

A. COVER PAGE

Project Title: Metabolomics of World Trade Center-Lung Injury: Biomarker Validation, Longitudinal Assessment and Dietary Intervention	
Grant Number: 5 U01 OH011300-04	Project/Grant Period: 7/1/2017 – 6/30/2022 (including one year no cost extension)
Reporting Period: 7/1/2017 – 6/30/2022 (including one year no cost extension)	Date Submitted: 9/30/2022
Program Director/ Principal Investigator Anna Nolan, MD Phone Number: 646-501-6783 Email:anna.nolan@nyulangone.org	Administrative Official Information Anthony Carna, Senior Director - Sponsored Programs One Park Avenue, New York, NY 10016
Change of Contact PD/PI: N/A	
Human Subjects: Yes	Vertebrate Animals: No
hESC:	Inventions/Patents: Yes

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

Outline of major goals by AIM:

AIM I. Cases of WTC-LI and cases resistant to WTC-LI express a different metabolome than controls.

DISCOVER. Perform hypothesis-generating metabolomic profiling on serum sampled within 6 months of 9/11 in a pilot group of symptomatic firefighters presenting before March, 2008. Optimize the classification power of a multi-biomarker model (integrating metabolites, cytokines, and clinical data) in subjects with WTC-LI, resistant to WTC-LI, and cohort controls.

AIM II. Metabolomic biomarkers will predict WTC-LI in the broader FDNY WTC-exposed cohort.

DISCOVER and VALIDATE. Conduct a case-cohort study to investigate biomarkers that predict WTC-LI in firefighters. We will measure global metabolic expression in WTC-exposed, symptomatic firefighter serum sampled within 6 months of 9/11. Increased sample size and balanced representation of the full cohort will allow us to determine the impact of confounders, such as smoking history and BMI, on the ability of serum biomarkers to predict airway dysfunction.

AIM III. Dietary intervention reduces metabolic risk and will have a therapeutic effect on clinical endpoints such as FEV1, FeNO, vascular stiffness, and show concurrent changes of targeted biomarkers.

TREAT. Dietary Intervention and Pre/Post Biomarker Assessment: a technology-supported randomized clinical trial (RCT) in WTC-exposed FDNY firefighters. i. Establish baseline dietary habits in the cohort at their annual medical monitoring exam. ii. Randomize subjects to one of three diets: 1) Healthy U.S.; 2) Isocaloric Mediterranean (IsoMed); or 3) Calorie Restricted (CR). Compare BMI changes, targeted biomarkers, quality of life measures, lung function, FeNO, and pulse wave velocity (PWV) pre- to post-intervention.

B.2. What did you accomplish under these goals?

We have shown that Metabolic biomarkers predict WTC-LI in FDNY Firefighters. However, despite treatment with routine care such as inhalers and limiting exacerbation, those affected continue to experience morbidity. New cases of WTC-LI continue to arise. The adverse **impact** on quality of life and the cost of WTC-LI care are significant public health concerns.

We **identified and validated** metabolic contributors of WTC-LI through comprehensive metabolic profiling and integration of relevant clinical, environmental, and serum biomarkers. We **developed** a targeted behavioral dietary modification therapy based on metabolomic biomarkers that mitigated disease severity and progression, and improved the health and well-being of WTC-exposed subjects.

B.3. Competitive Revisions/Administrative Supplements

None

B.4. What opportunities for training and professional development did the project provide?

None

B.5. How did you disseminate the results to communities of interest?

Information derived from this investigation was summarized and disseminated to the following stakeholders:

A. Greater New York population via News Releases from NYU School of Medicine and FDNY resulting in Articles and Local Television stories.

2018

1. **Natural "Breakdown" of Chemicals Predicts Lung Damage in 9/11 Firefighters:** NYU, Dr. Anna Nolan explains how the diet of 9/11 firefighters affects the development of lung disease.
 - a. Story was carried by Reuters, Medscape, USA Today, Daily Mail, CBS News, Sirius XM
 - b. <https://nyulangone.org/news/fox-5-news-ny-study-suggests-911-lung-disease-impacted-diet>
 - c. September 11, 2018 | Chemistry World.com (United Kingdom) View article
 - d. *"NEW YORK (FOX5NY.COM) - Dr. Anna Nolan and her team at NYU School of Medicine looked at blood samples from some New York City firefighters"* September 5, 2018 | Fox 5 New York (New York) View article
 - e. *"Analysis of blood samples taken from World Trade Center (WTC) firefighters soon after 9/11 led to the identification of more than two dozen metabolites that,"* September 4, 2018 | MedPage Today (New Jersey) View article
 - f. *Natural "Breakdown" of Chemicals Predicts Lung Damage in 9/11 Firefighters "SOURCE NYU Langone Health NEW YORK Researchers say the results, published by NYU School of Medicine researchers in the journal BMJ Open Respiratory Research online"*
2. **NYU School of Medicine** also featured our GERD and BE work: <https://nyulangone.org/news/predicting-lung-injury-gastroesophageal-reflux-disease-911-firefighters>
3. **Men'sHealth: A Volcano Eruption in Hawaii is Producing Dangerous Sulfur Dioxide Gas.** Dr. Nolan interviewed as an expert on lung health and environmental exposure

2019

1. **NYU News:** [Predicting-lung-injury-gastroesophageal-reflux-disease-911-firefighters](#)
2. **Reuters:** Heart risk factors may predict lung damage in 9-11 responders - For firefighters who worked at "Ground Zero" around September 11, 2001, a group of heart-disease risk factors also predicted who was likely" March 21, 2019
3. NPR July 3, 2019: <https://www.wshu.org/post/update-911-victim-compensation-fund>
4. **NYU Langone News** [Natural-breakdown-chemicals-may-guard-against-lung-damage-911-first-responders](#) https://www.eurekalert.org/pub_releases/2019-09/nlh-no082719.php
5. **Scientists Identify Body Chemicals That Signal Which 9/11 Responders Are at Risk for Lung Disease – and Which Are Protected** *This press release received extensive media pick-up across the country.*
6. **Researchers Identify Chemicals in the Body That Protect 9/11 Responders From Lung Disease** *Tech Times* – September 4
7. **Study: 9/11 First Responders' Diet May Help Prevent Lung Disease** *Fox5 New York* – September 5
8. **Metabolites May Predict Lung Injury In 9/11 First Responders** *The Scientist* – September 3, 2019
9. **Battling Lung Disease in 9/11 Firefighters and First Responders.** Through her research on World Trade Center-related lung injuries and inflammation, Anna Nolan, MD, has found that certain metabolites— chemicals made as the body breaks down fats, proteins, and carbohydrates—can predict, and perhaps prevent, loss of lung function in firefighters and emergency workers at the disaster site. [Read an interview with Dr. Nolan.](#)
10. **NYU: Understanding Why Some 9/11 Rescue Workers Experienced Lung Disease & Others Didn't** <https://nyulangone.org/news/understanding-why-some-911-rescue-workers-experienced-lung-disease-others-didnt>; December 23, 2019

2020

1. **Bloomberg: Coronavirus Adds to Health Risks of Ailing 9/11 Responders. May 23.**
<https://about.bgov.com/news/coronavirus-adds-to-health-risks-of-ailing-9-11-responders/>
2. **Medscape** Interviewed May 2020. A Long Road to Recovery: Lung Rehab Needed After COVID-19 May 28, 2020
3. **Popular Science. June 8, 2020: Tear gas during COVID-19 is a public health disaster**
<https://www.popsoci.com/story/health/tear-gas-coronavirus/>
4. **Salon. July 19:** <https://www.salon.com/2020/07/19/how-police-are-causing-a-public-health-crisis/>: discussed the negative effects of particulates
5. **Doctor Radio “Pulmonology”** Frank Adams 6:30-7:00 AM September 15, 2020, a discussion of our current 9/11 research.

2021

1. **Scientific American:** <https://www.scientificamerican.com/article/health-effects-of-9-11-still-plague-responders-and-survivors/>
 2. **Scientific American:** 9/11 First Responders Continue to Experience Health Effects from Ground Zero Exposure Read more from [Scientific American](https://nyulangone.org/news/scientific-american-911-first-responders-continue-experience-health-effects-ground-zero-exposure). <https://nyulangone.org/news/scientific-american-911-first-responders-continue-experience-health-effects-ground-zero-exposure>
 3. **Eureka Alert:** <https://www.eurekaalert.org/news-releases/926936> Decades after toxic exposure, 9/11 first responders may still lower their risk of lung injury, News Release Sept 2
 4. **NYU:** Decades After Toxic Exposure, 9/11 First Responders May Still Lower Their Risk of Lung Injury. NYU Langone Study Shows That Losing Weight & Treating Excess Levels of Fat in Blood May Help Prevent Lung Disease in Those Exposed to Dangerous Levels of Fine Particles from Fire, Smoke & Toxic Chemicals <https://nyulangone.org/news/decades-after-toxic-exposure-911-first-responders-may-still-lower-their-risk-lung-injury>
 5. **Doctor Radio “Pulmonology”** Frank Adams 6:30-7:00 AM September 22, 2021. A discussion of our current WTC research.
- B.** Directly disseminated to WTC exposed populations via presentation at open symposia on health effects of 9/11 sponsored by NIOSH; the NYC Department of Health and Mental Hygiene; Mt. Sinai and FDNY and the WTC Steering Committee.
1. [FDNY WTC Program](#)
 2. [WTC CDC NIOSH Website](#)
 3. Preliminary results will also be presented at the WTC Research grantee meetings that are held twice a year. This enables dissemination of results and new findings to all WTC investigators.
- C.** **Results will be submitted to peer-reviewed journals and communicated to the wider scientific community.** Our group has successfully published peer-reviewed publications in collaboration with the FDNY (see attachment). In addition, the randomized control trial has been deposited on [Clinical Trials.gov](https://clinicaltrials.gov).
- D.** **Progress reports at weekly research meetings at both the FDNY and NYU.**
- E.** **Information presented at open symposia on health effects of 9/11 sponsored by NIOSH, the NYC Department of Health and Mental Hygiene, FDNY and the WTC Steering Committee.**

F. The information will also be provided to CDC/NIOSH for inclusion in their social media and website. <https://wwwn.cdc.gov/ResearchGateway/ResearchProjects/Details/137>

G. Dr. Nolan's Group maintains its own

1. Website [Nolan Lab.](#)

2. Twitter feed  https://twitter.com/anolan_md

3. LinkedIn Account  <https://www.linkedin.com/in/anna-nolan-1b674527>

H. Interim results recently submitted/presented at Planned Abstract Submissions to the following National and International Scientific Meetings

(Target Audiences will include pulmonologist and environmental/occupational physicians):

I. Abstracts and manuscripts developed from this proposal will submitted to the following future annual conferences

1. American Thoracic Society Conferences

- May 13-18, 2022 San Francisco, CA
- May 19-24, 2023 Washington, DC
- May 17-22, 2024 San Diego, CA
- May 16-21, 2025 San Francisco, CA

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

We have successfully applied for competitive funding continuation.

C. PRODUCTS

C.1. Publications, conference papers, and presentations

See attachment U01OH0 11300-05- Final RPPR_Nolan_CloseoutSection_2 Part 2.pdf

C.2. Website(s) or other Internet site(s) – include URL(s)**J. Dr. Nolan's Group maintains its own**

4. Website [Nolan Lab.](#)

5. Twitter feed  https://twitter.com/anolan_md

6. LinkedIn Account  <https://www.linkedin.com/in/anna-nolan-1b674527>

C.3. Technologies or techniques**As outlined in our publications and Nolan Lab Website****Interactive Metabolic Risk Modeler**

1. Click [here](#) to access the Interactive Metabolic Risk Modeler, which is an interactive shiny app for risk modeling that allows the user to visualize risk of lung disease as a function of metabolic health. To view license, copyright, and reference information for this app, view its source code.

This app supports the following publication:

Kwon S, Lee M, Crowley G, et al. *Dynamic Metabolic Risk Profiling of World Trade Center-Lung Injury: a Longitudinal Cohort Study*. American Journal of Respiratory and Critical Care Medicine. September 2021.

Measure MLI

2. Click [here](#) to download the Measure MLI plugin for ImageJ v1.52. This plugin is designed to measure mean linear intercept by serial measurement of a test line overlaying an image. Our method has been validated using simulated data and used in several of our publications to assess pulmonary mean linear intercept. Our method could also be used for a variety of other applications, including the measurement of grain size in geological settings.

The zip file contains the plugin, a readme with instructions, and a non-commercial research use license. If you use this resource, cite: Crowley G; Kwon S; Caraher EJ et al. *Quantitative lung morphology: semi-automated measurement of mean linear intercept*. Pulmonary Medicine. November 2019. <https://doi.org/10.1186/s12890-019-0915-6>

We have used this method in the following publications:

Caraher EJ; Kwon S; Haider SH et al. *Receptor for advanced glycation end-products and World Trade*

Center particulate induced lung function loss: A case-cohort study and murine model of acute particulate exposure. PLOS ONE. September 2017. <https://doi.org/10.1371/journal.pone.0184331>

Cell Tracker 3. Click here to access the Cell Tracker, which is an interactive shiny app for cell culture that allows the user to calculate cell counts, visualize colony growth over time for multiple lineages, and export data. To view license, copyright, and reference information for this app, view its source code.	
Spirometry Calculator 4. Click here to access the Spirometry Calculator, which calculates predicted spirometry based on NHANES III criteria. To view license, copyright, and reference information for this file, view its source code.	
Machine Learning Biomarker Identification 5. Click here to access the source code and numerical data underlying graphs for the Crowley et al. <i>PEDF, a Pleiotropic WTC-LI Biomarker: Machine Learning Biomarker Identification and Validation</i> . PLOS Comp Bio. 2021.	
C.4. Inventions, patent applications, and/or licenses As Above	
C.5. Other products and resource sharing As above	

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
Nolana01		Anna Nolan	MD	PI	0.60			n/a	USA	N/A

D.2 Personnel updates

a. Level of Effort:

b. New Senior/Key Personnel:

c. Changes in Other Support:

d. New Other Significant Contributors:

b. New Senior/Key Personnel: No change

c. Changes in Other Support: No change

d. New Other Significant Contributors: No change

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?

AIM I. Cases of WTC-LI and cases resistant to WTC-LI express a different metabolome than controls.

Characterizing WTC-LI. We identified serum biomarkers predictive of WTC-LI. FEV_1 < lower limit of normal (LLN) was used to define WTC-LI over other measurements such as accelerated decline because of its robustness and ubiquity in pulmonary literature, which improves generalizability of our findings. After the initial WTC exposure, only some subjects suffered symptomatic loss of FEV_1 . The FDNY's relational database of serial pulmonary function testing shows never-smoking firefighters had mean loss of 439 mL of FEV_1 in the first year post-9/11, followed by a mean annualized FEV_1 reduction of 26 mL per year in the subsequent 6.5 years. Obstruction caused the vast majority of abnormal FEV_1 in WTC-exposed firefighters. The prevalence of abnormal FEV_1 increased from 2% pre-9/11, to above 15%, then stabilized at 12.5% in 2008. The **incidence of respiratory disability** continued at twice the rate observed prior to 9/11/2001, demonstrating continued presentation of WTC-LI.

Predictive Biomarkers of WTC-LI. We aimed to define the pre-diagnosis global serum metabolome to further understand risks and pathways that contributed to these outcomes. WTC-Lung Injury (WTC-LI; $FEV_{1, \%pred} < LLN$; n=50) vs. cohort-controls (n=150) randomly selected after stratification on BMI and $FEV_{1, \%pred}$. Data was analyzed independently on each endpoint to identify metabolites of interest and build classifiers. Random forests trained on untargeted metabolomics data using a random hyper parameter space search. Hierarchical clustering of the refined profile was performed. WTC-LI metabolites—including N-acetyl-leucine, cysteine derivatives, prostaglandin and cortisone—classified cases with 5-fold cross-validated $AUC_{ROC}=0.94$ and 16.3% classification error. WTC-LI cases had significantly lower FEV_1 , FVC and FEV_1/FVC at all time points when compared to controls. In addition, cases of WTC-LI had significantly higher heart rate (HR) when compared to controls. Measures of BMI, age at 9/11, exposure, lipids and vascular measures when compared to their controls were no different. RF identified refined profiles to classify cases of WTC-LI by minimizing the weighted hamming distance as a function of hyperparameters, \log_2 (fold change) of those with WTC-LI compared to those without for the top 30 identified metabolites are shown via red/green shading.

AIM II. Significance of the link between metabolic and pulmonary health. MetSyn, which includes abdominal obesity, insulin resistance, dyslipidemia, and hypertension, affects more than 30% of adults (>47 million Americans) and is similarly prevalent in the FDNY cohort (Personal Communication, David Prezant). Vascular and metabolic biomarkers are significant predictors of WTC-LI. Previous cross-sectional studies have suggested associations of impaired lung function with MetSyn. Nearly half of chronic obstructive pulmonary disease (COPD) patients demonstrate the presence of components of MetSyn.

Modifiable metabolic risk factors are associated with WTC-LI. MetSyn increases the risk of WTC-LI. However, the temporal relationship of MetSyn, exposure intensity, and lung dysfunction is not well understood. We modeled the association of longitudinal MetSyn characteristics with WTC-lung disease to define modifiable risk. Consented firefighters (N=5,738) were active-duty on 9/11/01 (9/11). WTC-LI (N=1,475; $FEV_{1, \%pred} < LLN$) and non-WTC-LI (N=4,263; $FEV_{1, \%pred} \geq LLN$ at all exams) was the primary-outcome, $FVC_{\%, pred} < LLN$ and $FEV_1/FVC < 0.70$ were 2^o-outcomes.

We assessed: **I.** effect of concurrent MetSyn on longitudinal lung function by linear mixed models; **II.** temporal effect of MetSyn and exposure by Weibull-proportional hazards (PH); **III.** effects of MetSyn's

rate of change by two-stage models; **IV.** nonlinear joint effect of longitudinal MetSyn components by partially linear single index models (PLSI). WTC-LI cases were more often ever-smokers, arrived the morning (9/11), and had MetSyn. BMI \geq 30kg/m² and HDL<40mg/dL were most contributory to concurrent loss of FEV_{1%,pred} and FVC_{%,pred} while conserving FEV₁/FVC. BMI \geq 30kg/m² and dyslipidemia significantly predicted WTC-LI, FVC_{%,pred} <LLN in a Weibull-PH model. Dynamic risk assessment of WTC-LI based on MetSyn and exposure showed how reduction of MetSyn-factors further reduce WTC-LI likelihood in susceptible populations. MetSyn has a nonlinear relationship on WTC-lung disease, and increases in cumulative MetSyn risk factors exponentially increase WTC-LI risk. Interactive metabolic-risk modeling application developed to simplify PLSI interpretation. MetSyn and WTC-exposure contribute to the development of lung disease. Dynamic risk assessment may be utilized to encourage treatment of MetSyn in susceptible populations.

AIM III.

i. Establish baseline dietary habits in the cohort at their annual medical monitoring exam. In a recent observational study, we deployed the Rapid Eating and Activity Assessment for Patients-Short Version (REAP-S) at the FDNY WTC-HP. Low nutritional dietary habits were significantly associated with WTC-LI. Consumption of less vegetables and more processed meats increased the risk of WTC-LI. REAP-S is a short form Food Frequency Questionnaire (FFQ) that is ideal for rapid assessments.

ii. FIREHOUSE RCT. Particulate matter (PM) exposure and Metabolic Syndrome (MetSyn) are growing, global health concerns. FDNY first responders experienced a high exposure to PM following the collapse of the WTC, due to their detailed phenotyping we were able to observe that MetSyn characteristics were associated with higher risk of developing WTC-lung injury [WTC-LI; forced expiratory volume in 1 second (FEV₁) less than the lower limit of normal (LLN)]. Our prior metabolomics studies showed metabolites—polyunsaturated fatty acids and branched chain amino acids—rich in Mediterranean type diets were higher in subjects that didn't develop WTC-LI. Therefore, our objective was to investigate how a calorie-restricted Mediterranean diet could attenuate the adverse effects of WTC exposure among the affected FDNY population.

During our first funding period we completed the **F**ood **I**ntake **R**estriction for **H**eath **O**utcome **S**upport and **E**ducation (**FIREHOUSE**) RCT; which is a calorie-restricted Mediterranean 6-month dietary intervention of male firefighters with WTC-LI and BMI>27kg/m²; ClinicalTrials.gov Identifier: NCT03581006, NYU IRB # 17-00127. Power analysis and primary outcome assessment targeted at least a 1 kg/m² change of BMI (primary outcome) in the intervention group. Secondary outcomes include FEV₁, fractional exhaled nitric oxide (FeNO), pulse wave velocity (PWV), lipid profiles, targeted metabolic/clinical biomarkers, and quality of life measures. Change in outcomes from baseline to 6-months post-intervention will be compared between the two randomized groups. Interim analysis with an O'Brien Fleming boundary for a 3-look design was planned at the completion 30, 50, and 70 subjects in each group with an α spending rule of 0.001, 0.007, and 0.033, respectively. Subjects were randomized 1:1 to Low Calorie Mediterranean (LoCalMed), a technology-supported approach with social cognitive theory-based group counseling or Usual care (UC). We found that LoCalMed's estimated efficacy on BMI reduction crossed the pre-specified significance boundary on interim analysis compared to UC. In addition, improvements were observed in secondary-outcomes of lung health (FEV₁ and FVC), inflammation (WBC), vascular disease (DBP), QoL (SF-36, health perception) and dietary habits (less cholesterol, carbohydrates, fats, sweets and increased protein) in the LoCalMed arm.

SUPPLEMENTAL AIM (Validating Biomarkers in additional Cohorts):

I. In 1,180 WTC-General Responders' Cohort (WTC-GRC) workers and volunteers, we examined whether FEV₁<LLN was associated with an increased quantitative chest tomography (QCT) measured pulmonary artery:aortic diameter ratio (PAAr), to replicate with a different methodology Dr. Nolan's group previous finding. The multivariate logistic regression model confirmed the association

of $FEV_1 < LLN$ with PAAr (OR 1.63, 95% CI 1.21, 2.20, $p=0.0015$), with adjustment for previously identified important covariates, such as body mass index, smoking, airway wall thickness, bronchodilator response, sex, age, height, ethnicity/race, and WTC exposure. The finding is likely multifactorial, but raises the possibility of a distal vasculopathy.

II. A reduced forced vital capacity without obstruction (low FVC) is the predominant spirometric abnormality reported WTC workers and volunteers. Low FVC has been associated with obesity and metabolic syndrome, but its association with WTC occupational exposures had not been demonstrated. With data from the WTC-GRC ($n=10,284$) with at least two good quality spirometry between 2002 and 2018, we investigated the association between arrival at the WTC site within 48 hours, and low FVC (i.e., FVC below the lower limit of normal, with normal FEV_1/FVC ratio). We established that the prevalence of low FVC increased from 17.0% (95% CI 15.4%, 18.5%) in June 2003, to 26.4% (95% CI 24.8%, 28.1%) in June 2018, and exceeded at both times that of obstruction. In a multivariable analysis adjusting for multiple significant covariates such as obesity, at least 2 metabolic syndrome indicators (ORadj 1.32, 95% CI 1.19, 1.46), and other factors, early arrival at the WTC disaster site was significantly associated with low FVC, but only among men (ORadj =1.29, 95% CI 1.17, 1.43). Longitudinal FVC rate of decline did not differ by WTC site arrival time.

III. We also tested for association spirometrically defined COPD and early arrival (within 48 hr) at the 2001 WTC disaster site 17,996 GRC workers with at least two spirometries between 2002 and 2018. We used a nested 1:4 case-control design matching on sex and height (within 5 cm) using density sampling, and imputed missing data. In a predominantly (85.4%) male and overweight or obese (85.6%) population, 586 (3.3%) cases met the COPD case definition. In adjusted analyses, COPD was associated with early arrival at the WTC site, with adjusted odds ratio, and 95% CI of 1.3, 1.03-1.64, respectively. In these models, neither overweight/obesity nor at least 2 metabolic syndrome indicators appeared significant.

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

We have shown that Metabolic biomarkers predict WTC-LI in FDNY Firefighters. However, despite treatment with routine care such as inhalers and limiting exacerbation, those affected continue to experience morbidity. New cases of WTC-LI continue to arise. The adverse **impact** on quality of life and the cost of WTC-LI care are significant public health concerns.

We **identified and validated** metabolic contributors of WTC-LI through comprehensive metabolic profiling and integration of relevant clinical, environmental, and serum biomarkers. We **developed** a targeted behavioral dietary modification therapy based on metabolomic biomarkers that mitigated disease severity and progression, and improved the health and well-being of WTC-exposed subjects.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures. None

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them. None

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents. None

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements

None

G.2 Responsible Conduct of Research

None

G.3 Mentor's Research Report or Sponsor Comments

None

G.4 Human Subjects

G.4.a Does the project involve human subjects? Yes

G.4.b Inclusion Enrollment Data

See attachment U01OH0 11300-05- Final RPPR_Nolan_CloseoutSection_2 Part 3_Inclusions.pdf

G.4.c ClinicalTrials.gov

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA? yes

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research? Yes

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)? No

G.7 Vertebrate Animals

Does this project involve vertebrate animals? No

G.8 Project/Performance Sites

550 First Avenue, New York, NY 10016
NY-012

G.9 Foreign Component

No

G.10 Estimated Unobligated Balance

\$0

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

No

G.11 Program Income

Is program income anticipated during the next budget period?

No

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?

No change

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets

Note: project outcome information will be made public in NIH RePORTER

Our productive first funding period of this U01 included making substantial progress on all original aims and publishing 35 manuscripts and 50 abstracts. We have also authored the chapter “Acute Inhalational Injury” in Irwin and Rippe’s Critical Care Textbook. We developed, and made publicly available several software programs based on the results of our studies (<https://med.nyu.edu/nolanlab/software>). The methodology and implementation in analysis have been published in several peer-reviewed manuscripts. We validated the utility of MetSyn-defining biomarkers in predicting the development of WTC-LI (**AIM 1**), published and presented findings relevant to the hypotheses of **AIM 2**, incorporated preliminary data developed in the first funding period in **ALL AIMS**, and completed enrollment for our FIREHOUSE RCT (**AIM 3**).

Research Outcomes/Impact. Fire Department of New York (FDNY) rescue/recovery workers exposed to World Trade Center (WTC) particulate matter (PM) developed lung disease and continue to have their health and well-being adversely affected. We have discovered that biomarkers of metabolic syndrome (MetSyn) and vascular injury not only **predict** but are also modifiable risks of developing WTC-Lung Injury (WTC-LI). Our recent study’s associated editorial stated “The time has come to think of MetSyn not only as a cardiovascular risk factor, but also as a modifiable pulmonary one...”

Our body of work fits into the broader literature that explores the association of poor metabolic health and lung disease in those exposed to pollution. Although the mechanisms that lead pollution and MetSyn to lung disease remain poorly understood, they are an area of active investigation as part of the mandates of the James Zadroga 9/11 Health and Compensation Act. We also successfully completed our proof of concept Fat Intake REstriction for Health Outcome Support and Education (FIREHOUSE) RCT: a technology supported nutritional intervention comparing a low calorie Mediterranean type diet(LoCalMed) to usual care(UC).

Publications

Our **productivity during the funding period of this U01(July 01,2017-June 30,2021)**, allowed us to make substantial progress on all original aims and publish **36** papers. In addition, we have also presented over **50** abstracts. We have authored “**Acute Inhalational Injury**”, Chapter 178 in the 9th Edition of **Irwin and Rippe’s Critical Care Textbook**.

FIREHOUSE RCT has been posted on ClinicalTrials.gov

<https://clinicaltrials.gov/ct2/show/NCT03581006?cond=firehouse&draw=2&rank=1>

35 peer reviewed manuscripts; 5 Original Software; 2 Book Chapter Authored during the Funding Period of this U01

1. Kwon S, Lee M; Crowley G; Schwartz T; Zeig-Owens R; Prezant DJ; Liu M; **Nolan A**. Dynamic Metabolic Risk Profiling of World Trade Center-Lung Disease: a Longitudinal Cohort Study. *Am J Respir Crit Care Med*. 2021 Nov 1;204(9):1035-1047. doi: 10.1164/rccm.202006-2617OC. PMID: 34473012; ISSN: 1535-4970; CID: 4995692
 2. Verma Jasra S, Giricz O, Zeig-Owens R, Goldfarb D, Barreto-Galvez A, Pradhan K, Chen J, Choudhary GS, Aluri S, Bhagat TD, Shastri A, Thiruthuvanathan V, Goto H, Gerhardt J, Gordon S, Veerappan A, Haider SH, Bartenstein M, Nwankwo G, Landgren O, Weiden M, Fletcher F, Greenberger L, Ebert BL, Steidl UG, Britta Will, **Nolan A**, Prezant D, Madireddy A, and Verma A. "High burden of Clonal Hematopoiesis in First Responders Exposed to the World Trade Center Disaster". *Nature Medicine*; 28, 468–471 (2022). <https://doi.org/10.1038/s41591-022-01708-3>
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Original Software (access may be found on the NolanLab Webpage); Book Chapters and Other

37. **Interactive Metabolic Risk Modeler**, which is an interactive shiny app for risk modeling that allows the user to visualize risk of lung disease as a function of metabolic health. To view license, copyright, and reference information for this app, view its source code. This app supports the following publication: Kwon S, Lee M, Crowley G, et al. *Dynamic Metabolic Risk Profiling of World Trade Center-Lung Injury: a Longitudinal Cohort Study*. American Journal of Respiratory and Critical Care Medicine. September 2021
38. **MLI plugin for ImageJ v1.52**. This plugin is designed to measure mean linear intercept by serial measurement of a test line overlaying an image. Our method has been validated using simulated data and used in several of our publications to assess pulmonary mean linear intercept. Our method could also be used for a variety of other applications, including the measurement of grain size in geological settings. The zip file contains the plugin, a readme with instructions, and a non-commercial research use license. If you use this resource, cite: Crowley G; Kwon S; Caraher EJ et al. Quantitative lung morphology: semi-automated measurement of mean linear intercept. *Pulmonary Medicine*. November 2019
39. **Spirometry Calculator** which calculates predicted spirometry based on NHANES III criteria. To view license, copyright, and reference information for this file, view its source code.
40. Crowley G, Kwon S, Caraher EJ, Haider SH, Lam R, Batra P, Melles D, Liu M, **Nolan A**. Software developmen; <https://med.nyu.edu/nolanlab/software> details available in manuscript **Quantitative Lung Morphology: Semi-automated Measurement of Mean Linear Intercept**: *BMC Pulmonary Medicine*; 2019 October.
41. **Nolan A**, Weiden MD, Mohr LC, Prezant DJ. Acute Inhalational Injury; Chapter 178. In: *Irwin and Rippe's Critical Care Textbook*. 8th and 9th editions. USA: Lippincott; 2017 and 2022.

Conference Presentations

2022

Abstracts being presented (ATS San Francisco May 13-19th, 2022)

C95. WORLD TRADE CENTER 20TH ANNIVERSARY SYMPOSIUM May 17, 2022, 2:15 PM - 3:45 PM.
ATS 2022, San Francisco

1. James Kim; Rachel Lam; Wendy Phillips; Sophia Kwon; George Crowley; David J. Prezant; **Nolan A**. The Microbiome of Inflammation and Nutrition: World Trade Center FIREHOUSE RCT. https://doi.org/10.1164/ajrccm-conference.2022.205.1_MeetingAbstracts.A4793
2. George Crowley; Sophia Kwon; James S. Kim; Mengling Liu; **Nolan A**. A Pandemic's Lifecycle: A Longitudinal Validation of Predictors in 26,249 Severe COVID-19 NYC Admissions. https://doi.org/10.1164/ajrccm-conference.2022.205.1_MeetingAbstracts.A3543
3. Kwon Sophia; George Crowley; Mengling Liu; Rachel Zeig-Owens; Alexandra Mueller; David J. Prezant4; **Nolan A**. World Trade Center Particulate Matter-Induced Cardiorespiratory and Vascular Dysfunction

4. Lam Rachel; Sophia Kwon; George Crowley; Rachel Zeig-Owens; Alexandra Mueller; David J. Prezant and **Nolan A.** A Prospective Longitudinal Assessment of Nutrition in the FDNY World Trade Center-Exposed Cohort: an Update. https://doi.org/10.1164/ajrccm-conference.2022.205.1_MeetingAbstracts.A4796

2021

1. Lee M; Kwon B; Troxel AB; **Nolan A**; and Liu M. Partially Linear Single Index Hazards Regression with Time-Dependent Covariates. JSM 2021 August 7-12. American Statistical Society
2. Crowley G; Caraher EJ; Veerappan A; Lam R; Haider SH; Kwon S; Liu M; **Nolan A.** Metabolomics at the Intersection of Murine WTC-PM Exposure and High Fat Diet: A Machine Learning Assessment. TP112. PROTEOMICS/GENOMICS/METABOLOMICS IN LUNG DISEASE. ATS International Conference May 14-19, 2021 San Diego. AJRCCM Volume 203: A4337.
3. Crowley G; Kwon S; Liu M; **Nolan A.** ICU Admission and Mortality Prediction in Severe COVID-19: A Machine Learning Approach. TP049. COVID:ARDS AND ICU MANAGEMENT. ATS International Conference May 14-19, 2021 San Diego. AJRCCM Volume 203: A2564.
4. Crowley; Kwon; Li; Young; Liu; McRitchie; Sumner; Prezant; **Nolan A.** Metabolomics of WTC-Associated Aerodigestive Disease Includes Metabolites of Heme Oxygenase-1:a Pilot Study. TP062. TERRORISM AND INHALATIONAL DISASTERS: WORLD TRADE CENTER AND BEYOND. ATS International Conference May 14-19, 2021 San Diego. AJRCCM Volume 203: A3068.
5. Young IR; Cowman MK; Kirsch T; Crowley G; **Nolan A.** COVID-19 and PM Exposure: Identifying and Mitigating the Synergistic Deleterious Effects. TP062. TERRORISM AND INHALATIONAL DISASTERS: WORLD TRADE CENTER AND BEYOND. ATS International Conference May 14-19, 2021 San Diego. AJRCCM Volume 203: A3065.
6. Young IR; Lam R; Kwon S; Crowley G; Riggs J; Ostrofsky D; Nayar C; Zeig-Owens R; Schwartz T; Colbeth H; Mikhail M; Veerappan A; Pompeii ML; St-Jules D; Liu M; Prezant DJ; Liu M; Sevick MA; **Nolan A.** Food Intake Restriction for Health Outcome Support and Education (FIREHOUSE): A Randomized Clinical Trial. TP062. TERRORISM AND INHALATIONAL DISASTERS: WORLD TRADE CENTER AND BEYOND. ATS International Conference May 14-19, 2021 San Diego. ATS International Conference May 14-19, 2021. San Diego. AJRCCM Volume 203: A3069.
7. Kwon S; Crowley G; Liu M; **Nolan A.** Biomarkers of COVID-19, a Longitudinal and Retrospective Assessment of a NYC 1st Wave Cohort. TP051. COVID: LUNG INFECTION, MULTIORGAN FAILURE, AND CARDIOVASCULAR. ATS International Conference May 14-19, 2021 San Diego. AJRCCM Volume 203: A2626.
8. Veerappan A; Sunseri M; Crowley G; Kwon S; Young IR; **Nolan A.** Exogenous RAGE Inhibitor Attenuates Particulate Matter Induced Airway Hyperreactivity. B012. THE AIR OUT THERE: INVESTIGATIONS IN AIR POLLUTION. Monday, May 17, 2021; Mini Symposium. 5/17/2021 3:00:00 PM Eastern Time. ATS International Conference May 14-19, 2021 San Diego. AJRCCM Volume 203, May 3, 2021. 2021;203:A1094

2020

9. Kwon S, Lee M, Schwartz T; Zeig-Owens R; Prezant DJ, Liu M; **Nolan A.** 4088 Longitudinal Assessment of Metabolic Syndrome as a Modifiable Risk factor of World Trade Center Particulate Matter Exposure Associated Lung Disease, ACTS; Translational Science 2020 April 14-17th Washington DC. (Conference canceled due to COVID, Abstract Published) Journal of Clinical and Translational Science, 4(S1), 49-50. doi: 10.1017/cts.2020.180
10. Lee M; Kwon B; Troxel AB; **Nolan A**; and Liu M. Partially Linear Single Index Hazards Regression with Time-Dependent Covariates 30th International Biometric Conference; COEX | SEOUL, KOREA | 5-10 Accepted, JULY 2020. (presented virtually Due to COVID-19 Pandemic)

11. Kwon S, Lee M; Liu M, Prezant DJ, **Nolan A.** Assessing the Temporal Relationship of Metabolic Syndrome, a Modifiable Risk factor of World Trade Center Particulate Exposure Associated Lung Injury: a longitudinal case-cohort study. D55-RESPIRATORY HEALTH OUTCOMES OF WORLD TRADE CENTER EXPOSURES 18 YEARS LATER Thematic Poster Session. Wednesday May 20, 2020 8:45 AM - 3:00 PM ATS International Conference 2020 Philadelphia, PA. American Journal of Respiratory and Critical Care Medicine 2020;201:A7125
12. Veerappan A; Caraher EJ; Kwon S; Crowley G; Ostrofsky D; Oskuei A; Aristizabal O; Wadghiri Y; **Nolan A.** Synergistic Deleterious Effect of High Fat Diet and World Trade Center Particulate Matter Exposure: An Assessment of Cardiopulmonary Dysfunction and Injury. A47 - HEALTH EFFECTS OF AIR POLLUTION - ORGANIC DUST/BIOMASS. Thematic Poster Session; Sunday May 17, 2020 9:15 AM - 4:15 PM. American Journal of Respiratory and Critical Care Medicine 2020;201:A1790
13. Lam R; Kwon S; Sunseri M; Crowley G; Schwartz T; Zeig-Owens R; Halpren A; Colbeth H; Liu M; Prezant DJ; **Nolan A.** Nutritional Quality Predicts Airway Hyperreactivity/Lung Injury in the World Trade Center-Health Program Fire Department of New York Cohort. D55-RESPIRATORY HEALTH OUTCOMES OF WORLD TRADE CENTER EXPOSURES 18 YEARS LATER Thematic Poster Session. Wednesday May 20, 2020 8:45 AM - 3:00 PM ATS International Conference 2020 Philadelphia, PA. American Journal of Respiratory and Critical Care Medicine 2020;201:A7126
14. Crowley G; Kim J; Kwon S; Lam R; Prezant DJ; Liu M; **Nolan, A.** PEDF a Pleiotropic WTC-LI Biomarker: Machine Learning Biomarker Identification and Validation. D55-RESPIRATORY HEALTH OUTCOMES OF WORLD TRADE CENTER EXPOSURES 18 YEARS LATER Thematic Poster Session. Wednesday May 20, 2020 8:45 AM - 3:00 PM ATS International Conference 2020 Philadelphia, PA. American Journal of Respiratory and Critical Care Medicine 2020;201:A7124
15. Walsh BC; Forster M; Caplan A; **Nolan A.** "Understanding Medical Decision Making For Hospitalized Unrepresented Patients: A Systematic Review". D37-A PULMONARY CRITICAL CARE MEDLEY. Thematic Poster Session. Wednesday May 20, 2020 8:45 AM - 3:00. ATS 2020 International Conference; May 15-20, 2020 in Philadelphia, PA. American Journal of Respiratory and Critical Care Medicine 2020;201:A6612
16. Ostrofsky D; Kwon S; Lam R; Crowley G, M. Liu, Prezant DJ; **A. Nolan.** Association of Endogenous Secretory RAGE and World Trade Center Particulate Matter-induced AHR and Lung Injury. D55-RESPIRATORY HEALTH OUTCOMES OF WORLD TRADE CENTER EXPOSURES 18 YEARS LATER Thematic Poster Session. Wednesday May 20, 2020 8:45 AM - 3:00 PM ATS International Conference 2020 Philadelphia, PA American Journal of Respiratory and Critical Care Medicine 2020;201:A7128

2019

17. Jasra S, Giricz O, Zeig-Owens R, Goldfarb D, Barreto-Galvez A, Pradhan K, Chen J, Choudhary GS, Aluri S, Bhagat TD, Shastri A, Thiruthuvanathan V, Goto H, Gerhardt J, Gordon S, Veerappan A, Haider SH, Bartenstein M, Nwankwo G, Landgren O, Weiden M, Fletcher F, Greenberger L, Ebert BL, Steidl UG, Britta Will, **Nolan A**, Prezant D, Madireddy A, and Verma A. **High Burden of Clonal Hematopoiesis in First Responders Exposed to the World Trade Center Disaster.** Session: 503. Clonal Hematopoiesis: Aging and Inflammation: Poster III Hematology Disease Topics & Pathways: Biological Processes, hematopoiesis ASH Annual Meeting, December 5-8, 2020. San Diego Convention Center, San Diego, CA; Monday, December 9, 2019, 6:00 PM-8:00 PM; Hall B, Level 2 (Orange County Convention Center).
18. Kwon S; **Nolan A.** METABOLIC SYNDROME BIOMARKERS OF WORLD TRADE CENTER AIRWAY HYPERREACTIVITY: A 16 YEAR PROSPECTIVE COHORT STUDY. **Population-wide lung health: exposures and risks.** Ernest N. Morial Convention Center: 267. October 23, 2019. Presentation 11:00-11:15 am Chest New Orleans
19. Kwon S; Clementi E.; Crowley G; Schwartz T; Zeig-Owens R; Liu M; Prezant DJ; **Nolan A.** Clinical Biomarkers of World Trade Center Airway Hyperreactivity: a 16-Year Longitudinal Study. American Thoracic Society International Meeting Dallas, Texas, US. Sunday May 19, 2019 A104 - WILDFIRE, BIOMASS, AND WORLD TRADE CENTER EXPOSURES Poster Discussion Session 2:15 PM - 4:15 PM. American Journal of Respiratory and Critical Care Medicine 2019;199: A2492

20. Crowley G; Kwon S; Lin Y; Clementi E; Haider SH; Talusan A; Prezant DJ; Schwartz T; Zeig-Owens R; Liu M; McRitchie S; Sumner SJ; **Nolan A.** Metabolomics of WTC-Lung Injury (WTC-LI): a Validation Study. American Thoracic Society International Meeting Dallas, Texas, US May 2019. Sunday May 19, 2019 A104 - WILDFIRE, BIOMASS, AND WORLD TRADE CENTER EXPOSURES Poster Discussion Session 2:15 PM - 4:15 PM. American Journal of Respiratory and Critical Care Medicine 2019;199:A2490
21. Veerappan A; Oskuei A; Vaidyanathan S; Crowley G; Wadghiri YZ; **Nolan A.** World Trade Center Particulate Matter Associated Cardiopulmonary Dysfunction and Injury: Incorporating Echocardiography in a Murine Model. American Thoracic Society International Meeting Dallas, Texas, US. Sunday May 19, 2019 A104 - WILDFIRE, BIOMASS, AND WORLD TRADE CENTER EXPOSURES Poster Discussion Session 2:15 PM - 4:15 PM. American Journal of Respiratory and Critical Care Medicine 2019;199: A2491
22. Lam R; Riggs J; Sunseri M; Kwon S; Crowley G; Schwartz T; Zeig-Owens R; Halpern A; Liu M; Prezant DJ; **Nolan A.** Nutritional Assessment of the World Trade Center-Health Program Fire Department of New York Cohort. American Thoracic Society International Meeting Dallas, Texas, US. Tuesday May 21, 2019 C43 – COPD AND POPULATION HEALTH Thematic Poster Session; 9:15 AM - 4:15 PM. American Journal of Respiratory and Critical Care Medicine 2019;199: A4877
23. Oskuei A;Haider SH; George Crowley¹, BA¹, Sophia Kwon, DO, MPH¹, Rachel Lam; Jessica Riggs; Mena Mikhail; Angela Talusan; James S. Kim¹, Erin J. Caraher; Veerappan A; **Nolan A.** Receptor for Advanced Glycation End-Products and Environmental Exposure Related Obstructive Airways Disease: a Systematic Review. American Thoracic Society International Meeting Dallas, Texas, US. Tuesday, May 21, 2019. C45 - EFFECTS OF THE ENVIRONMENT ON PULMONARY HEALTH Thematic Poster Session; 9:15 AM - 4:15 PM. American Journal of Respiratory and Critical Care Medicine 2019;199: A4924
24. Oskuei A; Veerappan A; Vaidyanathan S; Crowley G; Wadghiri YZ; **Nolan A.** Novel Use of μ -PET/CT Imaging to Detect Cardiopulmonary Changes in a Murine Model Following World Trade Center Particular Matter Exposure. American Thoracic Society International Meeting Dallas, Texas, US. Sunday May 19, 2019 A104 - WILDFIRE, BIOMASS, AND WORLD TRADE CENTER EXPOSURES Poster Discussion Session 2:15 PM - 4:15 PM. American Journal of Respiratory and Critical Care Medicine 2019;199:A2493
25. Riggs J; Kwon S; Crowley G; Ostrofsky D; Talusan A; Mikhail M; Kim J; Zeig-Owens R; Schwartz T; Prezant DJ; Liu M; **Nolan A.** Validation of Biomarkers of WTC Lung Injury: Design of a Case Cohort Control. American Thoracic Society International Meeting Dallas, Texas, US. Sunday May 19, 2019 A104 - WILDFIRE, BIOMASS, AND WORLD TRADE CENTER EXPOSURES Poster Discussion Session 2:15 PM - 4:15 PM. American Journal of Respiratory and Critical Care Medicine 2019;199: A2494
26. Mikhail M; Crowley G; Veerappan A; Haider SH; Caraher EJ; Lam R; Kwon S; Ostrofsky D; **Nolan A.** Quantifying Cardiopulmonary Collagen Deposition in a Murine Model of WTC-PM Exposure. American Thoracic Society International Meeting Dallas, Texas, US. Sunday May 19, 2019 A50 - MOLECULAR MECHANISMS OF ENVIRONMENTAL AND OCCUPATIONAL LUNG DISEASES Thematic Poster Session. 9:15 AM - 4:15 PM. American Journal of Respiratory and Critical Care Medicine 2019;199: A1831
27. Ostrofsky D; Lam R; Haider SH; Crowley G; Talusan A; Kwon S; Zhang L; Liu M; **Nolan A.** Synergistic Interleukin-1 α Elaboration due to World Trade Center Particulate Matter and Lipid Co-Exposure in vitro is not NF- κ B Dependent. American Thoracic Society International Meeting Dallas, Texas, US. . Sunday May 19, 2019 A104 - WILDFIRE, BIOMASS, AND WORLD TRADE CENTER EXPOSURES Poster Discussion Session 2:15 PM - 4:15 PM. American Journal of Respiratory and Critical Care Medicine 2019;199: A2497
28. Riggs J; Lam R; Kwon S; Crowley G; Oskuei A; Liu M; St. Jules DE; Prezant DJ; Sevvick MA; **Nolan A.** Food Intake REstriction for Health OUtcome Support and Education (FIREHOUSE) Trial: Study Design. Chest Congress Bangkok Thailand April 2019. Chest 155(4):227A. DOI: 10.1016/j.chest.2019.02.214
29. Kwon S; Clementi E.; Crowley G; Schwartz T; Zeig-Owens R; Liu M; Prezant DJ; **Nolan A.** Clinical Biomarkers of World Trade Center Airway Hyperreactivity: a 16-Year Longitudinal Study. Chest Congress Bangkok Thailand, April 10, 2019. Chest 155(4):142A. DOI: 10.1016/j.chest.2019.02.134

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30. Haider SH; Crowley G; Sunseri M; Erin J. Caraher; Rachel Lam; Kwon S; Prezant DJ; Chen LC; Schmidt AM; **Nolan A.** Advanced Glycation End-products Receptor: Mediator of Persistent Airway Reactivity after Particulate Matter Exposure. 11125 Rapid Abstract Poster Discussion Session: A105 - DUST AND

PARTICULATE MATTER EXPOSURE RAPiD. American Thoracic Society International Conference, San Diego: Sunday May 20, 2018 2:15 PM - 4:15 PM **American Journal of Respiratory and Critical Care Medicine 2018;197: A2587**

31. Kwon S; Haider SH; Caraher EJ; Lam R; Crowley G; Schwartz T; Liu M; Prezant DJ; **Nolan A.** Lipids Metabolic Syndrome Biomarkers of Lung Injury in World Trade Center Exposed Firefighters: a 15 Year Longitudinal Cohort Study. 9392 Rapid Abstract Poster Discussion Session: A105 - DUST AND PARTICULATE MATTER EXPOSURE RAPiD. American Thoracic Society International Conference, San Diego: Sunday May 20, 2018 2:15 PM - 4:15 PM **American Journal of Respiratory and Critical Care Medicine 2018;197: A2584**
32. Caraher EJ; Haider SH; Kwon S; Crowley G; Chen LC; **Nolan A.** Pioglitazone Pre-Treatment by Gavage Attenuates Particulate Matter Induced Lung Disease. 14571 Thematic Poster Session - C34-COPD POTPOURRI. American Thoracic Society International Conference, San Diego: Tuesday May 22, 2018 9:15 AM - 4:15 PM **American Journal of Respiratory and Critical Care Medicine 2018;197: A476**
33. Caraher EJ; Crowley G; Haider SH; Kwon S; Lam R; Riggs J; Oskuei A; **Nolan A.** Lipids as Modifiable Risk Factors of Environmental Lung Disease: a Systematic Review of the Good, the Bad and the Misunderstood 14685 Thematic Poster Session - C34 - COPD POTPOURRI. American Thoracic Society International Conference, San Diego: Tuesday May 22, 2018 9:15 AM - 4:15 PM **American Journal of Respiratory and Critical Care Medicine 2018;197: A4777**
34. Crowley G; Kwon S; Haider SH; Caraher EJ; Lam R; Liu M; Prezant DJ; **Nolan A.** Metabolite and Biomarker Predictors of World Trade Center-Lung Injury: an Integrated Multiplatform Machine Learning Approach. 12817 RAPiD: Rapid Abstract Poster Discussion Session - A105 DUST AND PARTICULATE MATTER EXPOSURE. American Thoracic Society International Conference, San Diego: Sunday May 20, 2018 2:15 PM - 4:15 PM **American Journal of Respiratory and Critical Care Medicine 2018;197: A2588**
35. Lam R; Caraher EJ; Sunseri M; Haider SH; Kwon S; Crowley G; **Nolan A.** Nutritional Assessments and Obstructive Airways Disease: a Systematic Review. 11853 Thematic Poster Session: A66 - PULMONARY REHABILITATION: CLINICAL STUDIES IN COPD. American Thoracic Society International Conference, San Diego: Sunday May 20, 2018 9:15 AM - 4:15 PM. **American Journal of Respiratory and Critical Care Medicine 2018;197: A2165**

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37. Gershner, K; Doo, K; Paulsen, J; Cho, M; **Nolan, A.** A case of treatment-resistant eosinophilic-granulomatosis with polyangiitis with diffuse alveolar hemorrhage: Management and clinical outcome. Chest, Toronto Canada, October 2017. Volume 152, Issue 4, Supplement, Page A428.
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39. SH Haider, G Crowley, L Zhang, R Lam, E Caraher, S Kwon, DJ Prezant, AM Schmidt, **A Nolan.** Persistence of World Trade Center Particulate Induced Hyperresponsiveness and the Role of RAGE. Military Health System Research Symposium: Kissimmee, FL, US August 27, 2017.
40. G Crowley; S Kwon, SH Haider, L Zhang, R Lam, D Kim, M Liu; DJ Prezant; **A Nolan.** Metabolite and Biomarker Predictors of WTC-Lung Injury: an Integrated Multiplatform Pilot Analysis. *ACTS Translational Science*: Washington DC, US April 19-21, 2017.
41. SH Haider, L Zhang, G Crowley, EJ Caraher, R Lam, S Kwon, AM Schmidt, LC Chen, DJ Prezant, **A Nolan.** Receptor for Advanced Glycation End-products: Mitigating the Persistent Effects of Particulate Matter Induced Airway Injury. *ACTS Translational Science*: Washington DC, US April 19-21, 2017.
42. S. Kwon, G. Crowley, S.H. Haider, R. Lam, L. Zhang, R. Zeig-Owens, T. Schwartz, D. Prezant, **A. Nolan.** Weight Loss as a Modifiable Risk: Body Mass Index and Loss of Lung Function in World Trade Center Particulate Exposure B95 NEW INSIGHTS FROM WORLD TRADE CENTER PARTICULATE EXPOSURE

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 47. Crowley G; Kwon S; Haider SH; Caraher EJ; **Nolan A**. Quantitative Lung Morphology: Semiautomated Method of Mean Chord Length Measurements. C80-C IMAGING METHODOLOGY AND APPLICATION TO LUNG DISEASE / Thematic Poster Session / Tuesday, May 23. Am J Respir Crit Care Med 2017;195: A6510. Washington DC, US May 2017
 48. Beattie J; Parajuli S; Sanger M; Lee G; Pleninger P; Crowley G; Kwon S; Murthy V; Manko JA; Caplan A; Dufort EJ; Staples E; Pastula DM; **Nolan A**. Zika Virus-Associated Guillain-Barré Syndrome in a Returning U.S. Traveler. A58. CRITICAL CARE CASE REPORTS: NEURO-CRITICAL CARE / Thematic Poster Session / Sunday, May 21 Am J Respir Crit Care Med 2017; 195: A2008 Washington DC, USA.
 49. Weiden MD; Zeig-Owens R; Hall CB; Singh A; Aldrich TK; Schwartz T; Webber MP; Cohen HW; Kelly KJ; **Nolan A**; Prezant DJ. Predictors of Accelerated FEV1 Decline in World Trade Center-Exposed Firefighters: a 15-year Longitudinal Study. B95 NEW INSIGHTS FROM WORLD TRADE CENTER PARTICULATE EXPOSURE STUDIES / Mini Symposium / Monday, May 22 Am J Respir Crit Care Med 2017;195: A4650: Washington DC, USA.
 50. Ahmed NH; **Nolan A**; Rouf A; Hanif A; Mukherjee V. Critical Care in the resource-limited setting: Conclusions of a Needs-Assessment in a Public Hospital in Dhaka, Bangladesh. A38 IMPROVING QUALITY AND OUTCOMES OF CRITICAL CARE / Thematic Poster Session / Sunday, May 21 Am J Respir Crit Care Med 2017; 195: A1438: Washington DC, USA.
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