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The Long-Term Effects of COVID-19 on Firefighter Health

Presenters:

Dr. Denise Smith, Skidmore College
Dr. Sara Jahnke, Center for Fire, Rescue and EMS Health Research
Dr. Steven Moffatt, Ascension St. Vincent Public Safety Medical
Fire Chief (Ret.) Craig Haigh, Hanover Park Fire Department

January 27, 2022

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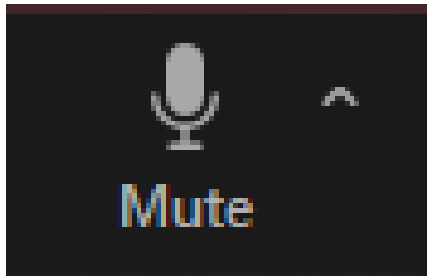

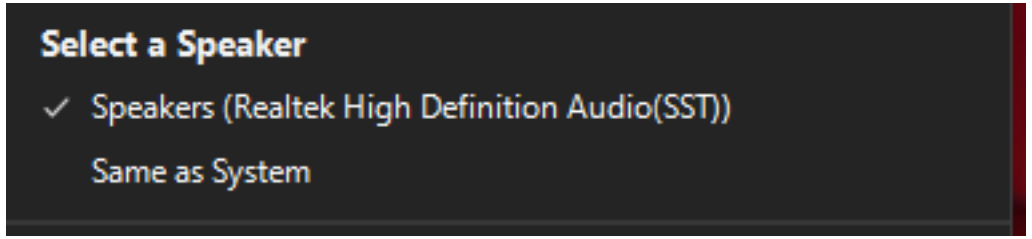

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This research was sponsored by:

U.S. DHS FEMA Assistance to Firefighters Grant

Dr. Denise Smith, Skidmore College

Dr. Smith is Tisch distinguished professor, professor for health and human physiological sciences department, and director of first responder health and safety laboratory at Skidmore College in Saratoga Springs, NY. Dr. Smith earned her Ph.D. in Kinesiology with a specialization in Exercise Physiology from the University of Illinois at Urbana-Champaign in 1990. Her research is focused on the physiological effects of firefighting, particularly the cardiovascular strain associated with the combination of heavy physical work, heat stress, and the psychological stress that firefighters routinely encounter. She is the Principal Investigator on an AFG project titled “Continuing Fight Against COVID (C-FACT)” aimed at understanding the challenges of COVID-Long in the Fire Service.

Dr. Sara Jahnke, Center for Fire, Rescue and EMS Health Research

Dr. Jahnke is the Director and Senior Principal Investigator of the Center for Fire, Rescue and EMS Health Research at the National Development and Research Institutes, Inc. Dr. Jahnke has served as the Principal Investigator of several large-scale studies of the health and readiness of the US Fire Service funded by the Department of Homeland Security, the National Institutes of Health, and the American Heart Association. Current projects include studies focused on the health of women in the fire service, research on workplace violence, exposure assessments on the fire ground, and randomized controlled trials of wellness interventions. She serves as a co-investigator of several other studies focused on fitness, nutrition, and health behaviors in both firefighters and military populations.

Dr. Steven Moffatt, Ascension St. Vincent Public Safety Medical

Dr. Steven Moffatt is the founder of Public Safety Medical, an occupational medical practice based in Indianapolis, Indiana. Public Safety Medical provides hundreds of fire and law enforcement departments across Indiana and the bordering states with specialized medical, fitness, and psychological evaluations and interventions. Dr. Moffatt is a highly regarded medical subject matter expert for public safety professions. He is a pioneer in the development of standards for medical surveillance programs for firefighters, law enforcement officers, and other first responders. Dr. Moffatt serves on national boards including the International Association of Chiefs of Police, the IAFF/IAFC Wellness-Fitness Task Force, the National Fire Protection Association, and the National Institute for Occupational Safety and Health. In 2015, Dr. Moffatt formed the National Institute for Public Safety Health, a private non-profit research center specializing in investigations to improve the health and wellness of firefighters and law enforcement officers.

Craig Haigh, Fire Chief Ret., Hanover Park Fire Department

Craig A. Haigh began his fire service career in 1983 as a volunteer in his hometown of Hampton, IL. In 1988 he joined the City of Rock Island (IL) Fire Department as fulltime firefighter and was ultimately appointed as their first EMS Coordinator where he developed and implemented the department's paramedic program. He served as Hampton's volunteer fire chief from 1991 to 1995, where he developed and implemented their Intermediate/Advanced EMT program. From 1995, he served as the fire chief of the King (NC) Volunteer Fire Department and then returned to Illinois in 2002 to serve as Fire Chief/Director of Emergency Management for the Village of Hanover Park. He was the 2012 Illinois Career Fire Chief of the Year. Chief Haigh also works as a Field Staff Instructor with the University of Illinois Fire Service Institute (IFSI). He is the recipient of the 2019 International Association of Fire Chiefs – Chief Alan Brunacini Executive Safety Award given for his work in developing operational practices based on scientific research in an effort to reduce firefighter deaths and injuries due to cardiovascular/medical events. Chief Haigh retired in July 2021 from full-time service as a firefighter and now serves as a consultant focusing on management and organizational leadership. Chief Haigh is a nationally certified paramedic, an accredited Chief Fire Officer, and a Member of the Institute of Fire Engineers.

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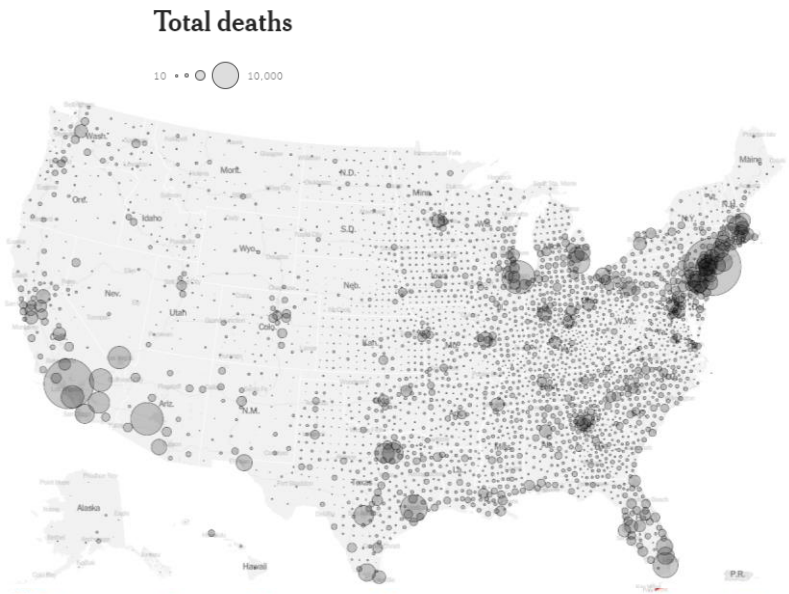
Here we go…

COVID LONG & Continuing the Fight Against COVID-19 Together (C-FACT)

Denise Smith, Ph.D., Skidmore College

COVID-19 Pandemic

- **Global burden**
  - 314.9M cases
  - 4.5M deaths
- **US burden**
  - 63.4M cases
  - 863,896 deaths



Data as of 1/12/2022
Worldometers.info

COVID-19 Pandemic

Burden among firefighter community

Total Public Safety Officers = 1,111

Fire:

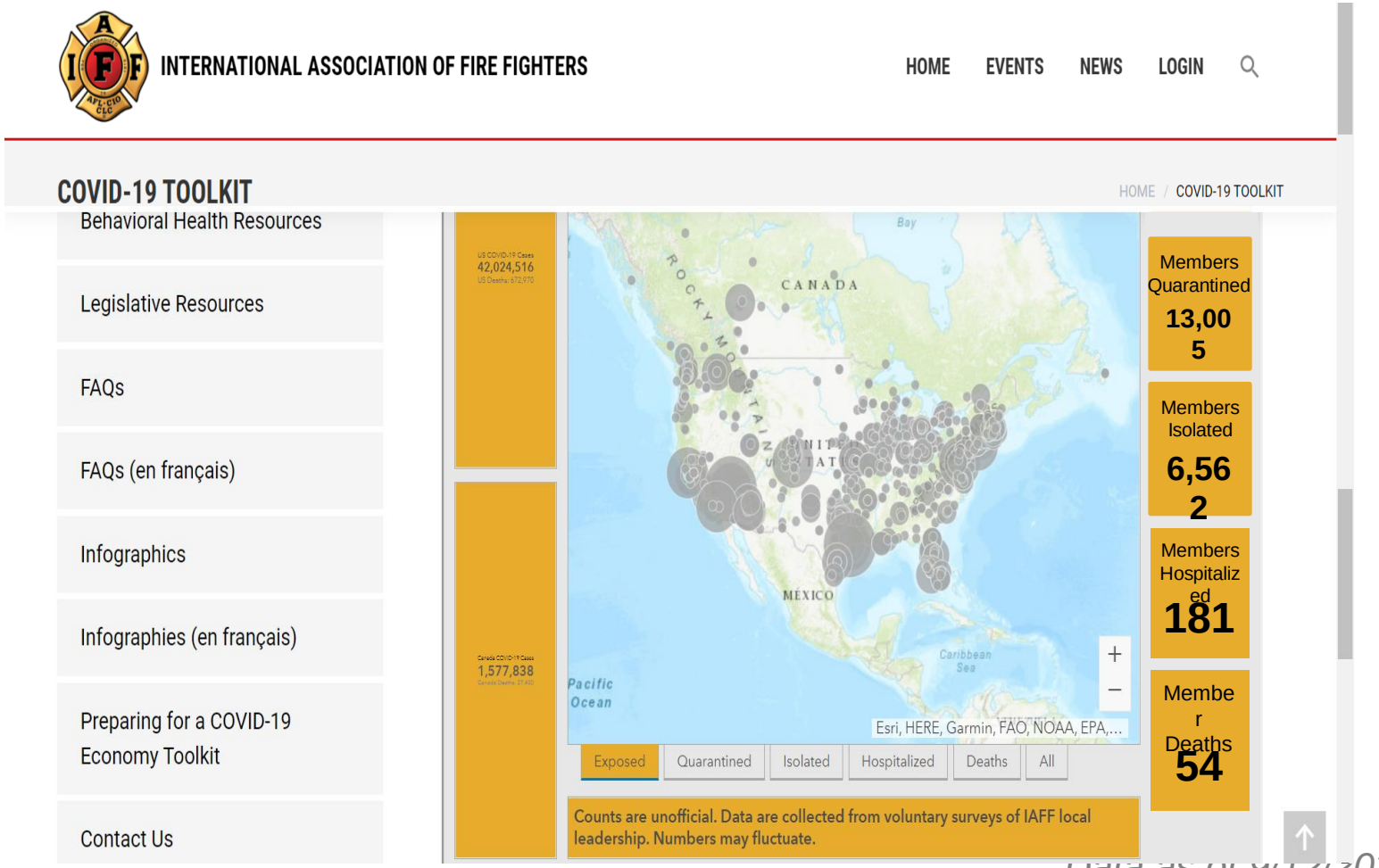
244 total

2020= 86

2021 to-date= 156

Take Care. Be Careful. Pass It On.
BillyG

Data as of 1/12/22



Data as of 9/12/2021


Ray Vaughn
FDNY

Description

COVID-19 has been characterized by a long list of symptoms of varying severity and the potential for said symptoms to linger indefinitely. While exercise has been widely used to bolster one's health across various conditions, there has understandably been less clarity regarding its application across individuals recovering from a COVID-19 infection. **While many individuals are able to quickly return to performing large volumes of activity, a subgroup continues to experience persistent fatigue, breathlessness, brain fog and exercise malaise, seemingly eliminating the possibility of returning to or adopting an active lifestyle.** Although there is still much to learn about effectively individualizing the exercise prescription, this webinar will review current strategies and considerations for prescribing exercise to those in the post COVID-19-infection phase.

Learning Objectives

1.Understand how to characterize the severity of post COVID-19-infection symptoms.
2.Have an understanding of tests that can be used to identify long-COVID-19 symptoms.
3.Understand the considerations for developing an exercise prescription relative to the individual's COVID-19 infection severity.
4.Have an understanding of how to guide an individual with severe long-COVID-19 symptoms through pacing.

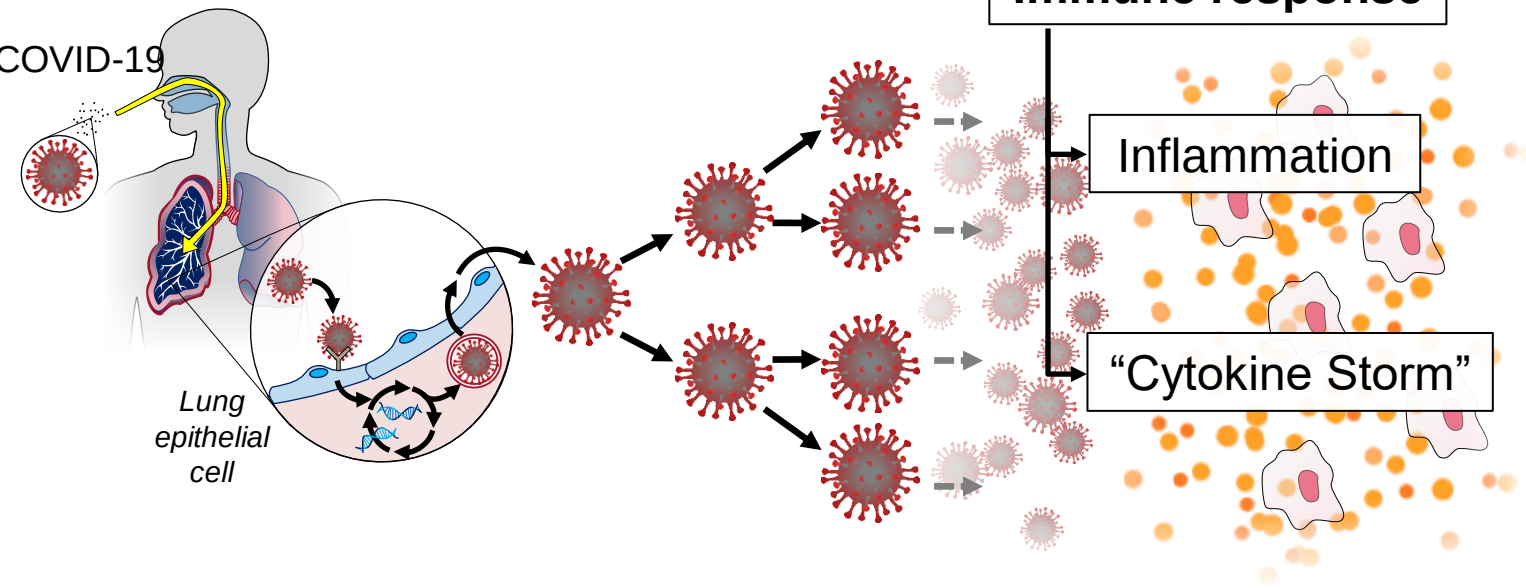
COVID-19 Pandemic
Burden among firefighter community

- ↑Risk of COVID-19 contact/spread
  - Routinely engages with community
  - Live/work/eat in group living quarters
- Infection/Illness
  - Cases? – impaired health, work schedule//disability
  - 244 deaths

Cardiac	Vascular	Blood/Coagulatory
↑ Heart rate ↑ Cardiac work ↑ Diastolic dysfunction	↑ Arterial stiffness ↑ Blood flow ↑ Endothelial dysfunction	↓ Immune function (NK cell) ↑ Clotting potential ↑ Increased Inflammation

COVID-19 Overview

Virus infection → **Virus replication** → **Immune response** → **Acute symptoms** → **Prolonged symptoms**



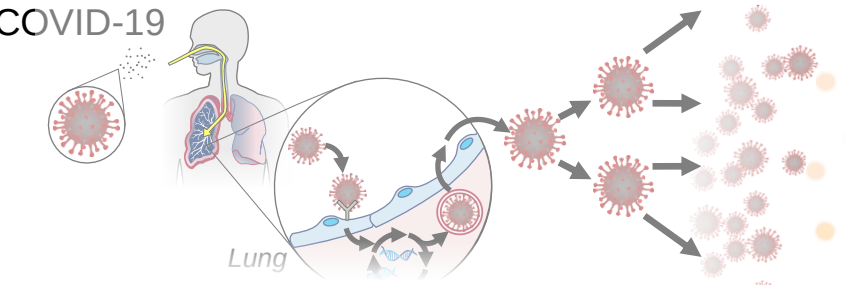
- Fever
- Dyspnea
- Fatigue
- Cough
- Headache
- Myalgia
- Sore throat
- Vomiting
- Dizziness

- “*COVID Long*”
- Wide-ranging symptoms

COVID-19 Overview

Infection → Replication → Immune response → Inflammation → "Cytokine Storm"

Replication → Acute symptoms → Prolonged symptoms



- "*COVID Long*"
- Wide-ranging symptoms

Stage 1: Mild

- COVID19 infects cells with ACE2 receptor
- **Symptoms**: fever, dry cough

Stage 2: Pulmonary

- ↑Inflammatory response, "cytokine storm"
- **Symptoms**: Shortness of breath, hypoxia

Stage 3: Hyperinflammation

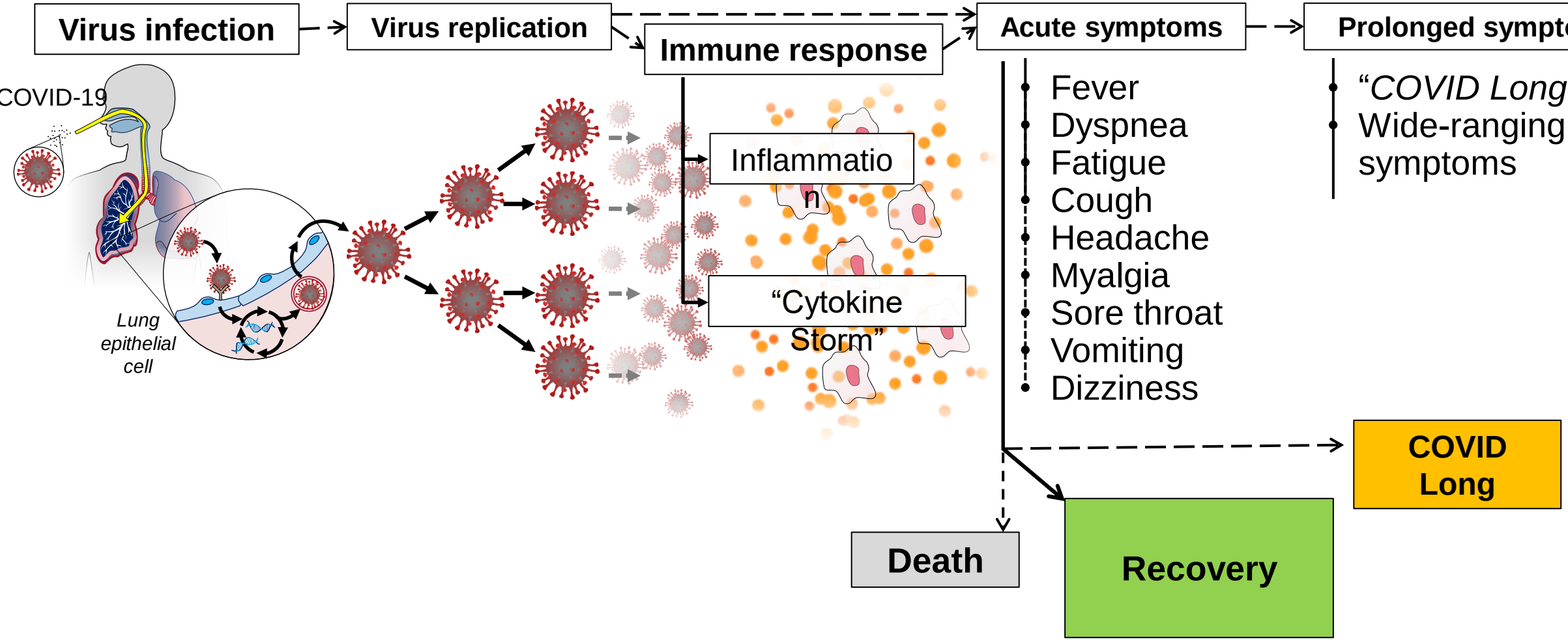
- Severe inflammatory response
- **Symptoms**: Acute respiratory distress, systemic inflammatory response, multi-organ failure

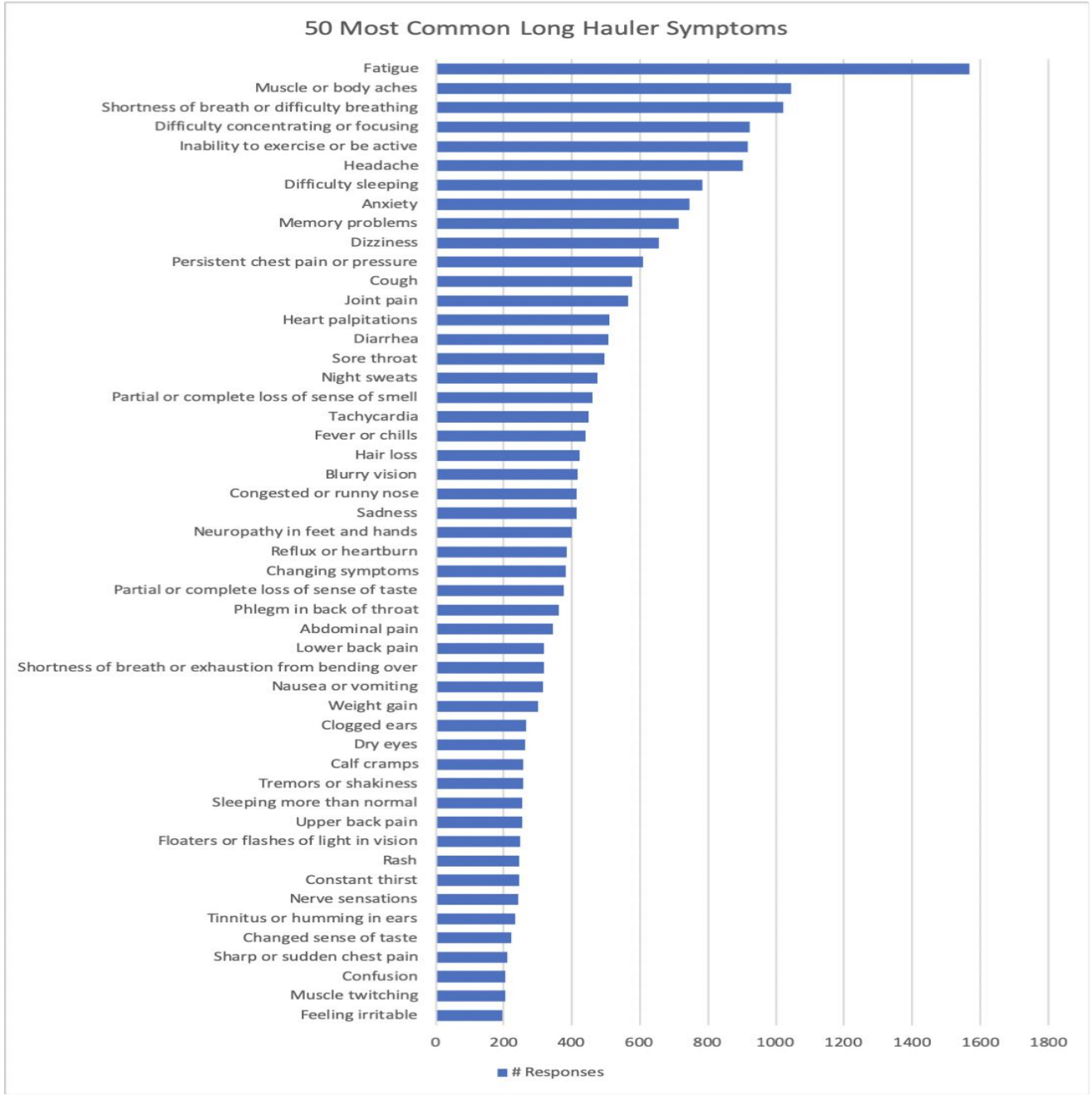
Predictors of severity

- **Healthy lifestyle/diet**
- **Therapeutic success**
- **Early diagnosis**
- **Vaccination status**

- **Viral load (Delta variant/vaccination)**
- **Older age**
- ***Cardiovascular disease***
- **Obesity, Type 2 diabetes**
- **Inflammation/inflammatory conditions**
- ***Endothelial dysfunction***
- **Other**

COVID-19 Overview

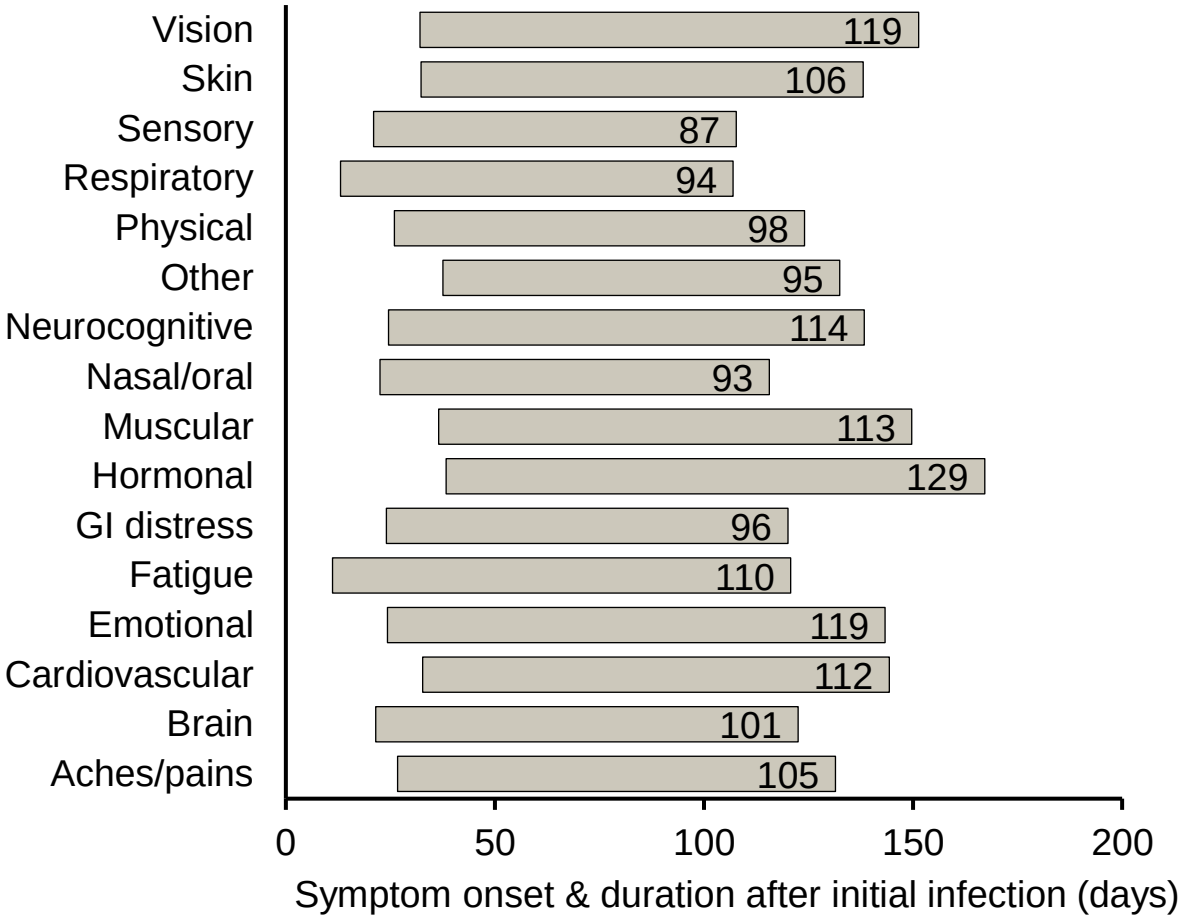




Lambert 2020. Survivor Corps

Long-term Consequence of COVID-19

-COVID Long: symptom onset and duration



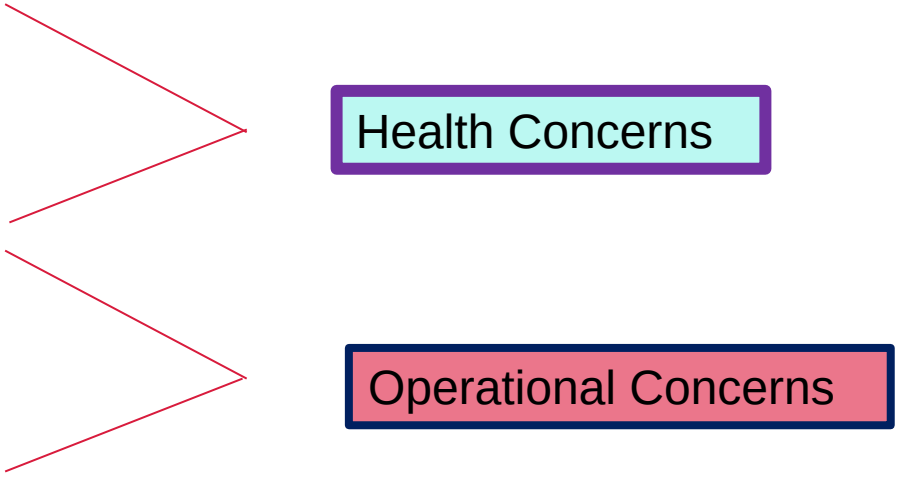
Lambert et al 2021, *COVID-19 Survivors' Reports of the Timing, Duration, and Health Impacts of Post-Acute Sequelae of SARS-CoV-2 (PASC) Infection*

C-FACT

Continuing the Fight Against COVID-19 Together

Critical Need for Fire Service Input

- Watch for and complete survey requests – and act as an influencer to encourage others to do so
- Share your stories, or encourage firefighters to share stories, about COVID-Long
  - Range of symptoms
  - Difficulty with RTW process
  - Challenges when returning
  - Concerns about staffing
  - Concerns about responses



C-FACT Continuing the Fight Against COVID-19 Together

Critical Need for Fire Service Input

- Share your stories, or encourage firefighters to share stories, about COVID-Long

……dsmith@skidmore.edu

- Initial COVID – how severe
- Long-term Symptoms – describe severity and length
- Treatments – indicate who provided care, diagnoses, treatments
- Concerns about RTW
- Specific Fire Service Concerns

Covid Long by the Numbers

Sara Jahnke, Ph.D.

Director & Senior Scientist

Why??? Working Hypotheses

1. May harbor virus in an organ(s)
2. Viral pieces may stick around in the body
3. COVID causes an autoimmune type response where the body attacks itself

(Iwasaki, 2021)

https://elemental.medium.com/how-vaccines-might-improve-long-covid-c1f41c4d7378

Covid Long

- Estimates of Covid Long between 10-30%, pre-vaccine data (Lambert et al., 2021; Rubin, 2020)
- Meta-analysis (primarily hospitalized) 72.5% had persistent symptoms

JAMA Network Open

Original Investigation | Infectious Diseases

Assessment of the Frequency and Variety of Persistent Symptoms Among Patients With COVID-19
A Systematic Review

Tahmina Nasserie, MPH; Michael Hittle, BS; Steven N. Goodman, MD, MHS, PhD

Abstract

IMPORTANCE Infection with COVID-19 has been associated with long-term symptoms, but the frequency, variety, and severity of these complications are not well understood. Many published commentaries have proposed plans for pandemic control that are primarily based on mortality rates among older individuals without considering long-term morbidity among individuals of all ages. Reliable estimates of such morbidity are important for patient care, prognosis, and development of public health policy.

OBJECTIVE To conduct a systematic review of studies examining the frequency and variety of persistent symptoms after COVID-19 infection.

EVIDENCE REVIEW A search of PubMed and Web of Science was conducted to identify studies published from January 1, 2020, to March 11, 2021, that examined persistent symptoms after COVID-19 infection. Persistent symptoms were defined as those persisting for at least 60 days after diagnosis, symptom onset, or hospitalization or at least 30 days after recovery from the acute illness or hospital discharge. Search terms included *COVID-19*, *SARS-CoV-2*, *coronavirus*, *2019-nCoV*, *long-term*, *after recovery*, *long-haul*, *persistent*, *outcome*, *symptom*, *follow-up*, and *longitudinal*. All English-language articles that presented primary data from cohort studies that reported the prevalence of persistent symptoms among individuals with SARS-CoV-2 infection and that had clearly defined and sufficient follow-up were included. Case reports, case series, and studies that described symptoms only at the time of infection and/or hospitalization were excluded. A structured framework was applied to appraise study quality.

FINDINGS A total of 1974 records were identified; of those, 1247 article titles and abstracts were screened. After removal of duplicates and exclusions, 92 full-text articles were assessed for eligibility; 47 studies were deemed eligible, and 45 studies reporting 84 clinical signs or symptoms were included in the systematic review. Of 9751 total participants, 5266 (54.0%) were male; 30 of 45 studies reported mean or median ages younger than 60 years. Among 16 studies, most of which comprised participants who were previously hospitalized, the median proportion of individuals experiencing at least 1 persistent symptom was 72.5% (interquartile range [IQR], 55.0%-80.0%). Individual symptoms occurring most frequently included shortness of breath or dyspnea (26 studies; median frequency, 36.0%; IQR, 27.6%-50.0%), fatigue or exhaustion (25 studies; median frequency, 40.0%; IQR, 31.0%-57.0%), and sleep disorders or insomnia (8 studies; median 29.4%, IQR, 24.4%-33.0%). There were wide variations in the design and quality of the studies, which had implications for interpretation and often limited direct comparability and combinability. Major design differences included patient populations, definitions of time zero (ie, the beginning of the follow-up interval), follow-up lengths, and outcome definitions, including definitions of illness severity.

(continued)

Key Points

Question What are the frequency and variety of persistent symptoms after COVID-19 infection?

Findings In this systematic review of 45 studies including 9751 participants with COVID-19, the median proportion of individuals who experienced at least 1 persistent symptom was 73%; symptoms occurring most frequently included shortness of breath or dyspnea, fatigue or exhaustion, and sleep disorders or insomnia. However, the studies were highly heterogeneous and needed longer follow-up and more standardized designs.

Meaning This systematic review found that COVID-19 symptoms commonly persisted beyond the acute phase of infection, with implications for health-associated functioning and quality of life; however, methodological improvements are needed to reliably quantify these risks.

+ Supplemental content

Author affiliations and article information are listed at the end of this article.

JAMA Network Open. 2021;4(5):e2111417. doi:10.1001/jamanetworkopen.2021.11417 May 26, 2021 1/19

Exhaustion

- 71.4% of patients with Long Covid report chronic fatigue
- Post-exertional symptom exacerbation affected most participants
- 58.7% met the scoring threshold that classifies patients as suffering from chronic fatigue syndrome.

Twomey et al. (2022)

Brain, Behavior, and Immunity 101 (2022) 93–135

Contents lists available at ScienceDirect

Brain Behavior and Immunity

journal homepage: www.elsevier.com/locate/ybrbi

Review Article

Fatigue and cognitive impairment in Post-COVID-19 Syndrome: A systematic review and meta-analysis

Felicia Ceban [a,b], Susan Ling [a,d], Leanna M.W. Lui [a], Yena Lee [a,c], Hartej Gill [a], Kayla M. Teopiz [a], Nelson B. Rodrigues [a], Mehala Subramaniapillai [a], Joshua D. Di Vincenzo [a,d], Bing Cao [e], Kangguang Lin [f,g], Rodrigo B. Mansur [a,h], Roger C. Ho [i,j], Joshua D. Rosenblat [a,d,h], Kamilla W. Miskowiak [k,l], Maj Vinberg [m,n], Vladimir Maletic [o], Roger S. McIntyre [a,b,c,d,h,*]

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ARTICLE INFO

Keywords:
Long COVID
Post-COVID-19 syndrome
Post-COVID-19 condition
Brain fog
Cognitive impairment
Fatigue
Inflammation
Functional outcomes
Population health
Depression
Cognition
Bipolar
COVID-19
Immunology
Mental illness
Anhedonia
Brain

ABSTRACT

Importance: COVID-19 is associated with clinically significant symptoms despite resolution of the acute infection (i.e., post-COVID-19 syndrome). Fatigue and cognitive impairment are amongst the most common and debilitating symptoms of post-COVID-19 syndrome.
Objective: To quantify the proportion of individuals experiencing fatigue and cognitive impairment 12 or more weeks following COVID-19 diagnosis, and to characterize the inflammatory correlates and functional consequences of post-COVID-19 syndrome.
Data sources: Systematic searches were conducted without language restrictions from database inception to June 8, 2021 on PubMed/MEDLINE, The Cochrane Library, PsycInfo, Embase, Web of Science, Google/Google Scholar, and select reference lists.
Study selection: Primary research articles which evaluated individuals at least 12 weeks after confirmed COVID-19 diagnosis and specifically reported on fatigue, cognitive impairment, inflammatory parameters, and/or functional outcomes were selected.
Data extraction & synthesis: Two reviewers independently extracted published summary data and assessed methodological quality and risk of bias. A meta-analysis of proportions was conducted to pool Freeman-Tukey double arcsine transformed proportions using the random-effects restricted maximum-likelihood model.
Main outcomes & measures: The co-primary outcomes were the proportions of individuals reporting fatigue and cognitive impairment, respectively, 12 or more weeks following COVID-19 infection. The secondary outcomes were inflammatory correlates and functional consequences associated with post-COVID-19 syndrome.

Abbreviation: PCS, Post-COVID-19 syndrome.

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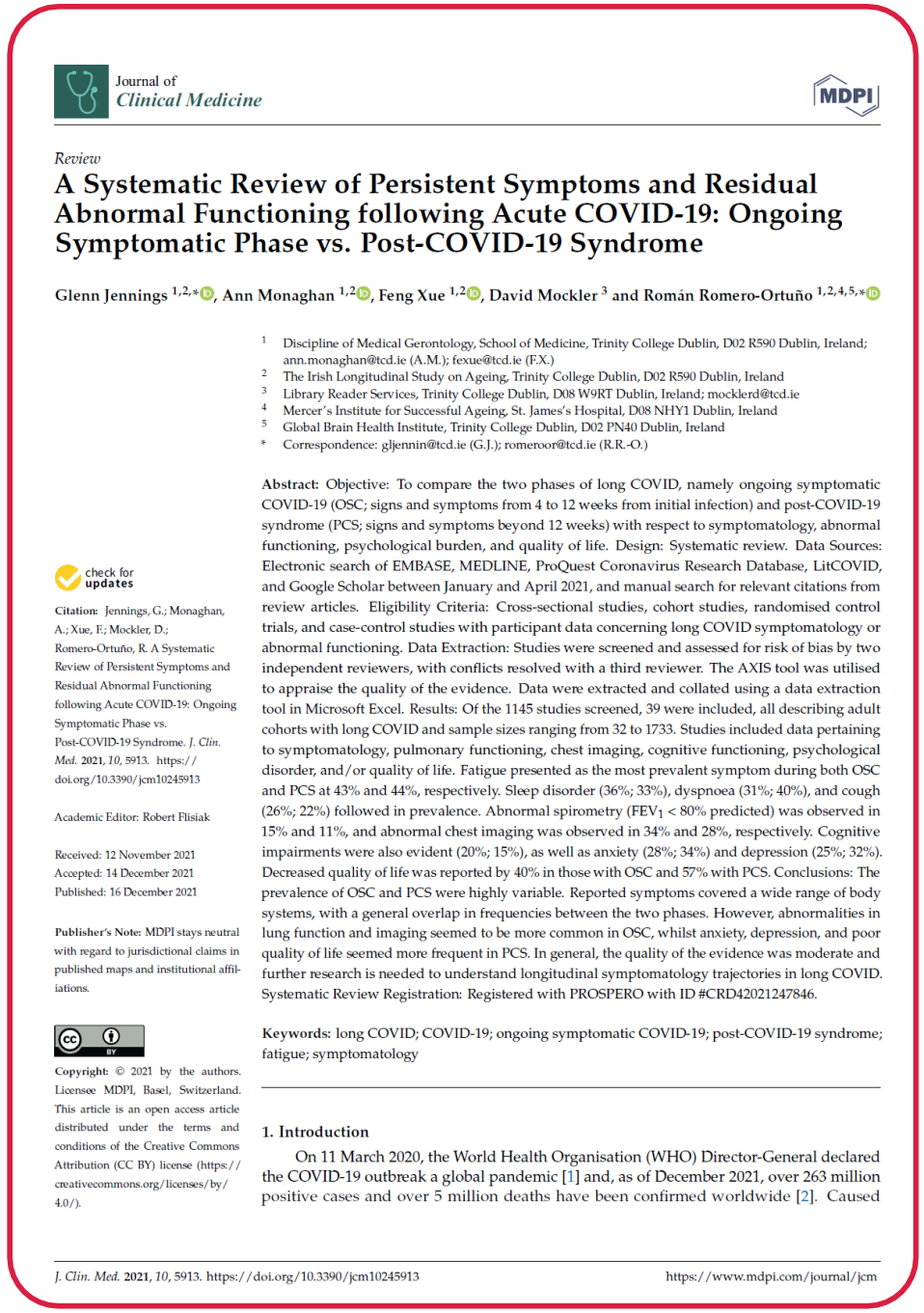
https://doi.org/10.1016/j.bbi.2021.12.020
Received 5 November 2021; Received in revised form 8 December 2021; Accepted 24 December 2021
Available online 29 December 2021

Cognitive Impairment

- Meta-analysis of 81 studies
- 1 in 3 people reported ongoing fatigue
- 1 in 5 people reported cognitive impairment



Journal of *Clinical Medicine*

MDPI

Review

A Systematic Review of Persistent Symptoms and Residual Abnormal Functioning following Acute COVID-19: Ongoing Symptomatic Phase vs. Post-COVID-19 Syndrome

Glenn Jennings [1,2,*], Ann Monaghan [1,2], Feng Xue [1,2], David Mockler [3] and Román Romero-Ortuño [1,2,4,5,*]

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Abstract: Objective: To compare the two phases of long COVID, namely ongoing symptomatic COVID-19 (OSC; signs and symptoms from 4 to 12 weeks from initial infection) and post-COVID-19 syndrome (PCS; signs and symptoms beyond 12 weeks) with respect to symptomatology, abnormal functioning, psychological burden, and quality of life. Design: Systematic review. Data Sources: Electronic search of EMBASE, MEDLINE, ProQuest Coronavirus Research Database, LitCOVID, and Google Scholar between January and April 2021, and manual search for relevant citations from review articles. Eligibility Criteria: Cross-sectional studies, cohort studies, randomised control trials, and case-control studies with participant data concerning long COVID symptomatology or abnormal functioning. Data Extraction: Studies were screened and assessed for risk of bias by two independent reviewers, with conflicts resolved with a third reviewer. The AXIS tool was utilised to appraise the quality of the evidence. Data were extracted and collated using a data extraction tool in Microsoft Excel. Results: Of the 1145 studies screened, 39 were included, all describing adult cohorts with long COVID and sample sizes ranging from 32 to 1733. Studies included data pertaining to symptomatology, pulmonary functioning, chest imaging, cognitive functioning, psychological disorder, and/or quality of life. Fatigue presented as the most prevalent symptom during both OSC and PCS at 43% and 44%, respectively. Sleep disorder (36%; 33%), dyspnoea (31%; 40%), and cough (26%; 22%) followed in prevalence. Abnormal spirometry (FEV_1 < 80% predicted) was observed in 15% and 11%, and abnormal chest imaging was observed in 34% and 28%, respectively. Cognitive impairments were also evident (20%; 15%), as well as anxiety (28%; 34%) and depression (25%; 32%). Decreased quality of life was reported by 40% in those with OSC and 57% with PCS. Conclusions: The prevalence of OSC and PCS were highly variable. Reported symptoms covered a wide range of body systems, with a general overlap in frequencies between the two phases. However, abnormalities in lung function and imaging seemed to be more common in OSC, whilst anxiety, depression, and poor quality of life seemed more frequent in PCS. In general, the quality of the evidence was moderate and further research is needed to understand longitudinal symptomatology trajectories in long COVID. Systematic Review Registration: Registered with PROSPERO with ID #CRD42021247846.

Keywords: long COVID; COVID-19; ongoing symptomatic COVID-19; post-COVID-19 syndrome; fatigue; symptomatology

check for updates

Citation: Jennings, G.; Monaghan, A.; Xue, F.; Mockler, D.; Romero-Ortuño, R. A Systematic Review of Persistent Symptoms and Residual Abnormal Functioning following Acute COVID-19: Ongoing Symptomatic Phase vs. Post-COVID-19 Syndrome. *J. Clin. Med.* **2021**, *10*, 5913. https://doi.org/10.3390/jcm10245913

Academic Editor: Robert Flisiak

Received: 12 November 2021
Accepted: 14 December 2021
Published: 16 December 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

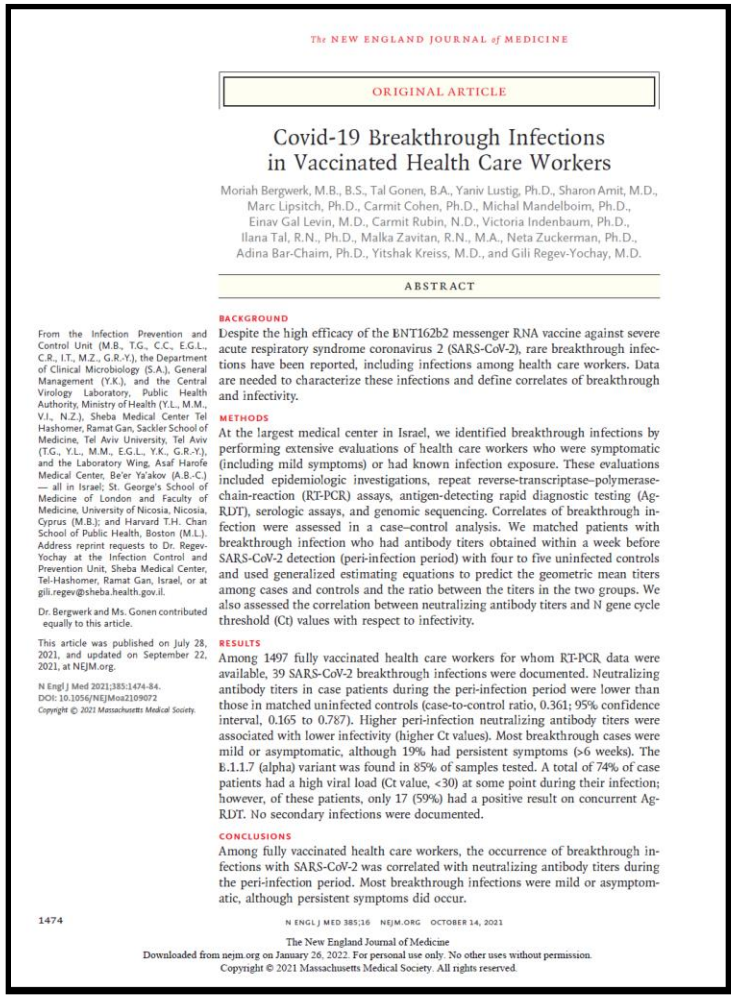
1. Introduction

On 11 March 2020, the World Health Organisation (WHO) Director-General declared the COVID-19 outbreak a global pandemic [1] and, as of December 2021, over 263 million positive cases and over 5 million deaths have been confirmed worldwide [2]. Caused

Among those with Long Covid

- 44% Fatigue
- 33% Sleep disorder
- 40% Dyspnoea
- 22% Cough
- 11% Abnormal spirometry
- 28% Abnormal chest imaging
- 15% Cognitive impairment
- 34% Anxiety
- 32% Depression
- 57% Reduced Quality of Life

Covid Long & Vaccines: Pre Delta



The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Covid-19 Breakthrough Infections in Vaccinated Health Care Workers

Moriah Bergwerk, M.B., B.S., Tal Gonen, B.A., Yaniv Lustig, Ph.D., Sharon Amit, M.D., Marc Lipsitch, Ph.D., Carmit Cohen, Ph.D., Michal Mandelboim, Ph.D., Einav Gal Levin, M.D., Carmit Rubin, N.D., Victoria Indenbaum, Ph.D., Ilana Tal, R.N., Ph.D., Malka Zavitan, R.N., M.A., Neta Zuckerman, Ph.D., Adina Bar-Chaim, Ph.D., Yitshak Kreiss, M.D., and Gili Regev-Yochay, M.D.

ABSTRACT

BACKGROUND

Despite the high efficacy of the BNT162b2 messenger RNA vaccine against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), rare breakthrough infections have been reported, including infections among health care workers. Data are needed to characterize these infections and define correlates of breakthrough and infectivity.

METHODS

At the largest medical center in Israel, we identified breakthrough infections by performing extensive evaluations of health care workers who were symptomatic (including mild symptoms) or had known infection exposure. These evaluations included epidemiologic investigations, repeat reverse-transcriptase–polymerase-chain-reaction (RT-PCR) assays, antigen-detecting rapid diagnostic testing (Ag-RDT), serologic assays, and genomic sequencing. Correlates of breakthrough infection were assessed in a case–control analysis. We matched patients with breakthrough infection who had antibody titers obtained within a week before SARS-CoV-2 detection (peri-infection period) with four to five uninfected controls and used generalized estimating equations to predict the geometric mean titers among cases and controls and the ratio between the titers in the two groups. We also assessed the correlation between neutralizing antibody titers and N gene cycle threshold (Ct) values with respect to infectivity.

RESULTS

Among 1497 fully vaccinated health care workers for whom RT-PCR data were available, 39 SARS-CoV-2 breakthrough infections were documented. Neutralizing antibody titers in case patients during the peri-infection period were lower than those in matched uninfected controls (case-to-control ratio, 0.361; 95% confidence interval, 0.165 to 0.787). Higher peri-infection neutralizing antibody titers were associated with lower infectivity (higher Ct values). Most breakthrough cases were mild or asymptomatic, although 19% had persistent symptoms (>6 weeks). The B.1.1.7 (alpha) variant was found in 85% of samples tested. A total of 74% of case patients had a high viral load (Ct value, <30) at some point during their infection; however, of these patients, only 17 (59%) had a positive result on concurrent Ag-RDT. No secondary infections were documented.

CONCLUSIONS

Among fully vaccinated health care workers, the occurrence of breakthrough infections with SARS-CoV-2 was correlated with neutralizing antibody titers during the peri-infection period. Most breakthrough infections were mild or asymptomatic, although persistent symptoms did occur.

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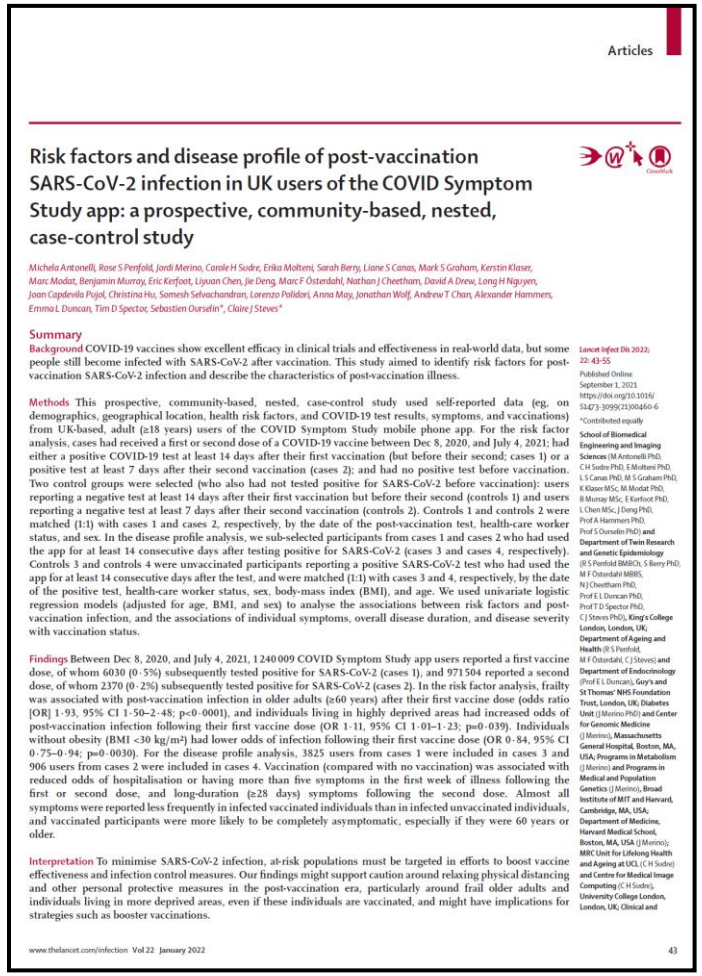
This article was published on July 28, 2021, and updated on September 22, 2021, at NEJM.org.

N Engl J Med 2021;385:1474-84.
DOI: 10.1056/NEJMoa2109072

- 1,497 vaccinated with Pfizer, 39 breakthrough cases
- Among breakthrough, 19% had Long Covid
  - Loss of smell, cough, fatigue, weakness, difficulty breathing, and/or muscle pain.
- Of total vaccinated, 0.5% developed Long Covid.

Long Covid: Vaccinated vs. Not Vaccinated



Articles

Risk factors and disease profile of post-vaccination SARS-CoV-2 infection in UK users of the COVID Symptom Study app: a prospective, community-based, nested, case-control study

Michela Antonelli, Rose S Penfold, Jordi Merino, Carole H Sudre, Erika Molteni, Sarah Berry, Liane S Canas, Mark S Graham, Kerstin Klaser, Marc Modat, Benjamin Murray, Eric Kerfoot, Liyuan Chen, Jie Deng, Marc F Österdahl, Nathan J Cheetham, David A Drew, Long H Nguyen, Joan Capdevila Pujol, Christina Hu, Somesh Selvachandran, Lorenzo Polidori, Anna May, Jonathan Wolf, Andrew T Chan, Alexander Hammers, Emma L Duncan, Tim D Spector, Sebastien Ourselin*, Claire J Steves*

Summary

Background COVID-19 vaccines show excellent efficacy in clinical trials and effectiveness in real-world data, but some people still become infected with SARS-CoV-2 after vaccination. This study aimed to identify risk factors for post-vaccination SARS-CoV-2 infection and describe the characteristics of post-vaccination illness.

Methods This prospective, community-based, nested, case-control study used self-reported data (eg, on demographics, geographical location, health risk factors, and COVID-19 test results, symptoms, and vaccinations) from UK-based, adult (≥18 years) users of the COVID Symptom Study mobile phone app. For the risk factor analysis, cases had received a first or second dose of a COVID-19 vaccine between Dec 8, 2020, and July 4, 2021; had either a positive COVID-19 test at least 14 days after their first vaccination (but before their second; cases 1) or a positive test at least 7 days after their second vaccination (cases 2); and had no positive test before vaccination. Two control groups were selected (who also had not tested positive for SARS-CoV-2 before vaccination): users reporting a negative test at least 14 days after their first vaccination but before their second (controls 1) and users reporting a negative test at least 7 days after their second vaccination (controls 2). Controls 1 and controls 2 were matched (1:1) with cases 1 and cases 2, respectively, by the date of the post-vaccination test, health-care worker status, and sex. In the disease profile analysis, we sub-selected participants from cases 1 and cases 2 who had used the app for at least 14 consecutive days after testing positive for SARS-CoV-2 (cases 3 and cases 4, respectively). Controls 3 and controls 4 were unvaccinated participants reporting a positive SARS-CoV-2 test who had used the app for at least 14 consecutive days after the test, and were matched (1:1) with cases 3 and 4, respectively, by the date of the positive test, health-care worker status, sex, body-mass index (BMI), and age. We used univariate logistic regression models (adjusted for age, BMI, and sex) to analyse the associations between risk factors and post-vaccination infection, and the associations of individual symptoms, overall disease duration, and disease severity with vaccination status.

Findings Between Dec 8, 2020, and July 4, 2021, 1 240 009 COVID Symptom Study app users reported a first vaccine dose, of whom 6030 (0·5%) subsequently tested positive for SARS-CoV-2 (cases 1), and 971 504 reported a second dose, of whom 2370 (0·2%) subsequently tested positive for SARS-CoV-2 (cases 2). In the risk factor analysis, frailty was associated with post-vaccination infection in older adults (≥60 years) after their first vaccine dose (odds ratio [OR] 1·93, 95% CI 1·50–2·48; p<0·0001), and individuals living in highly deprived areas had increased odds of post-vaccination infection following their first vaccine dose (OR 1·11, 95% CI 1·01–1·23; p=0·039). Individuals without obesity (BMI <30 kg/m²) had lower odds of infection following their first vaccine dose (OR 0·84, 95% CI 0·75–0·94; p=0·0030). For the disease profile analysis, 3825 users from cases 1 were included in cases 3 and 906 users from cases 2 were included in cases 4. Vaccination (compared with no vaccination) was associated with reduced odds of hospitalisation or having more than five symptoms in the first week of illness following the first or second dose, and long-duration (≥28 days) symptoms following the second dose. Almost all symptoms were reported less frequently in infected vaccinated individuals than in infected unvaccinated individuals, and vaccinated participants were more likely to be completely asymptomatic, especially if they were 60 years or older.

Interpretation To minimise SARS-CoV-2 infection, at-risk populations must be targeted in efforts to boost vaccine effectiveness and infection control measures. Our findings might support caution around relaxing physical distancing and other personal protective measures in the post-vaccination era, particularly around frail older adults and individuals living in more deprived areas, even if these individuals are vaccinated, and might have implications for strategies such as booster vaccinations.

Lancet Infect Dis 2022; 22: 43–55

Published Online September 1, 2021 https://doi.org/10.1016/S1473-3099(21)00460-6

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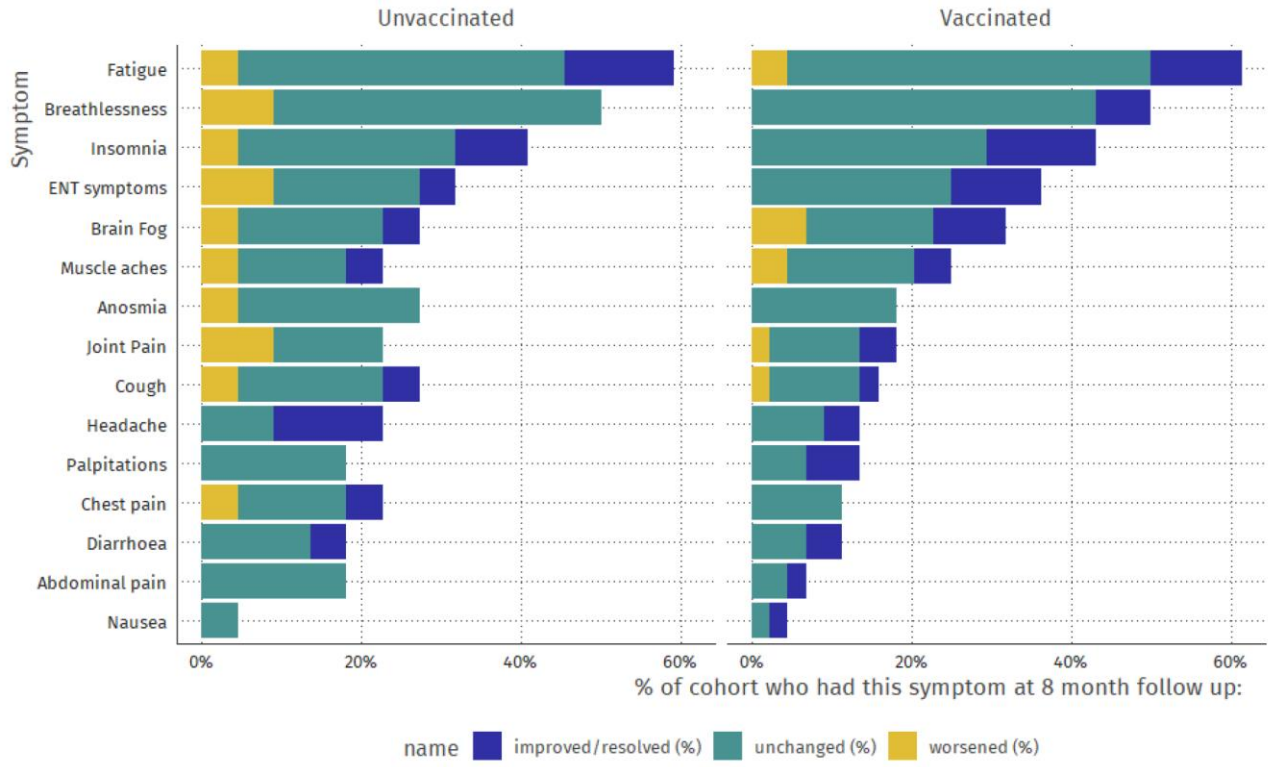
- UK, 1,240,009 adults
- Study strata
  - Unvaccinated
  - Partially vaccinated (positive test after 1st dose but before 2nd dose)
  - Fully vaccinated (positive test after dose 2).
- Rate of Long COVID
  - Partially vaccinated breakthrough (9.2%)
  - Unvaccinated (10.7%).
  - Vaccinated (5.2%)

Vaccinations Post Covid Infection

Figure 1: Symptoms at 8-month follow up with change following vaccination (or matched timepoint in unvaccinated group)



- 30% of people with Long Covid reported getting better with the vaccine
- Why?
  - Maybe the vaccine clears reservoirs in organs
  - Maybe the vaccine reprograms the autoreactive cells

RESEARCH FOUNDATION

RESEARCH FOR THE NFPA MISSION

Long COVID-19 in the Fire Service and the Occupational Medicine Perspective

Steven M. Moffatt, MD

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Background

- Occupational Health Involvement
  - COVID-19 guidelines interpretation
  - Return to work / fitness for duty / SCUBA
  - Identification of Long COVID-19 symptoms
  - Disability due to Long COVID

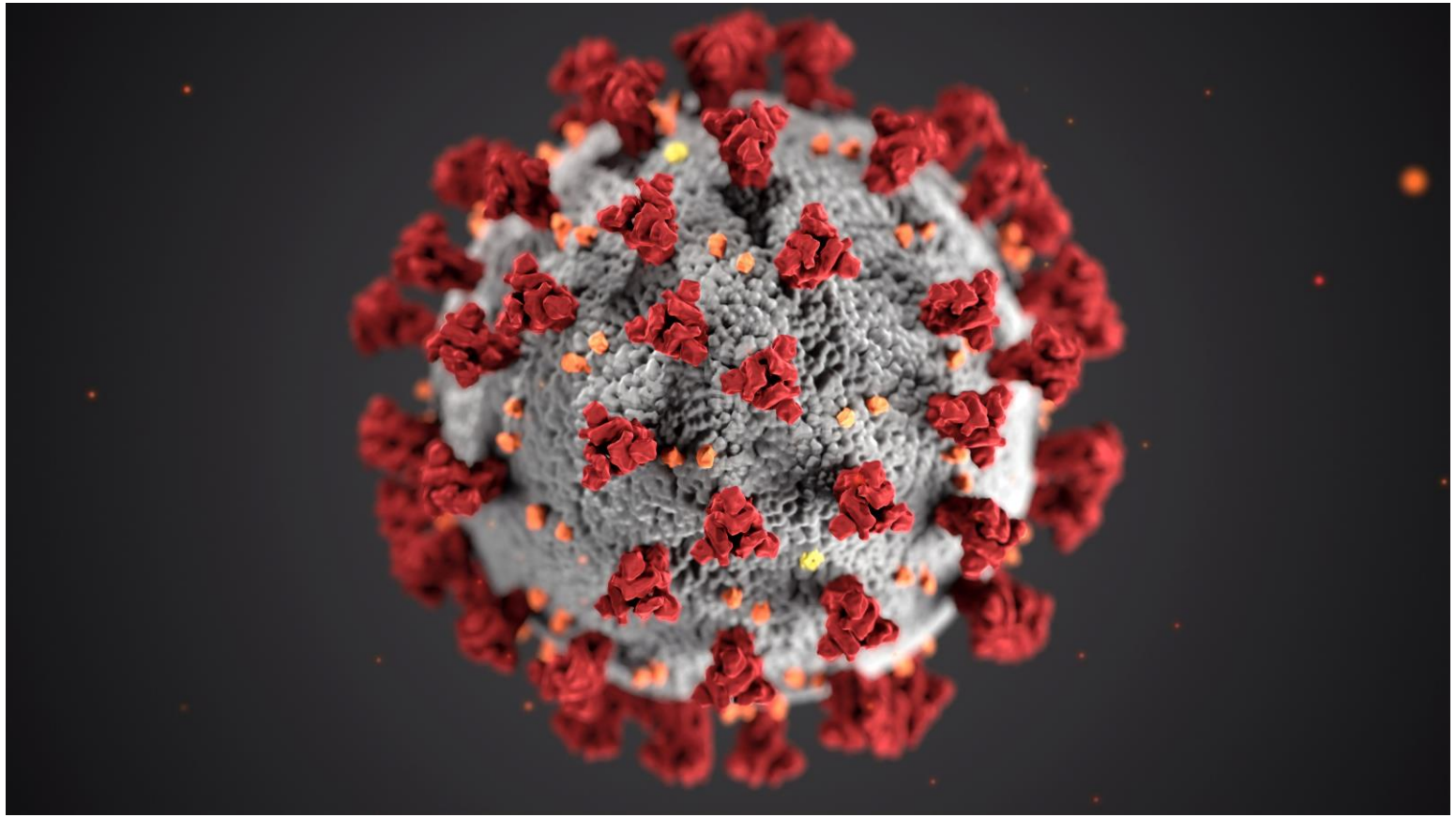
Background

- COVID-19 seen as a disease of cell damage with characteristics of:
  - Inflammation
  - Hypercoagulation
  - Autoimmune injury

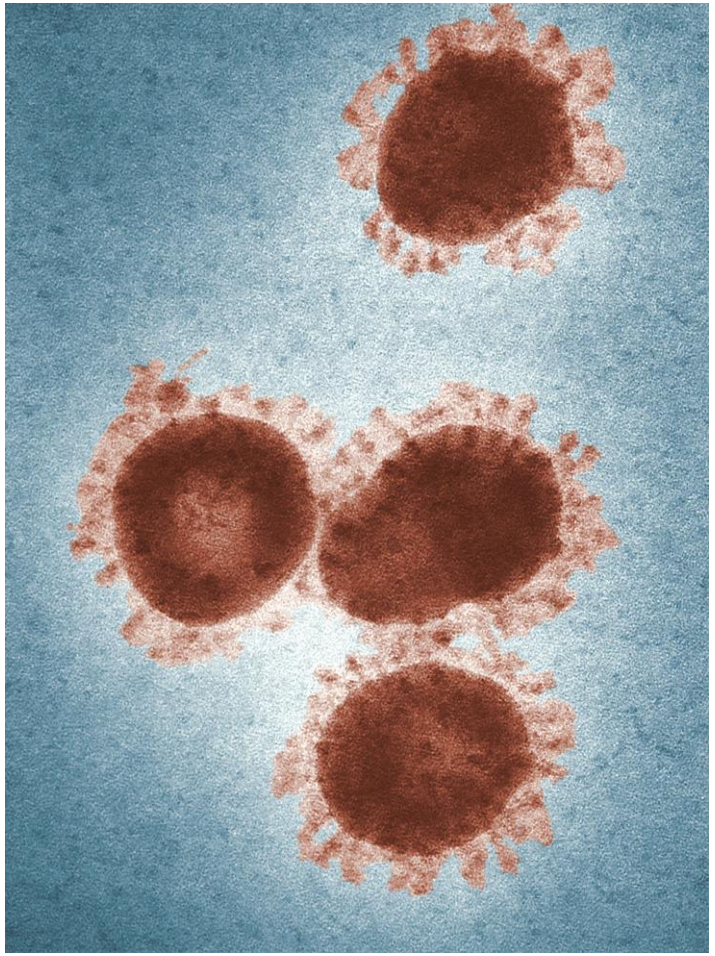
Organ damage
lungs/heart/neuro/kidneys

Long COVID-19

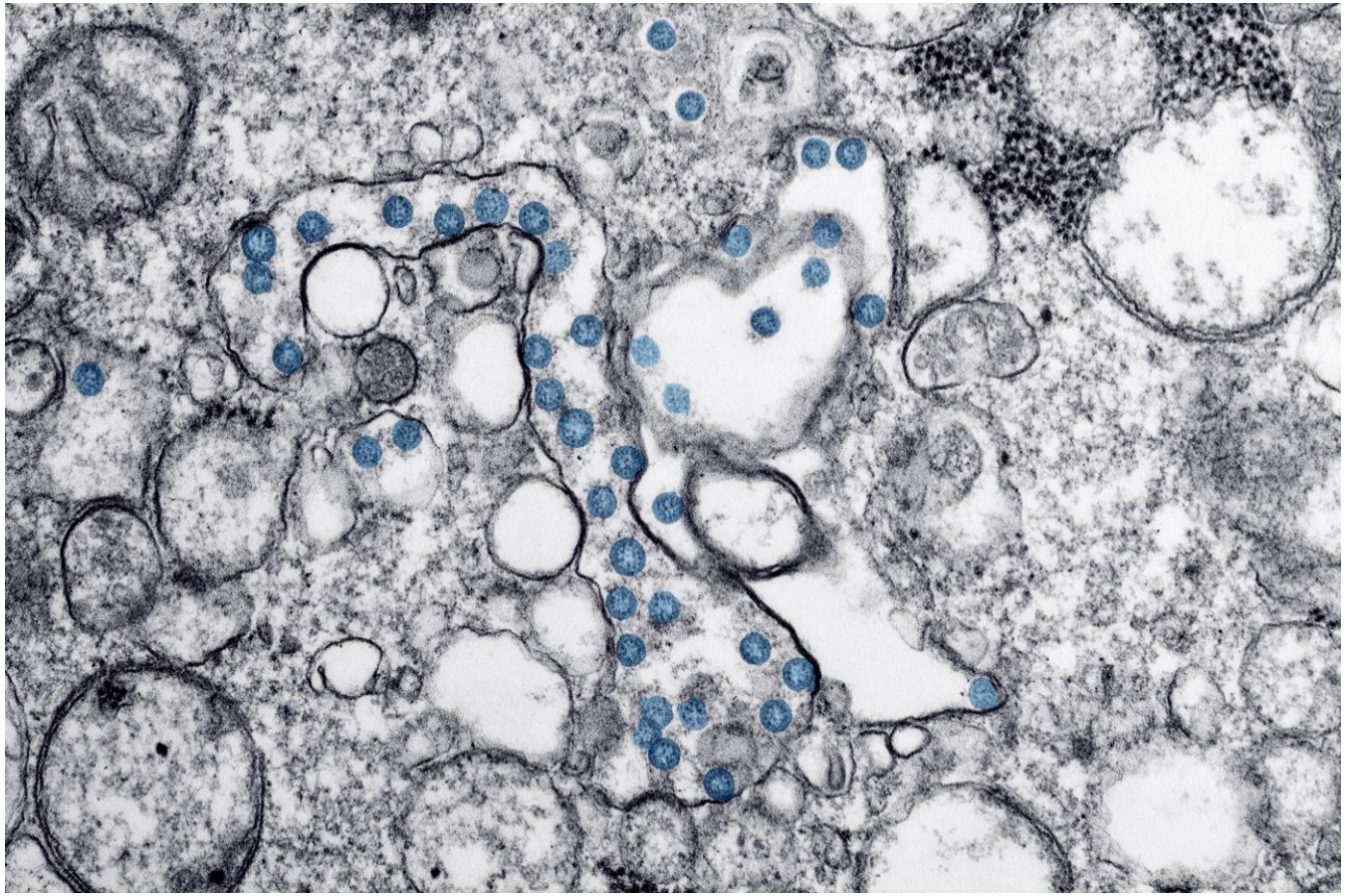
COVID 19 – Viral Model



COVID 19 – In Blood

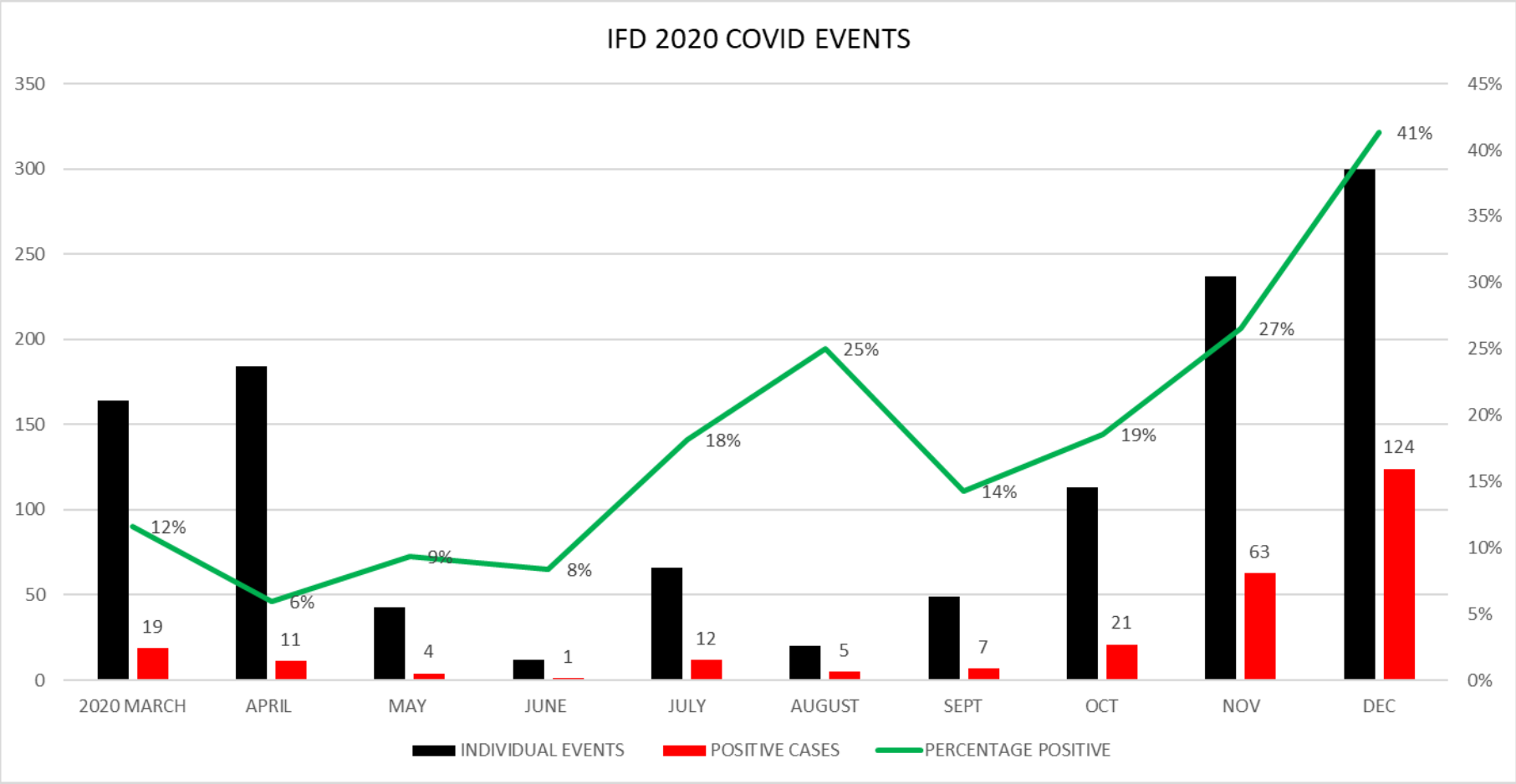


COVID 19 – In Tissue



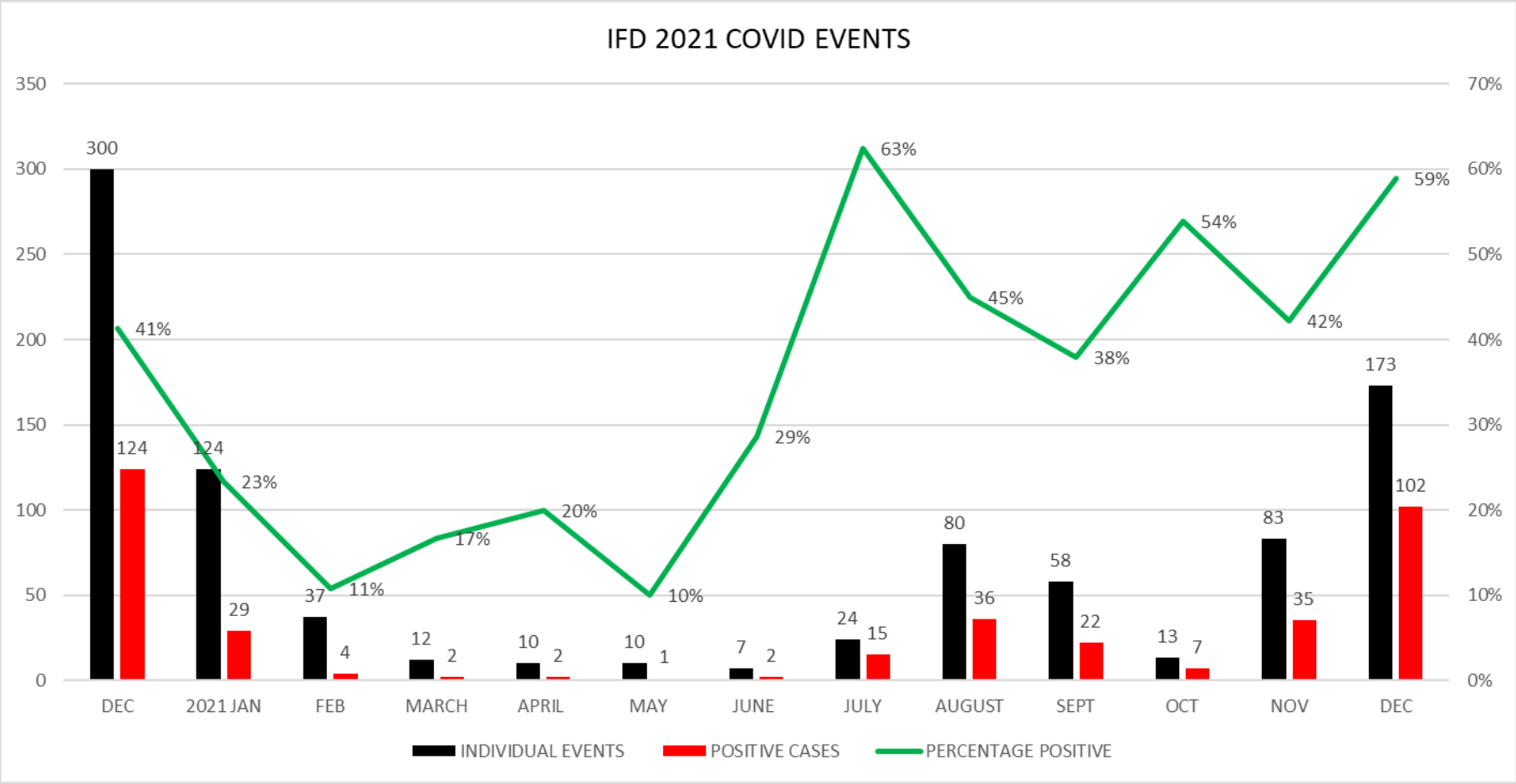
Preliminary Findings

Indianapolis Fire Department



Preliminary Findings

Indianapolis Fire Department



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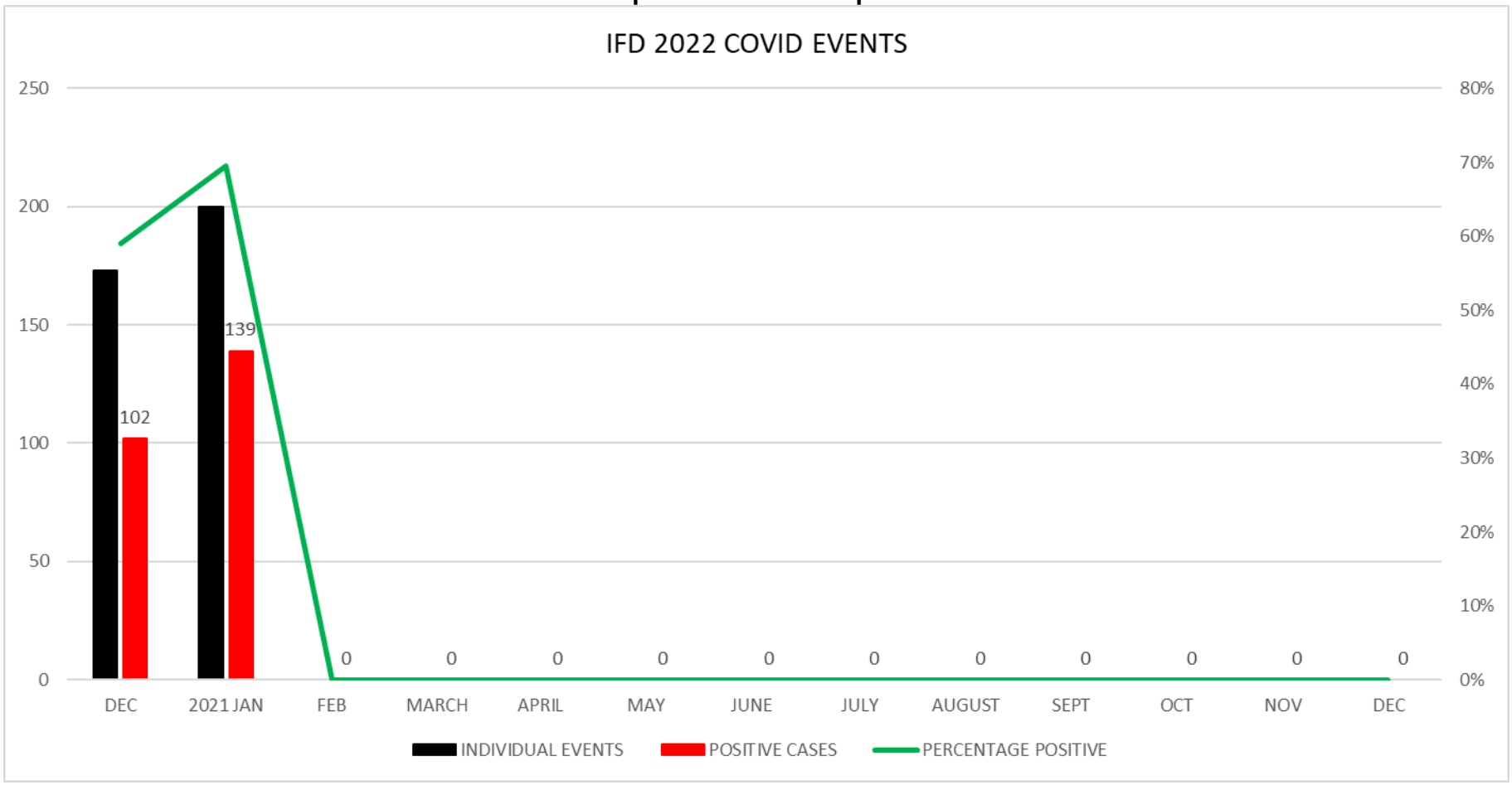
Preliminary Findings

Indianapolis Fire Department



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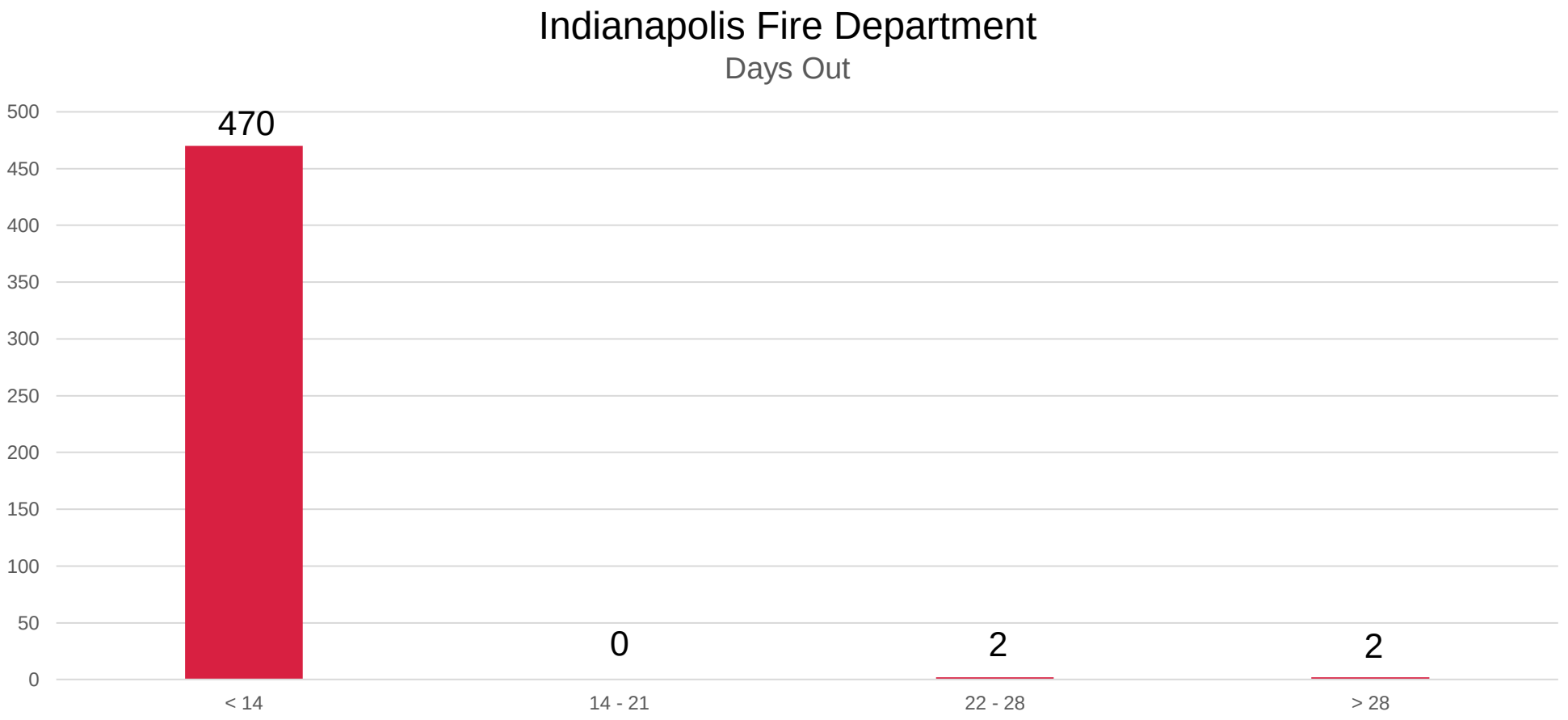

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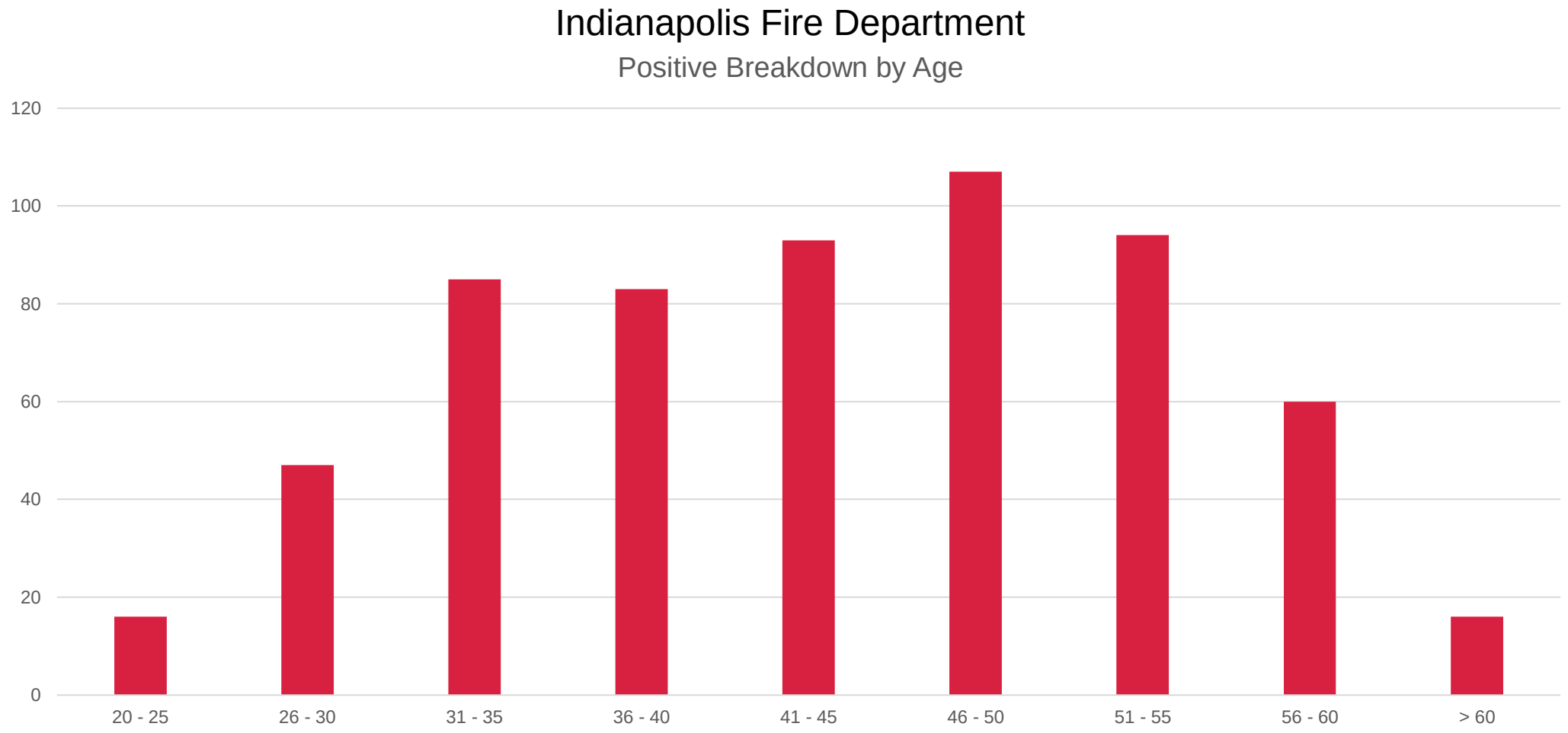
Preliminary Findings



Long COVID Symptoms

- Most common symptoms in IFD firefighter Long COVID-19 cases:
  - Post exertional exhaustion / fatigue
  - Shortness of breath or difficulty breathing
  - Cough
  - Memory, concentration, or sleep problems
  - Irregular or fast heart rate
  - Orthostatic dizziness
  - Depression or anxiety

Background

- Three categories of Long COVID-19
  - **Category 1**: Cell damage because of the virus which can cause lingering symptoms
  - **Category 2**: Symptoms related to chronic hospitalization – bed bound for weeks – Post Intensive Care Syndrome (PICS)
  - **Category 3**: Symptoms appear after recovery involving ongoing autoimmune response to inflammation

Source: American Medical Association. “What doctors wish patients knew about long COVID”. https://www.ama-assn.org/delivering-care/public-health/what-doctors-wish-patients-knew-about-long-covid

Category 1 – Long COVID-19

- Studies determine 50% COVID-19 taking 30-60 days to return to “normal”

Category 2 – Long COVID-19

- PICS may be next public health crisis after acute COVID-19
- PICS characterized by:
  - Decrease physical capacity - strength deficits
  - Cognitive decline
  - Mental health disturbances

Category 2 – Long COVID-19 (cont.)

- 20% COVID-19 require care in ICU involving extracorporeal membrane oxygenation (ECMO) or ventilation
- 50% of COVID-19 go on to develop PICS
- Some studies suggesting up to 30% of PICS develop a level of PTSD

Category 3 - Symptoms Appear after Recovery

- Further study needed and may be benefitted by patients with past novel coronavirus infection syndromes
  - SARS (Severe Acute Respiratory Syndrome – 2003)
  - MERS (Middle East Respiratory Syndrome – 2014)
- More data needed regarding Long COVID in the fire service

Prevention of Long COVID-19

- Prevent COVID-19 Infection:
  - All the regular mitigations
  - Vaccination and booster to reduce infection
  - Early testing / diagnosis COVID-19

Prevention of Long COVID-19

- If Infected:
  - Antivirals
  - Early detection of long COVID-19 symptoms
  - Referral for additional treatment

Thank You

Long COVID-19 in the Fire Service
Fire Service Perspective

Craig Haigh, Fire Chief (Ret.), Hanover Park Fire Department

Case Study:

- Firefighter/Paramedic – DoD Civilian Emergency Services
- Began service with DoD – 2005
- Sex/Race/Age:

  Male/White/Early 40s
- Contracted COVID – July 2020
  - Contact tracing source: fellow firefighters
  - DoD has ruled illness as a worker's compensation case

U.S. Department of Defense Fire & Emergency Services Logo

DoD Firefighter/Paramedic

- Hospitalized 1-week post diagnosis of COVID
  - Severe respiratory distress
  - Subsequently intubated
- Flown from local hospital to a University Hospital
  - Placed on ECMO (Extracorporeal Membrane Oxygenation)
    - 6-Week duration
    - Strong consideration given to placing him on the lung transplant list

DoD Firefighter/Paramedic

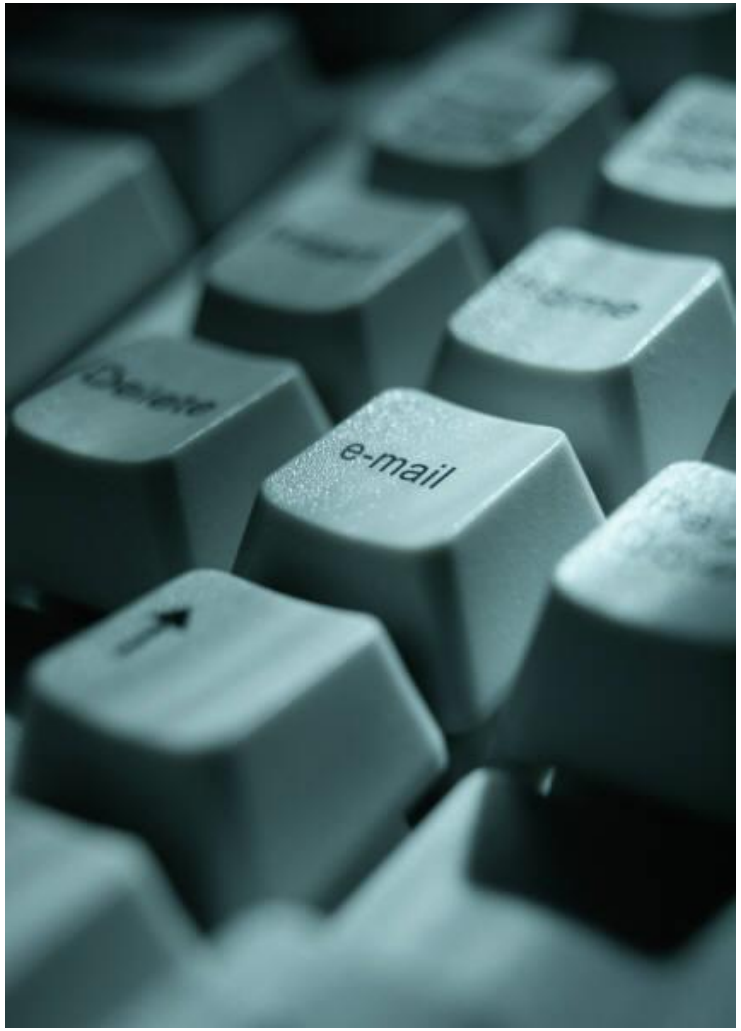
- Condition improved
- Released from University Hospital and retuned home
  - 12 weeks post admission
  - 13-14 weeks post diagnosis

- Current Status:
  - Returned to Limited Duty (working 24 hr. shift)
  - Lung capacity is not improving
  - No firefighting activity: Can serve as fire apparatus engineer or single role paramedic only

DoD Firefighter/Paramedic

- Impact of Department
  - Unable to sustain his limited capacity
  - Overtime required to cover his firefighting duties
  - Contemplate a move to fire prevention duties

- Impact of Firefighter
  - Anxiety / Depression
  - Feeling of “not pulling his weight”



Questions, Comments

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On behalf of The National Fire Protection Association, Fire Protection Research Foundation, Presenters and myself

Thank you for joining us today!

