/live/doctors-patients-mother-baby-pediatrics-telemedicine-computers.html.

Schünemann, Holger J., Nancy Santesso, Gunn E. Vist, Carlos Cuello, Tamara Lotfi, Signe Flottorp, Marina Davoli, et al. 2020. "Using GRADE in Situations of Emergencies and Urgencies: Certainty in Evidence and Recommendations Matters during the COVID-19 Pandemic, Now More than Ever and No Matter What." *Journal of Clinical Epidemiology*, June. https://doi.org/10.1016/j.jclinepi.2020.05.030.

Sittig, Dean F., and Hardeep Singh. 2020. "COVID-19 and the Need for a National Health Information Technology Infrastructure." *JAMA* 323 (23): 2373–74. https://doi.org/10.1001/jama.2020.7239.

Subash, Meera, Matthew Sakumoto, Jeremy Bass, Peter Hong, Anoop Muniyappa, Logan Pierce, Colin Purmal, et al. 2020. "The Emerging Role of Clinical Informatics Fellows in Service Learning during the COVID-19 Pandemic." *Journal of the American Medical Informatics Association: JAMIA*, November. https://doi.org/10.1093/jamia/ocaa241.

"Survey: Physician Practice Patterns Changing as a Result of COVID-19 | Merritt Hawkins." n.d. Accessed August 20, 2020. https://www.merritthawkins.com/news-and-insights/media-room/press/-Physician-Practice-Patterns-Changing-as-a-Result-of-COVID-19/.

Tartof, Sara Y., Lei Qian, Vennis Hong, Rong Wei, Ron F. Nadjafi, Heidi Fischer, Zhuoxin Li, et al. 2020. "Obesity and Mortality Among Patients Diagnosed With COVID-19: Results From an Integrated Health Care Organization." *Annals of Internal Medicine*, August. https://doi.org/10.7326/M20-3742.

Totten, Annette M., Dana M. Womack, Karen B. Eden, Marian S. McDonagh, Jessica C. Griffin, Sara Grusing, and William R. Hersh. 2016. *Telehealth: Mapping the Evidence for Patient Outcomes From Systematic Reviews*. AHRQ Comparative Effectiveness Technical Briefs. Rockville (MD): Agency for Healthcare Research and Quality (US). http://www.ncbi.nlm.nih.gov/books/NBK379320/.

Tufekci, Zeynep. n.d. "The Pandemic Heroes Who Gave Us the Gift of Time and Gift of Information." *Insight* (blog). Accessed December 2, 2020. https://zeynep.substack.com/p/the-pandemic-heroes-who-gave-us-the.

Verma, Seema. 2020. "Early Impact Of CMS Expansion Of Medicare Telehealth During COVID-19 | Health Affairs." July 15, 2020. https://www.healthaffairs.org/do/10.1377/hblog20200715.454789/full/.

Wang, C. Jason, Chun Y. Ng, and Robert H. Brook. 2020. "Response to COVID-19 in Taiwan: Big Data Analytics, New Technology, and Proactive Testing." *JAMA*, March. https://doi.org/10.1001/jama.2020.3151.

Williamson, Elizabeth J., Alex J. Walker, Krishnan Bhaskaran, Seb Bacon, Chris Bates, Caroline E. Morton, Helen J. Curtis, et al. 2020. "Factors Associated with COVID-19-Related Death Using OpenSAFELY." *Nature* 584 (7821): 430–36. https://doi.org/10.1038/s41586-020-2521-4.

Wu, Fan, Su Zhao, Bin Yu, Yan-Mei Chen, Wen Wang, Zhi-Gang Song, Yi Hu, et al. 2020. "A New Coronavirus Associated with Human Respiratory Disease in China." *Nature* 579 (7798): 265–69. https://doi.org/10.1038/s41586-020-2008-3.

Yakusheva, Olga, Eline van den Broek-Altenburg, Gayle Brekke, and Adam Atherly. 2020. "The Cure Is Not Worse than the Disease - A Humanitarian Perspective." SSRN Scholarly Paper. June 6, 2020. https://papers.ssrn.com/abstract=3638575.

Impact of COVID-19 on Digital Health and Health Informatics

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Agenda

- Informatics and digital health
  - Before COVID-19
  - During COVID-19
    - Health systems responses
    - Data collection
    - Telemedicine and telehealth
    - Other digital health applications
    - Pandemic science
    - Informatics workforce
  - After COVID-19

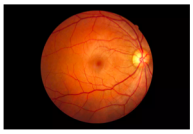
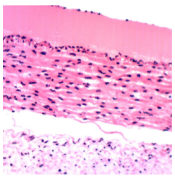
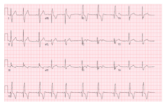
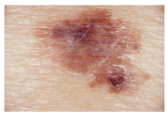
Informatics before COVID-19

- "Hot" areas included
  - Machine learning and artificial intelligence
  - Data standards and interoperability
  - Open science

3

Machine learning and artificial intelligence (AI)

- Most success in imaging (Liu, 2019), but others as well
- Predicting length of stay, mortality, readmission, and diagnosis at two large medical centers (Rajkomar, 2018)
- Aid pathologist exclude 65–75% of slides viewed while retaining 100% sensitivity (Campanella, 2019)
- Automated capture of physician-patient dialogue in exam room (Rajmokar, 2019)
  - Get keyboard (not computer) out of exam room?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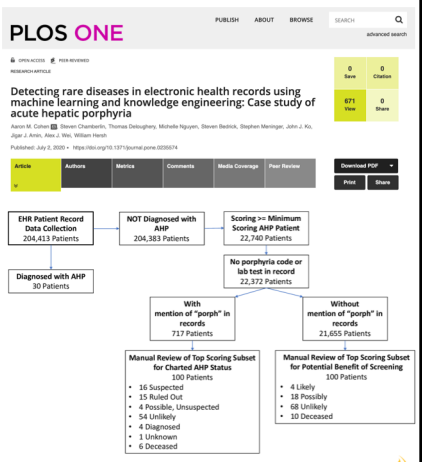
Many other uses for ML/AI

- Detection of rare diseases – often underdiagnosed
- Acute hepatic porphyria
  - Incidence 1/100,000
  - Typical 8-12 years to diagnosis
  - Defect in ALAS1 gene
  - Existing treatments available but RNAi drug givosiran more efficacious (Balwani, 2020)
- Applied ML to extract of 200K patients from OHSU (Cohen, 2020)
  - Identified 22 possible patients without diagnosis to explain symptoms
- Currently undertaking clinical investigation



Data standards and interoperability – 21st Century Cures Rule

- https://www.healthit.gov/curesrule
- SMART on FHIR standard – substitutable apps based on common data store (Mandel, 2016)
- Prohibits "information blocking"

Open science: good and bad

- Internet facilitates open science (National Academies, 2018), e.g.,
  - Open-access publishing
  - Preprint servers
  - Access to data for reproducibility and further analysis
- Facilitated sequencing and vaccine development for SARS-CoV-2 (Tufecki, 2020; Wu, 2020)
- With some complications
  - Predatory publishing (Beall, 2018)

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Health system responses to COVID-19

- UC San Diego (Reeves, 2020)
- University of Washington (Grange, 2020)
- Medical University of South Carolina (Ford, 2020)
- Washington University (Kannampallil, 2020)
- NewYork-Presbyterian Hospital/Weill Cornell Medical Center (Hsu, 2020)

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Informatics lessons learned (Hsu, 2020)

- Hospital leaders can use clinical informatics to
  - Aid clinical decision-making
  - Virtualize medical care
  - Coordinate communication
  - Defining workflow and compliance
- Recommendations
  - Create flexible order sets that adapt to evolving guidelines and meet needs across specialties
  - Enhance and support telemedicine
  - Electronically enable novel workflows quickly
  - Suspend non-critical administrative or billing functions in EHR
  - Use communication platforms based on tiered urgency that do not compromise security and privacy

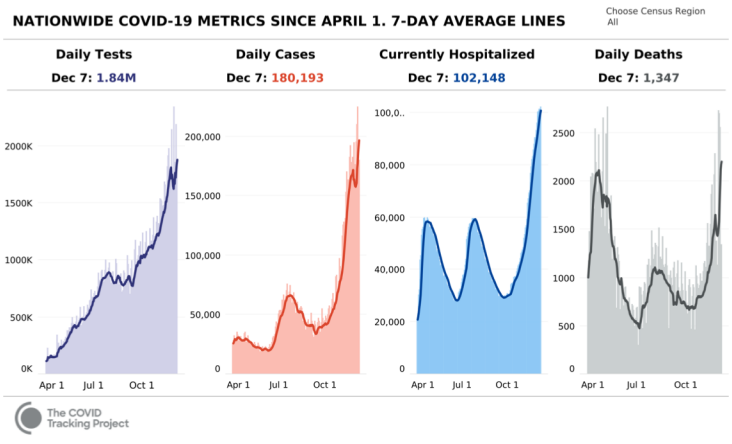
Countries that have done well

- Taiwan (Wang, 2020)
- New Zealand (Baker, 2020; Jeffries, 2020)
- Thailand (Bello, 2020)
- Vietnam (Dabla-Morris, 2020)
- Japan (Nishimura, 2020)

Taiwan (Wang, 2020)

- Recognition
  - Activation of National Health Command Center (NHCC)
- Management
  - Border control from air and sea
  - Case identification – using new data and technology
  - Quarantine of suspicious cases
  - Proactive case finding
  - Resource allocation – assessing and managing capacity
  - Reassurance and education of the public while fighting misinformation
  - Negotiation with other countries and regions
  - Formulation of policies toward schools and childcare
  - Relief to businesses
- Communications
  - When and where to wear a mask
  - Importance of handwashing
  - Danger of hoarding masks to prevent them from becoming unavailable to frontline health workers
- (Article supplement details all steps)

Meanwhile in the US



https://covidtracking.com/data/charts/us-all-key-metrics

Some key sources of data

- Johns Hopkins University Center for Systems Science and Engineering
  - https://coronavirus.jhu.edu/map.html
- University of Washington Institute for Health Metrics and Evaluation
  - https://covid19.healthdata.org/
- COVID Tracking Project
  - https://covidtracking.com/
- Our World in Data
  - https://ourworldindata.org/coronavirus
- Outbreak.info
  - https://outbreak.info/
- 91-DIVOC visualization
  - https://91-divoc.com/
- COVID Exit Strategy
  - https://www.covidexitstrategy.org/
- Oregon Health Authority
  - https://public.tableau.com/profile/oregon.health.authority.covid.19#!/
- COVID-19 Trial Finder (from ClinicalTrials.gov)
  - https://covidtrialx.dbmi.columbia.edu/dquest-flask/

Some key information resources

- US Government
  - https://www.coronavirus.gov/
  - https://www.nih.gov/coronavirus/
  - https://www.ncbi.nlm.nih.gov/sars-cov-2/
- American College of Physicians
  - https://www.acponline.org/clinical-information/clinical-resources-products/coronavirus-disease-2019-covid-19-information-for-internists
- American Medical Association
  - https://www.ama-assn.org/delivering-care/public-health/covid-19-2019-novel-coronavirus-resource-center-physicians
- Harvard Medical Student Curriculum
  - https://curriculum.covidstudentresponse.org/

Sources of evidence

- Prevent Epidemics Weekly Science Review
  - https://preventepidemics.org/covid19/science/weekly-science-review/
- McMaster Key Evidence Sources
  - https://www.mcmasterforum.org/networks/covid-end/resources-to-support-decision-makers/guide-to-key-covid-19-evidence-sources
- VA Evidence Synthesis Program
  - https://www.covid19reviews.org/
- World Health Organization
  - https://www.who.int/emergencies/diseases/novel-coronavirus-2019

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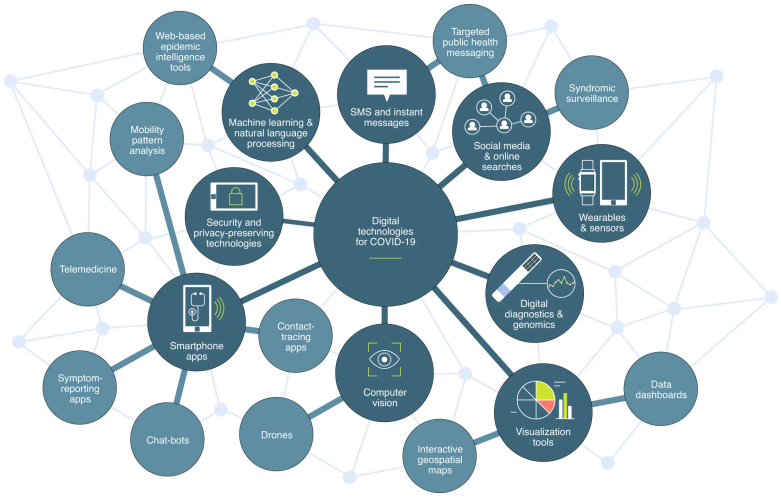
Many roles for "digital health" in COVID-19 (Budd, 2020)



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Informatics considerations

- Reiterate need for national health IT infrastructure (Sittig, 2020; Keesara, 2020)
- Balancing
  - Privacy vs. access (Lenert, 2020)
  - Speed vs. need for evidence (Schünemann, 2020)
- Role of AI?
  - Small so far with limited data and experience (Andoni, 2020, Lowe, 2020; Benaich, 2020)

Coding systems need updating

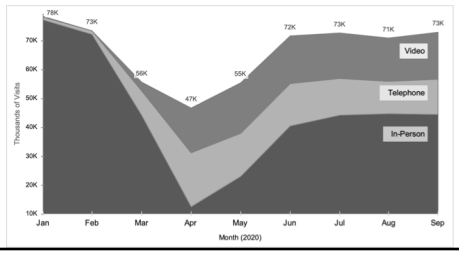
- Existing coding systems (e.g., ICD-10-CM) of limited value in a new disease (Crabb, 2020)
- Emergency use ICD codes for COVID-19 disease outbreak
  - https://www.who.int/classifications/icd/covid19/en/
  - U07.1 COVID-19, virus identified
  - U07.2 COVID-19, virus not identified
- New CPT-4 codes
  - https://www.ama-assn.org/press-center/press-releases/ama-announces-new-cpt-codes-covid-19-advancements-expand
  - 99072 – Additional supplies, materials, and clinical staff time over and above those usually included in an office visit or other non-facility service(s), when performed during a Public Health Emergency as defined by law, due to respiratory-transmitted infectious disease
  - 86413 – Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (Coronavirus disease [COVID-19]) antibody, quantitative

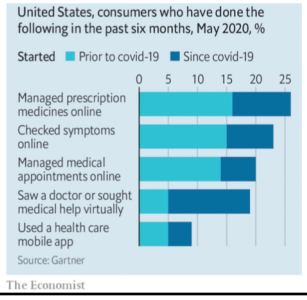
Telemedicine and telehealth

- Prior to COVID-19, moderate availability and niche use
  - Evidence base prior to COVID-19 (Totten, 2020)
- In 2018, accounted for 2.4% of all healthcare claims (encounters) (Rae, 2020)
- Hospitals use (Jain, 2020)
  - Any use – 47.6%
  - Intensive care unit – 26.8%
- Physician use (Kane, 2018)
  - Physician-to-patient – 15.4% overall, highest among radiology, psychiatry, pathology
  - Physician-to-physician – 11.2% overall, highest in pathology, emergency medicine, radiology

Telemedicine and COVID-19

- CMS allowed telemedicine for all Medicare visits; other insurers followed (Verma, 2020)
- Leading to rapid uptake
  - Massive increase, especially for non-urgent care (Mann, 2020; Bosworth, 2020)
  - 48% of physicians now using (Merritt Hawkins, 2020)
  - Including at OHSU





More telemedicine

- 11-fold increase in use in nursing homes (Alexander, 2020)
- Reduced assessment of blood pressure and lipid measurements in primary care (Alexander, 2020)
- Unreadiness for telemedicine more prevalent in patients who were older, male, Black or Hispanic, rural, and had lower education, income, and self-reported health (Lam, 2020)
- From the popular press
  - Communication with patients (Rosenthal, 2020)
  - A benefit to and beyond the pandemic (Brody, 2020)

US federal response

- CMS – Section 1135 Waiver expands telehealth services to allow (and will continue during public health emergency)
  - Service to Medicare beneficiaries regardless of patient location — including at the patient's home
  - Consultation via telephone without the requirement of video conferencing
  - Service to patients with whom the provider does not have a pre-existing relationship
  - Treatment by a physician or health care professional in another state so long as they have an equivalent license from another state and subject to any state law requirements that may apply
  - Application to any service without regard to the treatment or diagnosis of the patient, not just for COVID-19
- HIPAA – Covered health care providers may provide telehealth services by utilizing popular video chat applications including Apple FaceTime, Facebook Messenger video chat, Zoom, or Skype to provide telehealth services

Other applications of digital health

- Cough recordings for diagnosis – 98% sensitivity, 94% specificity (Laguarta, 2020)
- Pre-symptomatic detection from highly elevated heart rate from smartwatch data (Mishra, 2020)
- Diagnosis via smartwatch and activity tracker data with self-reported symptoms (Quer, 2020)
- Frequent, rapid, and low-cost testing (Mina, 2020; Larremore, 2020)
- SARS-CoV-2 detection with CRISPR-Cas13a and mobile phone (Fozouni, 2020)

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Research data collections

- US-based – National COVID Cohort Collaborative (N3C; Haendel, 2020)
  - https://covid.cd2h.org/
  - https://ncats.nih.gov/n3c
- International
  - Consortium for Clinical Characterization of COVID-19 by EHR (4CE; Brat, 2020)
    - https://covidclinical.net/
  - OpenSAFELY – UK-based collection of 24M primary care patient records from National Health Service (Williamson, 2020)
    - https://opensafely.org/
- COVID-19 Data Index
  - https://www.covid19dataindex.org/

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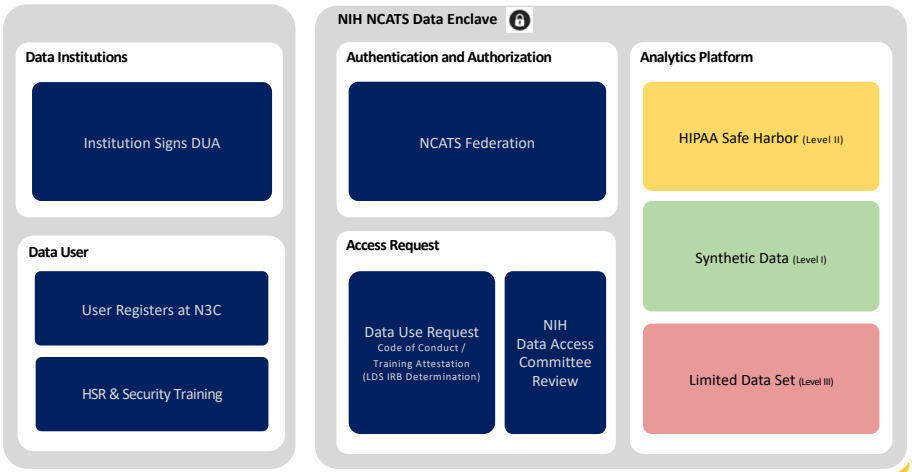
National COVID Cohort Collaborative (N3C)



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Challenges for science in a pandemic

- Modern communications have led to
  - "Toxic legacy of poor-quality research, media hype, lax regulatory oversight, and vicious partisanship" (Lenzer, 2020)
  - Proliferation of pseudoscience (Caulfield, 2020) and conspiracy theories (Allen, 2020; Neil, 2020)
  - Misuse of real-world data (Dolgin, 2020)
  - One-third of media mentions of misinformation associated with President (Evanega, 2020)
- Exacerbated by some advances in open science, such as preprints (Majumder, 2020; Fraser, 2020; Flanagin, 2020)
- Growing list of retracted papers (Retraction Watch, 2020; Bramstedt, 2020)
- Variable information quality of Web sites
  - Few meeting known quality indicators (Cuan-Baltazar, 2020)
  - Better for .org and .edu than .com sites (Joshi, 2020)

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Solutions for science in a pandemic

- Eliminate “waste and duplication” (Glasziou, 2020) in studies of drugs
- Preserve clinical trial integrity (McDermott, 2020)
- Rapidly progress from observational studies to RCTs (Califf, 2020)
- Beware of biases in the data – lower revenues of hospitals serving the underserved (Kakani, 2020)
- From WHO: data-driven decision-making and coordination in use (Azzopardi-Muscat, 2020)

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Informatics after COVID-19

- Back to the “hot” areas?
  - Machine learning – determine implementation and efficacy in real-world settings
  - Data standards – achieving the vision of SMART on FHIR and AllOfUs
    - https://allofus.nih.gov/
    - https://www.researchallofus.org/
  - Better science and use of data – reckoning with misinformation, especially on social media, and attention to biases in data

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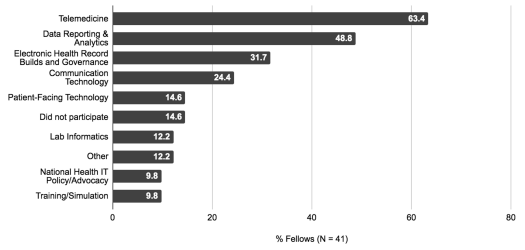
Including the important role for clinical informatics subspecialists

- Many roles played in response to COVID-19 (Subash, 2020)



- Including opportunities at OHSU
  - http://www.ohsu.edu/informatics

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Thank You!

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