UC San Diego

CENTER FOR HEALTHCARE CYBERSECURITY

Research Approach and Current Bibliography

The UC San Diego Center for Healthcare Cybersecurity is building a multidisciplinary, data-driven research program focused multiple key areas in the healthcare cybersecurity domain. By combining the deep clinical knowledge of practicing physicians with the technical expertise of computer science faculty, the Center can conceptualize, design, and execute impactful projects which address relevant questions and produce data that can be used to guide operational decision making and resource allocation.

We seek to enhance the cybersecurity resiliency and preparedness of critical health infrastructure to ensure patient safety. Our work aims to support the technologies, interventions and policies that will protect the "target rich, cyber poor" rural and critical access hospitals which, when disrupted by ransomware and other cybersecurity threats, may fail to provide the care needed by vulnerable populations already at risk for geographic and resource induced healthcare disparities.

Current research initiatives include:

- Developing best practices for the secure deployment and maintenance of cloud infrastructure in healthcare operational workflows
- Identifying critical patient safety impacts in the setting of ransomware attacks, and developing clinically oriented incident response plans
- Discovering methodologies for rapid identification of hospitals affected by ransomware relying on passive, publicly available signals
- Designing rapidly deployable emergency downtime technology platforms that can restore patient safety and business continuity functionality while augmenting paper workflows
- Creating rigorously constructed controlled trials which validate the impact of commonly accepted cybersecurity pratices like phishing training and multifactor authentication
- Developing and validating didactic curricula for both health science students and computer science students to develop both a healthcare-engaged technical workforce and cybersecurity literate clinician population
- Performing medical device cybersecurity research, including penetration testing and vulnerability analysis as well as research focused on software bill of materials evaluations, low energy trustworthy resource constrained computing systems for next generation secure by design medical devices, and regulatory and market based functional projects

UC San Diego

CENTER FOR HEALTHCARE CYBERSECURITY

- Assessing economic and operational impacts of proposed healthcare cybersecurity regulation and policy, particularly devising cost estimates for commonly recommended minimum cybersecurity standards or controls
- Developing simulated environments and exercises for both the deployment and subsequent evaluation of platforms and devices as well as clinical training of cybersecurity concepts and practices

Selected Healthcare Cybersecurity Research Bibliography

C Dameff, J Selzer, J Fisher, J Killeen, J Tully. Clinical Cybersecurity Training Through Novel High-Fidelity Simulations. J Emerg Med. 2018 Dec 12. pii: S0736-4679(18)31055-2. doi: 10.1016/j.jemermed.2018.10.029.

J Tully, M Jarrett, S Savage, J Corman, C Dameff. Digital Defenses for Hacked Hearts: Why Software Patching Can Save Lives. Journal of the American College of Cardiology. 2018 July 3. https://doi.org/10.106/j.jacc.2018.03.540 PMID: 29957225.

M Goebel, C Dameff, J Tully. Hacking 9-1-1: Infrastructure Vulnerabilities and Attack Vectors. J Med Internet Res. 2019 Jul 9;21(7):e14383. doi: 10.2196/14383. PMID: 31290401

C Dameff, M Pfeffer, C Longhurst. Cybersecurity implications for hospital quality. Health Serv Res. 2019 10; 54(5):969-970. PMID: 31506957

C Dameff, J Farah, J Killeen, T Chan. Cyber Disaster Medicine: A New Frontier for Emergency Medicine. Ann Emerg Med. 2020 05; 75(5):642-647. PMID: 31959537.

J Tully, A Coravos, M Doerr, C, Dameff. Connected Medical Technology and Cybersecurity Informed Consent: A New Paradigm. J Med Internet Res. 2020;22(3):e17612. DOI: 10.2196/17612. PMID: 32224492.

J Tully, J Selzer, J Phillips, P O'Connor, C Dameff. Healthcare Challenges in the Era of Cybersecurity. *Health Secur*. 2020 May/Jun; 18(3)228-231. Doi:10.1089/hs.2019.0123. PMID: 32559153.

L Maggio, C Dameff, S Kanter, B Woods, J Tully. Cybersecurity Challenges and the Academic Health Center: An Interactive Tabletop Simulation for Executives. *Acad Med* 2021. Nov 24. doi: 10.1097/ACM.0000000000003859. PMID: 33239532.

N Sullivan, J Tully, C Dameff, C Opara, M Snead, J Selzer. A National Survey of Hospital Cyber Attack Emergency Operation Preparedness. *Disaster Med Public Health Prep.* 2023. Mar 22;17:e363. doi:10.1017/dmp.2022.283. PMID:36945857

C Dameff, J Tully, T Chan, E Castillo, S Savage, P Maysent, T Hemmen, B Clay, C Longhurst. Ransomware Attack Associated With Disruptions at Adjacent Emergency Departments in the US. *JAMA Network Open*. 2023. May 8;6(5):e2312280 doi:10.1001/jamanetworkopen.2023.12270 PMID:37155166

Peer Reviewed Manuscripts Published After Center Formation October 2023

UC San Diego

CENTER FOR HEALTHCARE CYBERSECURITY

L van Boven, R Kusters, D Tin, F van Osch, H De Cauwer, L Ketelings, M Rao, C Dameff, D Barten. Hacking Acute Care: A Qualitative Study on the Health Care Impacts of Ransomware Attacks Against Hospitals. Ann Emerg Med. 2024 Jan; 83(1):46-56. PMID: 37318433.

T Pham, T Loo, A Malhotra, C Longhurst, D Hylton, C Dameff, J Tully, G Wardi, R Sell, A Pearce. Ransomware Cyberattack Associated with Cardiac Arrest Incidence and Outcomes at Untargeted, Adjacent Hospitals. *Crit Care Explor.* 2024. PMID: 38605720

H Neprash, C Dameff, J Tully. Cybersecurity Lessons From the Change Healthcare Attack. *JAMA Int. Med* 2024 Sept 9 doi:10.1001/jamainternmed.2024.3162

G Ho, A Mirian, E Luo, K Tong, E Lee, L Liu, C Longhurst, C Dameff, S Savage, G Voelker. Understanding the Efficacy of Phishing Training in Practice. IEEE Symposium on Security and Privacy. 2024

M Frieden, I Straw, N Kahl, N Yung, G Madden, C Dameff, J Tully. Cybersecurity Preparedness and Resiliency in a Family Medicine Clinic. *Family Practice Management*. 2025 In press.

J Tully, R Gabriel, R Waterman, C Dameff. Digital Disasters – The Growing Threat of Healthcare Ransomware. *Anesthesiology*. 2025 In press.