

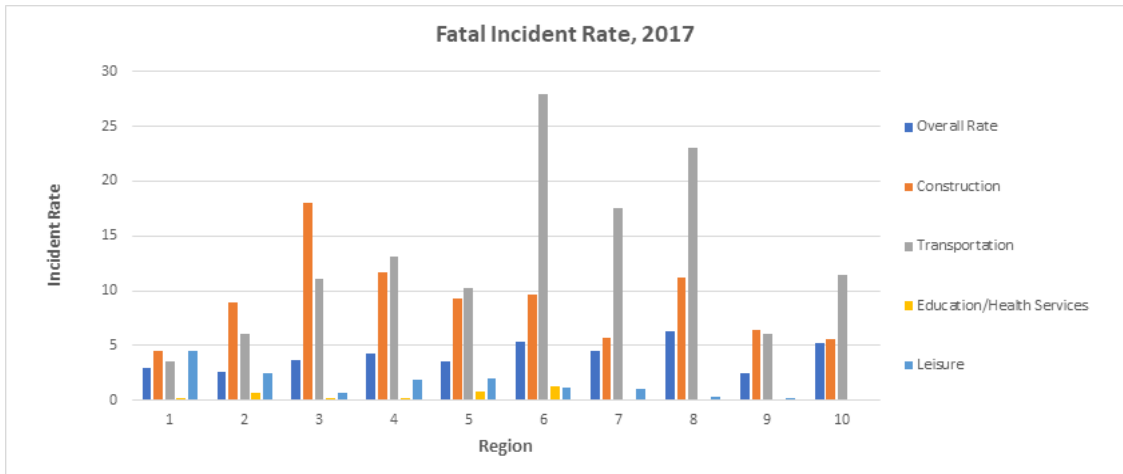
## **The Rocky Mountain Center for Occupational and Environmental Health**

### **University of Utah and Weber State University: 2022**

*“Protecting the worker and the environment through interdisciplinary education, research, and service.”*

- Established in 1977 to meet the need for a comprehensive occupational and environmental health and safety program in the West.
- Became a National Institute for Occupational Safety and Health (NIOSH) Education and Research Center (ERC) in 1978. One of only 18 ERCs in the U.S.
- In 2018, approved by NIOSH for an additional five years with increased funding now to \$1.8 million per year (Best score in US!)
- In 2021, statutorily changed into a multi-university program, jointly run by U.Utah and Weber State University
- Provides Masters and Ph.D.s in Ergonomics, Safety, Industrial Hygiene, Injury Prevention, Occupational Medicine; Continuing Education courses, research, and provides service.
- Implemented unique Master of Science in Occupational Health Program. First graduates 2009. Developed PhD in Occupational and Environmental Health 2012.
- Implemented new undergraduate minor in Occupational Safety and Health.
- Developing BS-OSH at Weber State U. Developing Occup. Health Nursing at WSU.
  - NIOSH estimates 25,000 shortfall in safety professionals.
- Invented Occupational Safety and Health Solutions course to take teams of students to solve real-world OSH problems for businesses, improving competitiveness of businesses.
- Over 735 graduates of academic programs since 1977.
- High ratings from graduates (99.2 % are satisfied or very satisfied with our programs).
- >150,000 Continuing Education and Outreach students.
- Serving over 3,000 businesses.
- Research to prevent trucking deaths (4,500/yr.) and nursing injuries transferring patients.
- Faculty lead development of national guidelines for treatment of occupational injuries.
- Published national treatment guidelines (>19,000 references). 2022: Disability Prevention, 2021: Anxiety.
- Developed the only occupational health guideline for COVID
- Research showing COVID likely spread by microdroplets and aerosols
  - Also explains ongoing spread despite masks and lockdowns, which are at best, only partially effective
- Vaccine efficacy studies for CDC with healthcare, first responder, and frontline workers.
- Each day, 9,000 of the nation’s workers sustain disabling injuries on the job; 137 people die from work-related illnesses; economic burden equivalent to cancer and heart disease.

Region 8 Workplace Fatalities cf. Other Regions (Bureau Labor Stats.)



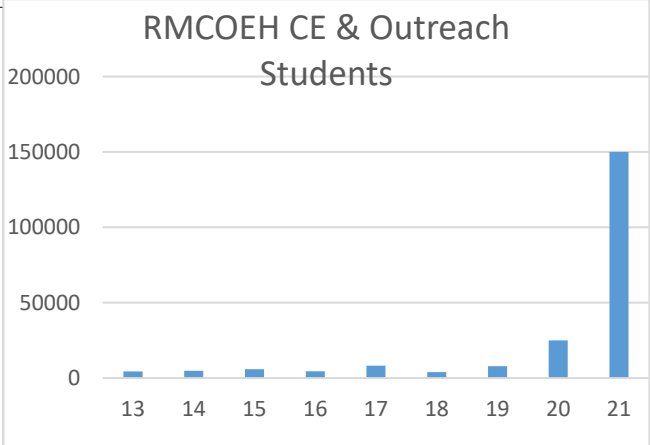
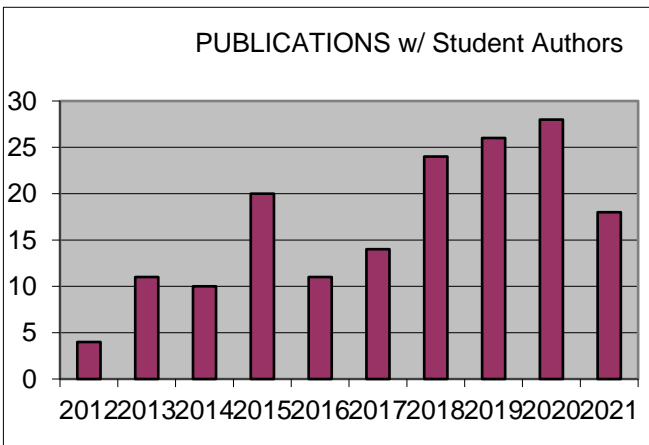
**VISION:** Be the leading international Center in meeting current and future occupational and environmental health and safety challenges.

**MISSION:** Protect workers and the environment through interdisciplinary education, research, and service.

**GOALS:**

1. Advance superior OSH academic programs.
2. Conduct meaningful OSH research.
3. Provide exceptional continuing education, service, and outreach.
4. Engineer OSH Solutions.

- RMCOEH has 392 full-time, adjunct and other supporting faculty (18 FPE)
- Funding increased 53.1% over 5-years!
- NIOSH reported 602 research publications from all funding streams in Oct. 2017-Sept. 2018, including 35 Centers and many research grants,
  - Yet RMCOEH authored 50 (66 pubs in 2021) publications **or 8.3%!!**
- 12,971(269,611 2-years) Outreach students/contacts over 5-years!
- **36,596 contact hours!**
- 82 separate outreach activities to 4,821 trainees during 2018-2019
- 16,684 CE trainees attended 1,123 CE activities over 5 years, with over 210,740 hours of instruction!



- RMCOEH trained 736 graduates to date.
- Overall 26.4% minority students.
  - Graduation rate for underrepresented minorities 100%
  
- **Graduate Surveys:**
  - Job titles are: Manager 17.2%; Director 22.4%; Staff 35.3%; Other 25.9%.
  - Average estimated injury reductions: 35.9%.
  - Median annual cost savings from graduates' OEHS work are: \$100-250K.
  - Median budget under graduates control is \$120K (range 0-\$3.26 **Billion!**).
  
  - How much would you recommend the RMCOEH programs?
 

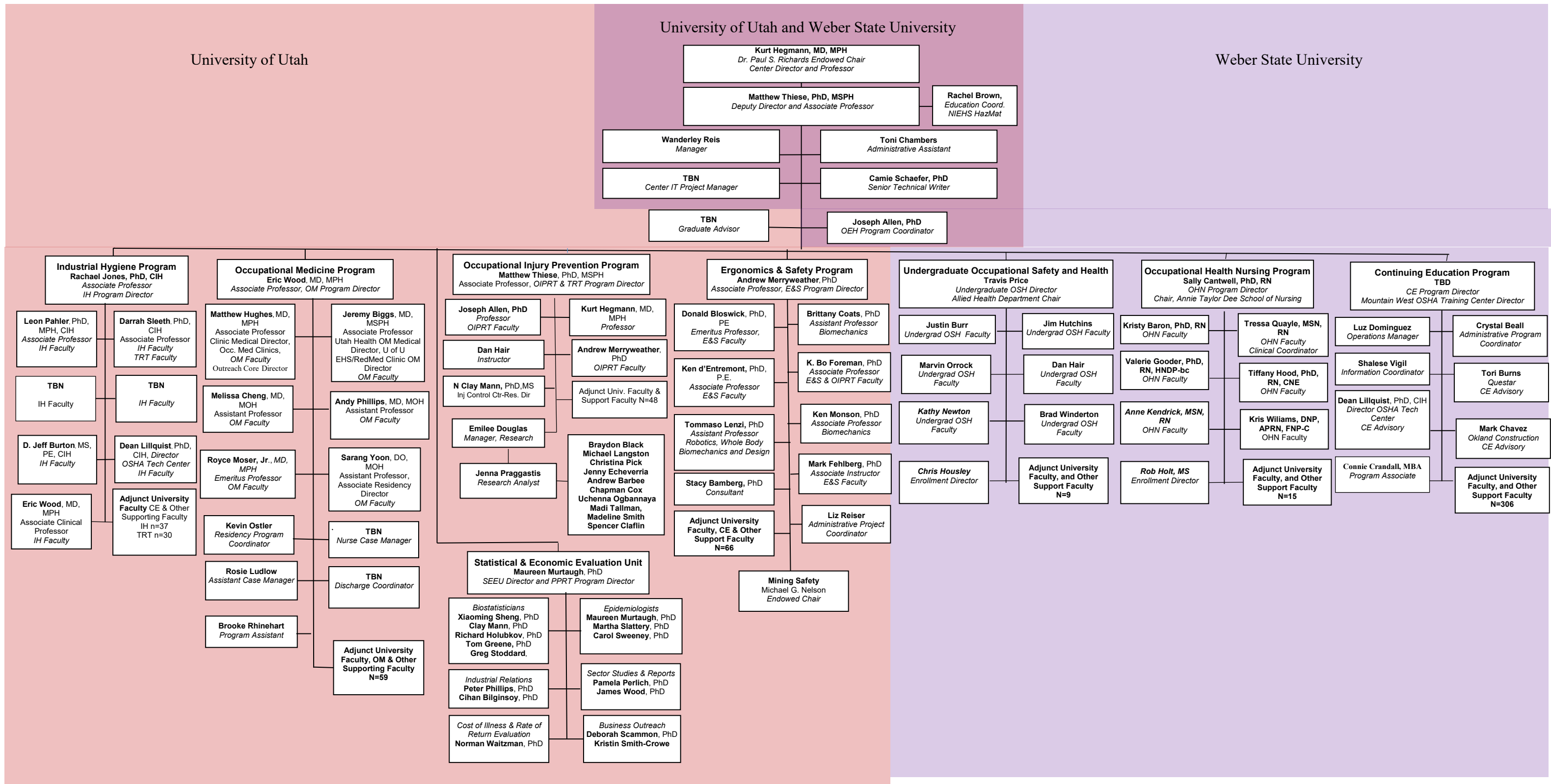
<b><u>Enthusiastically recommend</u></b>	(10) 67, 56.8
	(9) 36, 30.5%
	(8) 13, 11.0%
	(7) 1, 0.8%
	(6) 1, 0.8%
	(5) 0.0%
	(4) 0.0%
	(3) 0.0%
	(2) 0.0%
<b><u>Recommend against</u></b>	(1) 0.0%

**Future Plans. Over the next 5-year period, we plan to:**

- (1) Further diversify funding,
- (2) Increase our existing academic programs
- (3) Advance our robust Research Training
- (4) Grow our research programs, and;
- (5) Implement a distance-based Master of Occupational Health program.

# ROCKY MOUNTAIN CENTER FOR OCCUPATIONAL AND ENVIRONMENTAL HEALTH – ORGANIZATIONAL CHART

## University of Utah and Weber State University



Rocky Mountain Center for

# RMCOEH

Occupational and Environmental Health

*Dedicated to protecting workers and their environment  
through interdisciplinary education,  
research, and service.*



**Visit our Website**

[www.medicine.utah.edu/rmcoeh](http://www.medicine.utah.edu/rmcoeh)

**Find us on Facebook**

Rocky Mountain Center for  
Occupational and Environmental  
Health (@UofUOEH)

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Rocky Mountain Center for  
Occupational and Environmental  
Health

**Follow us on Twitter**

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**Watch our videos on YouTube**

Channel: Rocky Mountain Center

**Submit an alumni profile**

Email Toni Chambers at  
[toni.chambers@hsc.utah.edu](mailto:toni.chambers@hsc.utah.edu)

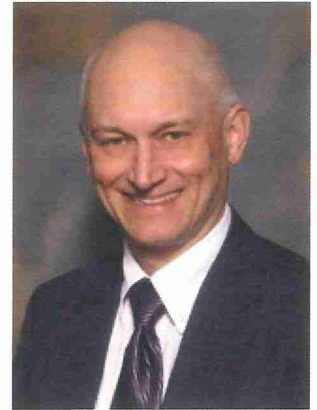
We want to hear from you!

## In this Issue

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**“Protecting workers and their environment through interdisciplinary education, research, and service.”**

## **A Message from the Center Director**



As the number of COVID-19 vaccinations rises, the faculty, trainees, and staff of the Rocky Mountain Center for Occupational and Environmental Health (RMCOEH) are preparing for the post-pandemic future. The lessons of the past year have made it clear the vital role that occupational and environmental health will play in this “new normal,” whether it be by establishing vaccine efficacy in the real world (read more about Dr. Sarang Yoon’s work on pgs. 4-5), dedicating research effort to environmental health (read more about Dr. Darrah Sleeth’s work on pg. 6), preparing workers of the future to meet virtually as well as in boardrooms (read more about Dr. Joe Allen’s work on pg. ), or in the numerous other ways that we are all working to meet and improve the days to come.

In turn with the changing times, we here at RMCOEH have initiated a new partnership that will widen the breadth and scope of education and research that we offer to Utah, Region 8, and across the nation. Senate Bill 172 invested the University of Utah and Weber State University with shared governance of the RMCOEH. Although the Senate bill offers only the first strokes on the canvas of this collaboration, we here at the Center are excited to see what details will be revealed over the weeks and months to come. We look forward to expanding our reach and expertise in creating safe and healthy workplaces and workers.

Many other new initiatives have taken their first steps this spring, from Dr. Rachael Jones’s application to form a center for Total Worker Health® (pg. 7) to Dan Hair’s continued efforts to build an undergraduate major in occupational safety and health (pg. 15). We have said our goodbyes to valued team members (pg. 13) while welcoming new ones (pg. 14) who will accompany the Center on its journey of change. Our collaborations with trusted friends and advisors of the Center, such as WCF Insurance, continue to foster an environment to produce excellence in education and research.

Perhaps fittingly, one of the most visible changes this year will be the movement of many Center functions to our new building on 250 E (pg. 3). The build-out comes with all the challenges of change—delays, confusion, new choices to be made—but these barriers are well-worth the improvements to come. One of the most exciting additions to our new space will be the WCF-supported Eddie P. and Karen Mayne Education Center. This gathering space will be named to celebrate the Maynes, who have been pioneers in supporting the growth of occupational and environmental health in Utah. We look forward to the day when events will be held there, which will be a fitting joining of past, present, and future.

Kurt T. Hegmann, MD, MPH  
RMCOEH Director  
Dr. Paul S. Richards Endowed Chair in Occupational Safety and Health

# NEW PARTNERSHIPS FOR RMCOEH



## WEBER STATE UNIVERSITY

On March 23, 2021, Utah Governor Spencer Cox signed Senate Bill 172 into law alongside Senator Karen Mayne, University of Utah Vice President for Research Andy Weyrich, Weber State President Brad Mortensen, Weber State Provost Ravi Krovi, Mr. Dennis Lloyd of WCF Insurance, Mr. Rob Gardner from Liberty Mutual, and two other members of the RMCOEH Advisory Board.

Although it was one of many bills that Governor Cox signed into law that day, it was notable for at least one reason. Turning to Senator Mayne, Governor Cox thanked her for sending him an “easy one” that he only had to read once. The legislation encourages undergraduate occupational safety training, recognizes Utah State University’s excellent Industrial Hygiene program, and fosters an environment for restarting the RMCOEH’s Occupational Health Nursing program. This “no-brainer” for Governor Cox sets the groundwork for the RMCOEH to become a multi-university institution that joins together the expertise of the University of Utah with Weber State University.



Chief Sponsor: Karen Mayne (D-WVC)



## THE UNIVERSITY OF UTAH

Leadership at both institutions will share responsibility for joint operation of the RMCOEH, joint construction of the RMCOEH’s budget and of the RMCOEH Advisory Board. The legislation also doubles the cap on the tax credit mechanism to support the center, which was originally passed in 2005 (SB159) and is a dollar-for-dollar tax deduction against worker’s compensation premium taxes paid by worker’s compensation insurers and qualified self-insured employers.

Discussions are ongoing at present in terms of implementing new programs and certificates, how this cross-institutional collaboration can best increase the outreach, research, and educational activities linked to the Center, and more. Center Director Dr. Hegmann and Deputy Director Dr. These are hard at work discussing how to build an administrative core that crosses institutional lines. Meetings have already taken place to introduce faculty and staff across universities. Although plans at present are chiefly in the formative stage, this move has been heralded with considerable enthusiasm and excitement from all parties involved.



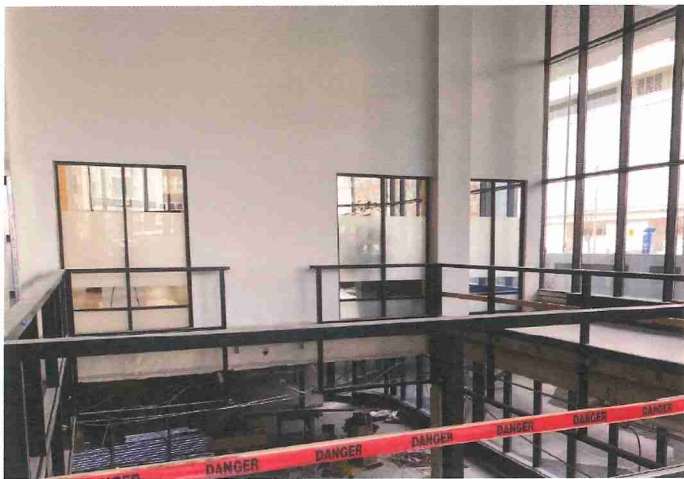
House Sponsor: Val L. Peterson (R-Orem)



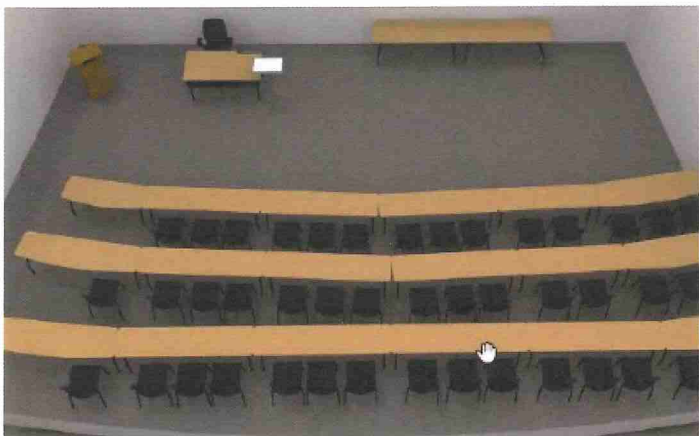
# READYING A NEW SPACE



Searching for a perfect home is never easy, especially for an inter-departmental (now inter-institutional) center with numerous faculty and staff, many of whom require specialized spaces to carry out the RMCOEH's mission. As Center leadership toured various buildings and adequate space was not found on the U.Utah campus, they sought out a place where organizational psychology research could be conducted in Dr. Allen's Center for Meeting Effectiveness while research assistants conducted data analysis and literature reviews, at the same time as community members gathered for OSHA and NIOSH classes and patients saw physicians in exam rooms nearby. Fortunately, the 250 building in downtown Salt Lake City proved versatile enough to handle the multifaceted needs of the RMCOEH.



However, the unique demands of the Center required that the build-out be designed and conducted over months. Although the old home at 391 Chipeta Way is scheduled to be demolished, the shift to remote work has allowed RMCOEH's operations to continue apace. Right now, the future offices are filled with hazard tape and new windows and doors, all of which are looking more and more complete by the day.



All this construction is supported by a generous gift of \$1.1 million from WCF Insurance. WCF's values include helping others succeed, and their dedication to helping promote workplace safety is reflected in their generosity to the RMCOEH. As part of their gift, WCF is honoring two pioneers of occupational safety in Utah: Eddie P. Mayne, a labor leader and state senator whose legacy can be seen across Utah, and the late senator's equally illustrious wife, Karen Mayne, who succeeded her husband in the Utah Senate. The Education Center named for the Maynes will become a key gathering point for occupational health and safety research, education, and training.

# RECOVER STUDY FINDINGS

Readers may remember Dr. Sarang Yoon's (pictured below top left) aptly named CDC-funded RECOVER study: a multi-site longitudinal cohort study dedicated to monitoring SARS-CoV-2 infection rates among healthcare workers, first responders, and essential frontline workers. Soon after the study began, RECOVER's mission expanded to include studying vaccine efficacy in the "real world." As Dr. Hegmann has remarked, initial studies nearly always overstate efficacy by controlling some of the chaos of daily lives—something that could potentially pose trouble for the newly developed SARS-CoV-2 vaccines. However, through the efforts of Dr. Yoon and other investigators across the country, the CDC has found 80% efficacy after one dose of either the Pfizer or Moderna vaccines, and 90% after the vaccination series was completed. This excellent news indicates that vaccination is key to ending the pandemic.

Dr. Yoon will be continuing with this valuable work through March of 2022, which will help the CDC determine how long vaccine immunity lasts as well as continuing to monitor infection rates among

occupational populations most at risk. RECOVER results will also be used to test the efficacy of vaccines against variants, as well as the severity of any breakthrough infections.



Facts about RECOVER:

- RECOVER includes participants from Arizona, Florida, Oregon, Minnesota, and Utah

- 450 of the participants were first responders, healthcare workers, and essential workers from Utah

- The Utah section of the study drew many staff from the RMCOEH Research Team, a longstanding team of undergraduate and graduate students whose research experience proves invaluable to future educational and employment opportunities.

## SEE THE FACES OF



# MMWR PUBLICATION

On March 29, 2021 the CDC published results from the RECOVER study in the Morbidity and Mortality Weekly Report (MMWR) titled Interim Estimates of Vaccine Effectiveness of BNT162b2 and mRNA-1273 COVID-19 Vaccines in Preventing SARS-CoV-2 Infection Among Health Care Personnel, First Responders, and Other Essential and Frontline Workers — Eight U.S. Locations, December 2020–March 2021. The MMWR is an epidemiological digest that has existed in various forms since 1896, and offers public health information from state health departments, CDC-funded studies, and other valuable findings. The publication discussing the RECOVER findings quickly reached the attention of various media outlets as well as individuals on social media. See the two figures below for a glimpse into how widespread these findings have been.



The publication is currently #8 for its initial attention out of 3,608 prior MMWR publications, signifying an extraordinary detail of impact. The University of Utah celebrated these findings via press releases and social media announcements at the department and university levels, including presentations at the University of Utah 3i Initiative and the University Clinical Livestream. National news outlets included The New York Times, The Wall Street Journal, CNN, The Los Angeles Times, The Washington Post, and more (see below for snapshots).

“This is very reassuring news,” said the CDC’s Mark Thompson, the study’s lead author. “We have a vaccine that’s working very well.”

**Pfizer, Moderna vaccines are 90% effective after two doses in study of real-life conditions, CDC confirms**

**Pfizer and Moderna Covid-19 work in real-world conditions**

**very effective**

In addition, the data indicated the vaccines can reduce the risk of coronavirus infections whether or not they cause symptoms, the CDC said.

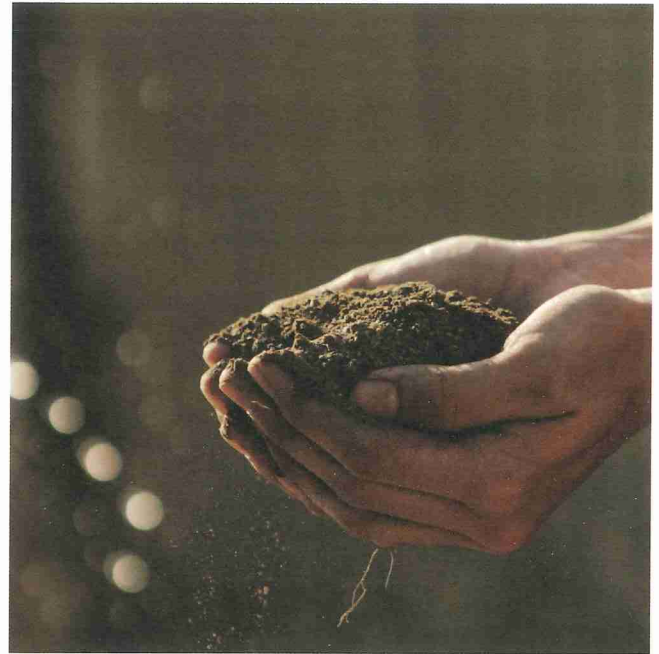
The results of this study are similar to what scientists saw in clinical trials for the vaccines, but studies like this are important to show how effective the vaccines are, particularly in a population that, through their work, can encounter a large number of people who have Covid-19.

# THE “E” IN OEH: ENVIRONMENTAL HEALTH

The “E” in OEH is never silent, although at first glance a casual observer might be forgiven for thinking that the focus is more on ensuring the safety and health of the worker rather than the environment surrounding them. In fact, environmental health is a key tenet that has only increased in practical and theoretical importance over the past decade. The hierarchy of controls that every OEH professional learns early on in training (see the figure on pg. 7 for an overview) prioritizes control of the worker’s environment first through engineering and administrative controls (e.g. ventilation and mandatory breaks) rather than implementing personal protection (e.g. a respirator). In addition, NIOSH and other organizations invested in worker and workplace health have recognized an employee’s right to clean, hazard-free, and green spaces is a fundamental one. Environmental health touches aspects of many, if not all, elements of work at the RMCOEH: noise levels, air quality, ventilation, and more.

One leading researcher at the RMCOEH who has dedicated considerable time and effort to environmental health is Dr. Darrah Sleeth, whose research examines how to monitor environmental health (through sampling technologies) as well as how to protect and preserve the environmental health of vulnerable populations. Dr. Sleeth, in collaboration with other RMCOEH and University of Utah faculty (e.g. Drs. Scott Collingwood, Rod Handy, and Tony Butterfield) has conducted important work in collaboration with Native American reservations in the Rocky Mountain West. Dr. Sleeth has led several pilot studies that have produced concerning data regarding air and soil quality and has worked with these communities to identify other areas of concern, such as access to clean water. Although environmental health inequities can lead to adverse health issues in the general population, they can have a particularly potent effect on reproductive, maternal, and pediatric health.

Dr. Sleeth’s work centers on community-based participatory research (CBPR). CBPR is a research method that



emphasizes a full partnership with a community and includes community input at every stage of the research and dissemination. Native American communities, who have often been exploited by scientific research, find that CBPR is an important first step in establishing trust with the research team. CBPR also ensures that communities can express their concerns, maintain ownership of their data, and put research findings into immediate practice. By working with community leaders and stakeholders, Dr. Sleeth and other investigators can focus on how to promote environmental health for the betterment of all.

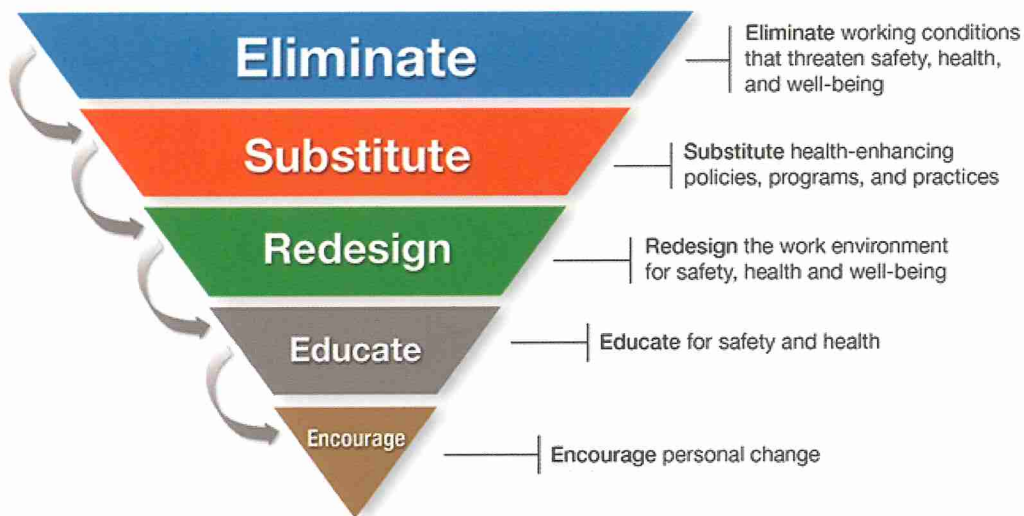


# RESEARCH UPDATES



Congratulations to Drs. Matt Thiese and Kurt Hegmann! They were recently awarded a subcontract with Applied Research Associates to conduct a systematic literature review on seizure standards for commercial truck drivers. This work will examine the risk of seizure recurrence among adults treated with antiepileptic drugs and those who are not treated with said drugs, and will present professional recommendations regarding commercial drivers following a seizure. Drs. Hegmann and Thiese will work with the RMCOEH Research Team to gather studies, including epidemiologic studies and randomized controlled trials, from a number of

databases, including PubMed, Scopus, and Google Scholar (among others). They will then evaluate individual state guidelines and regulations for commercial drivers, including exemption criteria, medical review criteria, and physician liability. They will also consult with known medical experts and develop presentations and reports compiling the information. This work is a natural extension of previous work from this team and will offer a valuable contribution to the field of commercial driver safety.

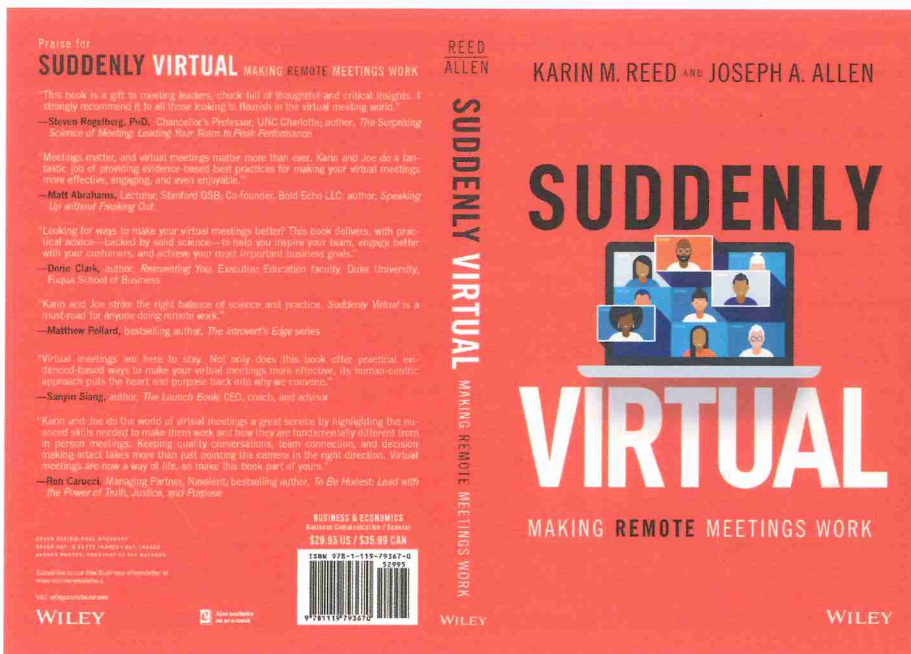


The traditional view of worker health and safety has often focused on the workplace alone, such as the creation of conditions that protect safety and health. However, NIOSH's Total Worker Health® (TWH) approach, which coalesced in 2011, takes "an integrated, holistic approach to worker well-being." TWH incorporates community support, environmental health, compensation and benefits, healthy leadership, work-life

quality, and workforce demographics alongside prevention and control of hazards and exposures. Furthermore, TWH also examines technology and labor dynamics in the workplace. As the workforce continues to change in 2021 and after, TWH is vital to keeping workers healthy and safe.

To that end, research from the RMCOEH incorporates the pyramid of engineering controls (see above) and other elements of TWH. And in February of 2021, Dr. Rachael Jones took one step toward a further incorporation of TWH by applying for a Center of Excellence in Total Worker Health. The proposed University of Utah Center for Promotion of Work Equity Research (U-POWER) consisted of five individual research projects from faculty from the RMCOEH and elsewhere, as well as evaluation and outreach cores designed to further the center's reach. Although the grant has yet to be scored, the process of building strong collaborative teams and preparing a 601-page proposal has taken research at RMCOEH a step closer to TWH.

# A GUIDE TO VIRTUAL MEETINGS



One area of Dr. Joe Allen's expertise is meeting science—the study of organizational behavior within meetings, scientific best practices for meetings, and using meetings as a tool to empower employees within an organization. After March of 2020 and the rise of remote work in response to COVID-19, Dr. Allen's research noticed a sharp shift in where and how people met: face-to-face meetings decreased by 66%, while virtual meetings rose 57%. As that shift happened, Dr. Allen noted a rise in corresponding meeting issues: Zoom fatigue, WebEx weariness, and growing disengagement with the faces visible across the screen. Cue a new partnership with Karin Reed, CEO

of Speaker Dynamics, a communication firm based in North Carolina. Together, they embarked on the process of translating their findings and expertise into a new book. *Suddenly Virtual: Making Remote Meetings Work* was published on March 9, 2021 after long hours spent creating a book with an urgent deadline. People needed help with their remote meetings, and they needed it now. Dr. Allen explains that his and Ms. Reed's goal was "to get the best practices for virtual meetings out there to help all of us combat zoom fatigue and succeed in our various roles, jobs, and industries." For more information on where to purchase, please visit Wiley Publications.

## Eight Tips for Better Virtual Meetings

1. Turn the camera on and keep it at eye level. Try making eye contact with the green dot of the camera.
2. Keep it natural and conversational.
3. Avoid counterproductive meeting behaviors like lateness, monologuing, and excessive complaining.
4. Foster the humor habit!
5. Check your tech in advance.
6. Create opportunities for meeting participants to engage in small talk. Even a minute or two of chatting can make for a better meeting.
7. Don't ignore the importance of production values: check your lighting and background.
8. Use meeting science checklists as a self-diagnostic tool.



# SELECTED PUBLICATIONS

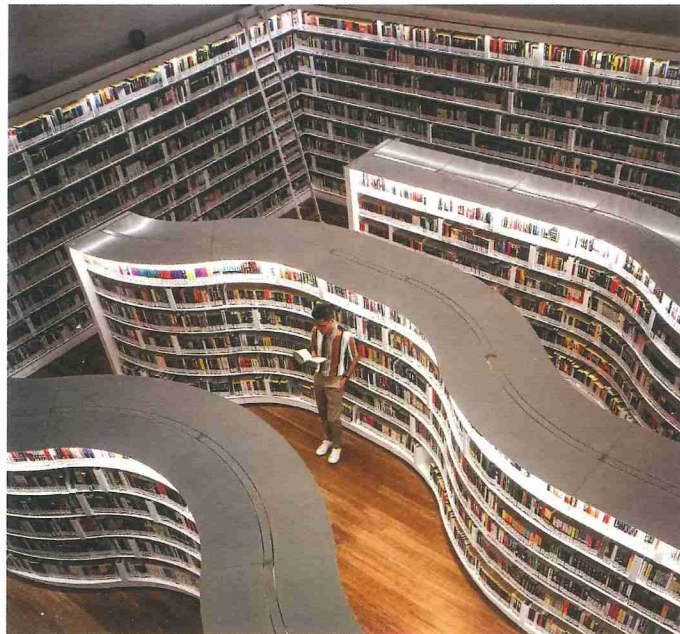
Dr. Rachael Jones collaborated on “Factors associated with environmental service worker cleaning practices in health care settings: A systematic review of the literature” with three other co-authors, including Dr. Angela Fraser at Clemson University. Environmental cleaning in healthcare settings (from hospitals to long-term care facilities) is vital to reducing the spread of healthcare-associated infections. This review identified 31 eligible studies that discussed environmental service workers (ESW) and disinfection in healthcare settings. Dr. Jones and other authors found that education and training sessions heightened ESW knowledge, skills, and perceptions. To be most effective, however, these training sessions needed to be continuous and combined with performance evaluation.

**Citation:** Hewage SCN, Cao LTT, Jones RM, Fraser AM. **Factors associated with environmental service worker cleaning practices in health care settings: A systematic review of the literature.** *Am J Infect Control.* 2021 Jan 9;50:196-6553(21)00003-1. doi: 10.1016/j.ajic.2021.01.001. Epub ahead of print. PMID: 33434592.

Dr. Andrew Merryweather and his coauthors discussed another aspect of healthcare safety in “Optimizing Hospital Room Layout to Reduce the Risk of Patient Falls.” Patient falls are a serious concern to patient safety. This article discussed a hospital room fall model that considered the effect of surrounding objects (i.e. if they were likely to increase or decrease the likelihood of a fall) as well as possible routes that patients might take inside the room. Dr. Merryweather and the authors modeled the impacts of these variables and presented results for two real-world hospital room types and found that patient fall risk was decreased by 18% on average when compared to a traditional hospital room.

**Citation:** Chaeibakhsh S, Sabbagh Novin R, Hermans T, Merryweather A, Kuntz A. **Optimizing Hospital Room Layout to Reduce the Risk of Patient Falls** 2021 January 01, 2021:[arXiv:2101.03210 p.]. Available from: <https://ui.adsabs.harvard.edu/abs/2021arXiv210103210C>.

Dr. Matt Thiese and co-authors (including Dr. Hegmann) analyzed a large pool of commercial driver exams (88,246) in “What Medical Conditions Limit



or Medically Disqualify Truck Drivers: A Large Cross Sectional Study.” Commercial drivers are required to be medically certified in order to continue employment, and this study investigated relationships between health and certification length. Significant relationships were found for opioid or benzodiazepine use, heart disease, seizures, stroke, musculoskeletal conditions, and vascular conditions. The most common conditions found were obesity, hypertension, and diabetes mellitus requiring medication. However, the authors also found variability in medical certification lengths related to differences between examiners.

**Citation:** Thiese MS, Moffitt G, Hanowski RJ, Kales SN, Porter RJ, Hartenbaum N, Hegmann KT. **What Medical Conditions Limit or Medically Disqualify Truck Drivers: A Large Cross Sectional Study.** *J Occup Environ Med.* 2021 Feb 1;63(2):139-146. doi: 10.1097/JOM.0000000000002101. PMID: 33523617.

Dr. Hegmann led a national, multispecialty team to construct peer-reviewed guidelines for the invasive treatment of low back disorders on behalf of the American College of Occupational and Environmental Medicine. Many systematic reviews were conducted for this project by the RMCOEH Research Team under the direction of Dr. Matthew Thiese. This work then relied on a medical expert panel which included orthopedic surgeons, neurosurgeons, physical therapists and many other specialists to develop guidance. The guidelines included which

# SELECTED PUBLICATIONS

surgical procedure(s) was indicated for which condition, whether for herniated discs, lumbar stenosis, spondylolisthesis, or other conditions. These guidelines are considered presumptively correct for the treatment of injured workers in the state of California and are used internationally.

**Citation:** Hegmann, K.T., Travis, R., Andersson, G.B.J., Belcourt, R.M., Carragee, E.J., Eskay-Auerbach, M., Galper, J., Goertz, M., Haldeman, S., Hooper, P.D., Lessenger, J.E., Mayer, T., Mueller, K.L., Murphy, D.R., Tellin, W.G., Thiese, M.S., Weiss, M.S., Harris, J.S. Invasive Treatments for Low Back Disorders (2021) *Journal of occupational and environmental medicine*, 63 (4), pp. e215-e241.

Dr. Maureen Murtaugh and colleagues worked to conduct a cross-sectional study of epidemiological factors and lipid biomarkers that may be associated with common health problems in Native American communities. This work was described in "Systemic Disease and Ocular Comorbidity Analysis of Geographically Isolated Federally Recognized American Indian Tribes of the Intermountain West." The research team collected photographs of the interior of the eye (fundus photos) and blood samples to detect lipid biomarkers to evaluate for risk of type II diabetes, hypertension, and retinal manifestations of tribal and non-tribal members in the study areas of Ibupah, Utah, and the Four Corners. Different comorbid factors with retinal disease outcomes were found depending on the two tribes who participated in the study.

**Citation:** Hicks PM, Haaland B, Feehan M, Crandall AS, Pettey JH, Nuttall E, Self W, Hartnett ME, Bernstein P, Vitale A, Shakoor A, Shulman JP, Sieminski SF, Kim I, Owen LA, Murtaugh MA, Noyes A, DeAngelis MM. Systemic Disease and Ocular Comorbidity Analysis of Geographically Isolated Federally Recognized American Indian Tribes of the Intermountain West. *J Clin Med*. 2020 Nov 7;9(11):3590. doi: 10.3390/jcm9113590. PMID: 33171720; PMCID: PMC7694968.

Dr. Joe Allen has a long and productive research partnership with Dr. Roni Reiter-Palmon at the University of Nebraska Omaha, and their latest publication is no exception. "Team in Small Organizations: Conceptual, Methodological, and Practical Considerations" recognizes the vital role that

teams play in accomplishing complex work demands. The authors used systems models of teamwork to examine the conditions under which teams work, their core processes, and how small organizations can modify team strategies intended for large organizations to best succeed in their work.

**Citation:** Reiter-Palmon R, Kennel V, Allen JA. Teams in Small Organizations: Conceptual, Methodological, and Practical Considerations. *Front Psychol*. 2021 Mar 18;12:530291. doi: 10.3389/fpsyg.2021.530291. PMID: 33815183; PMCID: PMC8012669.

Dr. Darrah Sleeth's work with two Native American reservations was recognized in the publication of "A Quantitative Comparison of Heavy Metal Concentrations in the Soils on Two Rocky Mountain West Tribal Reservations." Dr. Sleeth and her research team conducted pilot-level sampling of air and soil at two Native American reservations in the Rocky Mountain West to determine possible dangers to health. Soil was monitored for heavy metals, and in one case, high levels of lead were found adjacent to a former community center. Concerning levels of radon were also found, and Dr. Sleeth's CBPR approach (see pg. 5) allowed the research team to work with tribal authorities to arrange additional monitoring and remediation.

**Citation:** Robello, R., Lake, K., Handy, R., Sleeth, D., Collingwood, S. C., & Schaefer, C. (2021). A Quantitative Comparison of Heavy Metal Concentrations in the Soils on Two Rocky Mountain West tribal Reservations. *Journal of Student Research*, 10(1). <https://doi.org/10.47611/jsr.v10i1.1182>

## Other Selected Publications:

Allen, J.A., Prange, K. Another Meeting Just Might Do It!: Enhancing Volunteer Engagement Using Effective Meetings (2021) *Human Service Organizations Management, Leadership and Governance*, 45 (1), pp. 49-65.

Lei, H., Jones, R.M., Li, Y. Quantifying the relative impact of contact heterogeneity on MRSA transmission in ICUs-a modelling study (2020) *BMC Infectious Diseases*, 20 (1), art. no. 6.



# CONGRATULATIONS

Dr. Jeremy Biggs of the RMCOEH has been central to preserving the health and safety of employees and patients alike in the University of Utah Health system. Throughout the pandemic, Dr. Biggs has served not only as the Medical Director of the Work Wellness Clinic at the University of Utah, but also as the “PPE Czar” responsible for guiding the use and supply of personal protective equipment. Dr. Biggs also led countless other valuable projects key to safe opening, including the design of “self-swabbing” stations for COVID-19, which allowed patients to swab themselves while a staff member observed at a safe distance. In addition, he led investigation into the safety of athletic functions, including a report on the safety of resuming football games. These additions not only protected players but provided a key sense of normalcy during days that felt anything but. During this time, Dr. Biggs has also worked with local organizations to help protect workers against the spread of infectious respiratory aerosols. He has built up a number of longstanding relationships between the RMCOEH, the U, and members of the community. And so, it was more than fitting that Dr. Biggs was awarded the title of a 2020 Utah Healthcare Hero by Utah Business. This award seeks to recognize those individuals who “went above and beyond, pivoting their time, creativity, ingenuity, and magnanimity to face off against a global pandemic.” In addition to providing expert guidance through the production and publication of a book on virtual meetings,



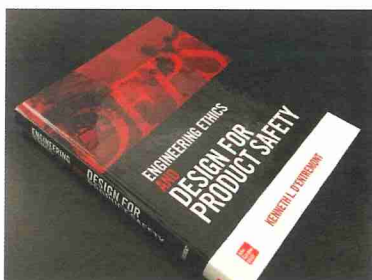
Dr. Joe Allen has worked long hours to share knowledge with the community forced to go “suddenly virtual.” Although he has invested many hours into outreach, perhaps the most prominent one was a presentation at Zoomtopia, the Zoom User Conference. Dr. Allen presented for an hour regarding meetings, mindfulness, and how to best manage virtual meetings. The event had 1,000 live attendees, with 120,000 streaming views on Twitter afterwards. Congratulations, Dr. Allen!



Two staff members were honored at the Department of Family and Preventive Medicine awards in 2021. Ms. Crystal Beall (left) was awarded the Distinguished Service Award for her longstanding commitment and dedication to the Continuing Education Program, where she provides oversight and administrative/managerial support, including national-level work with the OSHA Directorate of Training and Education. In addition, Dr. Camie Schaefer (right), Senior Technical Writer of the RMCOEH and a member of the research administration team at the department, was awarded the Excellence in Mission and Scholarship Award. Research development



and administration have become career passions for her, especially in supporting the world-class research from the RMCOEH.



Lastly, congratulations to Dr. Ken d’Entremont on the release of his valuable book, Engineering Ethics and Design for Product Safety! We discussed some specifics of this book in our last newsletter, but wanted to take a moment to celebrate the fact that it has been out in the world for several months and has been named #1 of the 10 Best New Product Design Books To Read In 2021 by Book Authority. For more information or how to purchase the book, visit Barnes and Noble, Amazon, or anywhere else books are sold.

# INTRODUCING DR. WILSON



Last year, the RMCOEH welcomed a new postdoctoral scholar to our (virtual) halls. Dr. Amanda Wilson came to us after completing her PhD in Environmental Health Sciences at the University of Utah. Her mentoring team includes University of Utah faculty Drs. Rachael Jones and Frank Drews. Dr. Wilson's areas of expertise include microbial exposure and risk assessment, human behavior, and exposure modeling, all of which she has leveraged to add to the body of research on COVID-19. Her COVID-19 research, which includes work in an air sampling device feasibility study led by Drs. Rachael Jones and Kerry Kelly. Dr. Wilson collaborated with Kamaljeet Kaur, a chemical engineering PhD student, to conduct sampling in the Medical Intensive Care Unit (MICU) and the COVID-19 ward at the University of Utah Hospital (see below). Dr. Wilson collaborated internationally to develop COVID-19 risk assessment models and co-developed a risk scoring algorithm for a COVID-19 contact tracing app, Covid Watch. Dr. Wilson was featured in Hispanic Engineer & Information Technology magazine in 2018 and has

been interviewed by Discover Magazine, New York Magazine, and The Washington Post on her COVID-19 and fomite-mediated exposure research. Her research has proven so valuable to this conversation that it was cited in a CDC Science Brief on SARS-CoV-2 and Surface (Fomite) Transmission for Indoor Community Environments.

Dr. Wilson's dissemination of research is widespread, with several upcoming publications and frequent presentations nationwide. She has given presentations in the Education Research Center Industrial Hygiene Webinar Series, University of Utah COVID flash talks, University of Utah Department of Chemical Engineering seminar, University of Utah IDEAS seminar, and at the Household & Commercial Products Association Annual Meeting. Two conference symposia for the International Society of Exposure Science (ISES) and AIAA Aviation Forum have been accepted, where she will be presenting with University of Utah faculty Drs. Rachael Jones and Tony Saad.



Dr. Wilson has co-authored with department faculty and staff, including Drs. Rachael Jones, Darrah Sleeth, and Camie Schaefer, and has one paper accepted with revisions in the Journal of Occupational and Environmental Hygiene, one under review in the Journal of the Royal Society Interface, and two more publications in preparation. She recently led an international collaboration with researchers from the University of Leeds on integration of CFD, human behavior, and microbial exposure models, published in Indoor Air. She and Dr. Marco-Felipe King were awarded a Royal Society International Travel Grant to continue this collaboration on public health engineering research.

She will be starting an assistant professor position in Environmental Health Sciences at the University of Arizona in July 2021 and was recently awarded the University of Arizona Health Sciences Career Development Award to expand her research training to address asthma and microbial risk-risk tradeoffs for healthcare workers conducting surface cleaning and disinfection. Faculty and staff at the RMCOEH look forward to seeing her undoubted future success and hope to see her return for many research collaborations in the future.

# UPDATES FROM CONTINUING ED



**Training Institute  
Education Centers®**

**Mountain West  
OSHA Education Center**

2021 will offer a realm of bright possibilities for our Continuing Education program; but as with all bright lights, we see one shadow. We regret to announce that the CE Director, Dr. Diane Johnson, is leaving to become Associate Vice President of Online Learning at Snow College. However, this shift will allow the CE program to continue to benefit from Dr. Johnson's efforts, as she plans to make new connections and expand the reach of OSHA and NIOSH classes to the areas within and near Snow College.



## Spotlights on Upcoming Courses:

### **OSHA 3015: Excavation, Trenching & Soil Mechanics**

Dates: July 20-22  
Tu, W and Th



This course covers the OSHA Excavation Standard and safety and health aspects of excavation and trenching. Course topics include practical soil mechanics and its relationship to the stability of shored and unshored slopes and walls of excavations, introduction of various types of shoring (wood timbers and hydraulic), soil classification, and use of protective systems. Upon course completion students will have the ability to assess their employer's compliance with the OSHA Excavation Standard, utilize soil testing methods to classify soil types, determine protective systems for excavation operations, and training requirements.

Additionally, we are doubly fortunate that Ms. Connie Crandall, former Director of the CE Program, will come back on a consulting basis to help ease the next transition of the CE Program, as the program continues to seek to expand the reach each of CE courses and allow them to provide an even greater service to the workers of Region 8 and others across the nation.



We would like to recognize the longstanding efforts of CE staff members Crystal Beall (Program Coordinator), Luz Dominguez (Program Facilitator), and Shalese Ramirez (Registration Coordinator). This team of extraordinary employees has carried the CE Program through the challenges of the COVID-19 pandemic and the need to offer courses online, a move to a different building, and changing tides of leadership and affiliation. Their efforts have allowed the CE Program to offer OSHA courses as well as NIOSH classes, Hazwoper training, and much more.



### **Asbestos Inspector Training**

Dates: June 14-16, 2021  
M, Tu and W

This course provides "AHERA" training as required by Federal regulations. State and local agencies may also impose AHERA training requirements. Participants who Successfully complete the course and pass an exam will receive a certificate of "AHERA" accreditation. This 3-day course is intended for individuals who inspect for asbestos, identify suspected asbestos containing materials (ACM), collect samples, or assess the condition of asbestos-containing materials.



# NEW & OLD FRIENDS

This past March, the RMCOEH was excited to welcome Wanderley Reis da Silva as the new Program Manager. Mr. da Silva brings with him to the position operational experience in areas as diverse as healthcare, retail, corporate real estate, and facility/operations. His education includes a BA & MA from Brigham Young University, an MBA from Case Western University, doctoral studies (ABD) from University of California Los Angeles, and a post-doctoral bridge to business program at Virginia Polytechnic. Mr. da Silva offers expertise in program management, accounting, performance analysis, grants and contracts management, and business analysis (among his many other talents!). Outside of work, he enjoys spending time with his "better half" Rachel and their two children Camilla and Jordan, who are both students at Weber State. He is also a devotee of long-distancing running (e.g. the Wasatch 100 Mile Endurance Run), kayaking, photography, and reading. When asked about his plans for working at the RMCOEH, he responded that "They say a person needs just three things to be truly happy in this world: Someone to love [My family and friends], something to do [MAIN reason I am here at the U], and something to hope for (Tom Bodett). I hope my experience at the U will make a difference not only for the institution, but for a better World!"



Just as we say hello to new friends and members of the RMCOEH, we bid adieu to others. The RMCOEH would like to honor Dr. Christopher (Chris) Kleinsmith, an alumnus of and dedicated contributor to the Occupational Medicine residency. Dr. Kleinsmith served his community as a beloved doctor and volunteer, and frequently offered his time to the RMCOEH as a preceptor to many residents over the past years. He also served on the Residency Advisory Board with distinction.

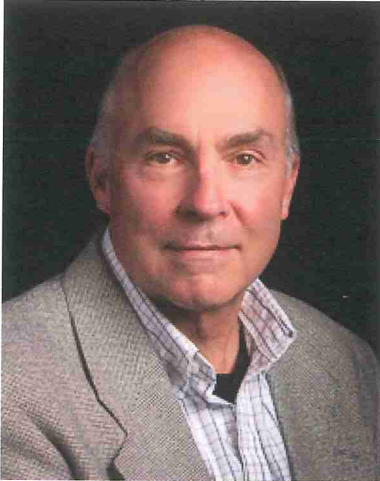
The following excerpt from his obituary gives some glimpse into this remarkable man's life:

"Chris graduated from Medical School at Kirksville College of Osteopathic Medicine in 1980. A Doctor of Osteopathy, Chris was Board-Certified in Aerospace Medicine, Occupational Medicine and Family Medicine. Chris served our country for 27 years in the US Air Force, retiring in 2007 as a Colonel. As a Flight Surgeon, "Doc" (his call sign) served in Europe, The Gulf War (Saudi Arabia), Korea, California, Oklahoma and Texas. However, he is best known for his many years at Hill Air Force Base (AFB). He was a "Black Widow" with the 421st Fighter Squadron / 388th Fighter

Wing, Chief of Aeromedical Services with the 75th Aerospace Medicine Squadron, and Flight Commander of the Occupational Medicine Flight. Upon retirement from active duty, Chris served as the civilian Chief of Occupational Medicine at Hill AFB, retiring in September 2020. Chris literally touched every mission at Hill AFB. Among his many unique accomplishments, he served as Senator John Glenn's flight surgeon for his space shuttle mission in 1998."

Thank you to Dr. Kleinsmith for your friendship to the RMCOEH and your commitment to occupational medicine and the wider human community.

# KEEPING THE LEGACY



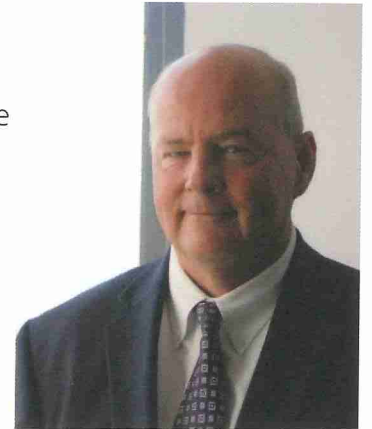
The RMCOEH is delighted and honored to announce the gift of the Capt. Eric J. and MSgt. John E. Esswein Endowed Scholarship. Capt. Eric J. Esswein, MSPH, CIH, CIAQP, FAIHA graduated from the RMCOEH's Industrial Hygiene Program in 1991 (under Drs. Jeff Lee and Bobby Craft). His >30 years experience in occupational health and safety/industrial hygiene led him to a long career in government service, including as an enlisted member of the U.S. Army and as an Environmental Health Officer in the U.S. Public Health Service assigned to NIOSH and the CDC. He is currently the CEO of Emeritus Health and Safety, which seeks to provide "training/education of workers about occupational health and safety risks and prevention of exposures through an understanding and appropriate use of the hierarchy of controls."

The scholarship is intended for students whose intentions are to go into government service (such as NIOSH, OSHA, ATSDR, etc) and focus on applied field-based industrial hygiene research. Capt. Esswein hopes that the focus on government service will help guide students to the same rewards he gained from his long and illustrious career. Thank you again to Capt. Esswein for his generosity in supporting the next generation of industrial hygienists!

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Dan Hair's longstanding dedication to occupational health has led him down many pathways during his career, from serving as Chief Risk Officer at WCF Insurance to his leadership of the burgeoning undergraduate degree in occupational safety and health. Mr. Hair has guided the formation of an undergraduate minor in OSH over the past few years, and is now turning his attention to building out the undergraduate major. Funds for this program have been dedicated by the Utah legislature as well as by private donors, and many of these are awaiting the program to emerge into its full potential. Mr. Hair's current hope is to offer the introductory course for the major in fall/spring/summer, and for the major itself to be possible to complete in 3 semesters. He hopes to get the word out to the rest of campus and is currently engaged in discussions with stakeholders at the University of Utah and Weber State.



David Roskelley is a frequent face seen in the halls the RMCOEH and well-known for his generosity in sharing his experiences (both in industrial hygiene and climbing Mount Everest!) with trainees. He is the Chair of the Advisory Committee for the IH program and has also frequently mentored IH students in their early careers. And in 2020, Mr. Roskelley continued to demonstrate his commitment to IH by co-authoring "The American Board of Industrial Hygiene: 60 years of progress." This invaluable article discusses how the American Board of Industrial Hygiene (ABIH) has changed over the past 60 years, and how that progress has been reflected in the field of IH. ABIH awards the Certified Industrial Hygienist certificate, which marks an individual as a qualified IH professional. Mr. Roskelley and his co-authors explain how ABIH has revised its mission to focus on the 4 Es: education, experience, ethics, and examination. The authors explain how each of the "e's" is evaluated and how each contributes to the CIH. This

read is critical for anyone who has or hopes to receive their CIH, and explains how the IH profession dedicates itself to integrity.

Citation: Larrañaga MD, Greeson NMH, Roskelley DC. The American Board of Industrial Hygiene: 60 years of progress. *J Occup Environ Hyg.* 2020 Jun;17(6):253-261. doi: 10.1080/15459624.2020.1745819. Epub 2020 May 26. PMID: 32453654.

# THE 2021 NORA CONFERENCE

This year's National Occupational Research Agenda (NORA) Young and New Investigators Symposium was held virtually, but the look and feel of the virtual conference was closer to what attendees typically expect in terms of a conference. Thanks to the use of the platform Gather.Town (see example below), attendees were able to interact socially in different virtual spaces.



Internationally renowned speaker Dan Clark delivered the keynote address on "The Art of Significance" thanks



to the 18th Annual Paul S. Richards, MD, Endowed Distinguished Visiting Lectureship in Occupational Medicine. The keynote focused on what Mr. Clark termed the 12 Highest Universal Laws that never change: Obedience, Perseverance, Stretching,

Trust, Truth, Winning, Doing Right, Harmony, Acceptance, Being Needed, Covenants, Forgiveness. These qualities are fundamental to the practice of occupational safety and health and offer insight on how to act with awareness and transform professional productivity.

Highlights from this NORA Symposium included presentations in the following areas: Ergonomics & Biomechanics; Industrial Hygiene, COVID; Slip, Rip, Fall, Physical Activity; Safety and Hazards in the Workplace.

A number of trainees and residents from the RMCOEH presented, including Dr. Trevor Pugh ("Risk of Falls Among Groundskeepers Maintaining Terraces at a Public Institution"), Spencer Claflin ("How do sleep and low back pain relate to 1-year prevalence of slips, trips, and falls among truck drivers?"), Alec Trollan ("Risk of Particulate Dust Inhalation of Human Cadaveric Bone in a Non-Pathological Research Laboratory Environment"), and Chapman Cox ("Depression in law professionals: does physical activity really matter?"). These and other presentations demonstrated the breadth of occupational and safety research currently done at the RMCOEH, and trainees turned out to support their peers in force.

Other schools represented at the NORA Symposium included Rowan University, Indiana University, University of Michigan School of Public Health, Washington State University, University of California Berkeley, and others. The social nature of the conference platform allowed these trainees to mingle and discuss their research with each other. Some of those conversations had the potential to act as a seed for future collaborations.

In other cases, presentations and posters served as proof of existing collaborations, as was the case with the many trainees involved in research led by Dr. Matt Thiese on the overall wellbeing and health in the legal profession. PhD candidate Uchenna Ogbonnaya and trainee Hyejun Lee both presented on relationships between various indicators of poor mental wellbeing (e.g., burnout, drug use, and major depressive disorder) and stressors among lawyers in Utah.

The RMCOEH looks forward every year to supporting this valuable conference, which allows young and new investigators a chance to mingle with their peers, present their research in a lower-stress environment, and learn more about the future of occupational health and safety. The NORA conference could not take place without the dedicated work of Drs. Andrew Merryweather, Ken d'Entremont, and Don Blowski, as well as administrative support from Ms. Liz Reiser. Here's to another successful conference in 2022!

# CATCHING UP WITH DR. ROM

Dr. Bill Rom founded the RMCOEH in 1977 and served as the first Center Director. During his time here, Dr. Rom trained 15 residents, 168 pulmonary/critical care fellows, and 30+ lab researchers. Much of his research has been dedicated to environmental lung disease, lung cancer, and World Trade Center Lung Disease. He is now the Sol and Judith Bergstein Professor of Medicine and Environmental Medicine, Emeritus at New York University School of Medicine where he has taught Climate Change and Global Public Health. He continues to serve as an example for all, especially when enjoying the world of Aspen ski racing (3 Giant Slalom and 3 Slalom races in 2021!).





Rocky Mountain Center for Occupational  
and Environmental Health

Department of Family and Preventive Medicine

Department of Mechanical Engineering

**HEALTH**  
UNIVERSITY OF UTAH

Rocky Mountain Center for Occupational and Environmental Health

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Salt Lake City, UT 84108

Phone: 801.581.4800

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<https://medicine.utah.edu/rmcoeh/>



# Rocky Mountain Center for Occupational and Environmental Health

## Major Interactions with Utah

Companies/Businesses/Churches/etc\*

2014 to 2021

(\*Does not include phone calls, discussions, consultations, or clinical evaluations.)

#1 Lead Safe	ATC Group Services, LLC
1-800 Water Damage of Utah County	ATI Titanium
204 <sup>th</sup> MEB Utah Army National Guard	ATK Techsystems
3 Form	ATS Welding Inc.
309 MXSG	AbateX Environmental Services, Inc.
3M Safety & Fall Protection	Above the Rest Abatement
3 <sup>rd</sup> Generation	Absentia Solutions
75 Logistics Readiness	Absolute Abatement & Cleanup
75 <sup>th</sup> LRS/LGRV	Absolute Testing
75 <sup>th</sup> MDG/GNE	Ace Consulting
85 <sup>th</sup> WMD CST	Acierto, LLC
926 Wing, Nellis AFB	Acknowlogy, LLC
A 1 Environmental Inc.	Actavis Laboratories Utah, Inc.
A Plus Benefits	Action Target
A Precise Home Inspection	Acuity Insurance
A-Pro Home Inspection Salt Lake	Adam White Speaks
A Team	Adler Hot Oil Services
A-1 Abatement	Admiral Beverage
A-1 Kitchens	Ado M&C, LLC
AAA Environmental	Advanced Drainage Systems
AAA Excavation	Advanced Fluid Containment
AAA Restoration	Advanced Paving and Construction
ABC	Advanced Restoration
ACME Construction	Advanced Window Products
ADR	Aerolite Consulting LLC
AECOM Environment	AgReserves, Inc.
AECOM/SLCDA	Agra Tech, LLC
AEEC, LLC	Air Care
AJ Services Restoration & Remodeling, LLC	Air Liquide
ALS Laboratory Group (Environmental)	Air Liquide Electronics
ALSCO Inc.	Air Quality Consulting
AM Asbestos	Akos
AMEC	Alaris
AMEC Foster Wheeler E&I	Albany Engineered Composites
AMPAC	Albertson's
APS Construction	All American Environmental
ARS Cleanup-Restore-Rebuild	All Aspects Remodeling
ARS Flood & Fire Cleanup	All Clean Inc.
ARUP	All Clean Inc. dba The Flood Co.
ASC	All Clear Environmental
ASML	All Pro Cleaning
ASSC	All Pro Disaster
	All Pro Services

Al Surface  
All Western Window  
Allegheny Technologies, Inc.  
Allegiant Managed Care  
Aline Building  
Allman Handyman  
Alpine Cleaning & Restoration  
Specialists, Inc.  
Alpine Customs Contracting  
Ameresco  
American Exteriors  
American Fork Hospital  
American Homes 4 Rent  
American Nutrition, Inc.  
American Safety  
American States  
American Water  
Americom Technologies Inc.  
Ames Construction, Inc.  
Ametros Financial  
Amico  
Amico – Orem  
Anchor Christian Academy  
Anchor Water Damage & Restoration  
Andeavor  
Andeavor Refining  
Anderson Engineering  
Ansell  
Antea Group  
Apache Industrial Services  
Apollo Mechanical Contractors  
Applied Geoscience & Environmental  
Apro Safety Training  
Aramsco  
Arco Electric  
Arnold Machinery Company  
Arrow Legal Solutions Group, P.C.  
Aahi Refining USA  
Asbestos Abatement Services  
Asbestos Abatement of Utah  
Asbestos Inspection, Inc.  
Asbestos Inspections and Management  
Ascent Construction  
Ash Grove Cement Company  
Ashley National Forest  
Ashley Regional Medical Center  
Aspen Roofing  
Asset Environmental Services, LLC

Assist Inc.  
Associated Brigham Contractors  
Associated Builders & Contractors  
Atlas General Contracting LLC  
Atlas Rigging & Transfer  
Auric Solar  
Auto Owners Insurance  
Autoliv  
Avalanche Construction  
Avalon Business Engineers  
Awareness is Key  
B2 Environmental, Inc.  
BAE Systems  
B. Jackson Construction, Inc.  
B.C. Abatement  
BD Medical Systems (Becton Dickinson)  
BFC Industrial Services, LLC  
BHI  
B.H., Inc.  
BHMH  
BK Plumbing  
BLM (Bureau of Land Management)  
BLM Price F.O.  
BLM – Color County District  
BLM, UT – CCDO  
BMC West  
BZI Steel  
Bard Access Systems  
Barker Flooring Installations  
Barnes Bullets  
Barr Engineering Co.  
Barrick Gold Corporation  
Barrick Gold of North America, Inc.  
Bear River Association of Governments  
Bear River Valley Hospital  
Beaver County School District  
Beehive Clothing  
Beehive Environmental  
Beehive Insurance  
Belfor Property Restoration  
Ben Byrd Construction, LLC  
Benchmark Administrators  
Bennett's Glass of Logan  
Berrett Brick & Stone, LLC  
Bertola Construction  
Best Friends Animal Society  
Big D Construction  
Big West Oil, LLC

**BioFire Defense**  
**BioFire Diagnostics**  
**Bioenvironmental Engineering**  
**Biomerics**  
**Black & McDonald**  
**Black & Veatch**  
**Black Diamond Restoration**  
**Black Environmental**  
**Black Rifle Coffee**  
**Blackburn & Stoll**  
**Blasting Solutions, Inc.**  
**Blegco**  
**Blue Hat Ventures**  
**Boart Longyear Company**  
**Boart Longyear Drilling Services**  
**Bodec Electric**  
**Bodell Construction**  
**Boeing**  
**Boss Systems Restoration**  
**Bowen Collins and Associates**  
**Box Elder County School District**  
**Bramha Group Inc.**  
**Brand Energy Solutions**  
**BrandSafway Solutions**  
**Bredero Shaw**  
**Brett Jespersen Painting Inc.**  
**Brendan Bagley Physical Therapy**  
**Brigham City Community Hospital**  
**Brigham Young University (BYU)**  
**BYU Construction**  
**BYU Law School**  
**Brightview Landscape Development**  
**Broadspectrum**  
**Broadspectrum/Trans Field Services**  
**Broken Arrow**  
**Brock Group**  
**Brock Services**  
**Browz LLC**  
**Bryce Christensen Excavating, Inc.**  
**Bryteling Construction LLC**  
**Buck Hall Vocational Consulting, LLC**  
**Budge Allergy**  
**Builders First Source/ProBuild**  
**Building Solutions**  
**Building Zone Industries**  
**Bureau of Reclamation**  
**Burns White LLC**  
**Bush Construction**

**Business – Be Ready Utah**  
**Bway Corporation**  
**CAS Inc.**  
**CB&I**  
**CCAP/Pcomp**  
**CCC Group Inc.**  
**CCI**  
**CCI Mechanical Inc.**  
**CDL Physicals of Utah**  
**CIO Medical Services**  
**CK Construction & Roofing**  
**CMT Engineering**  
**COP Construction, LLC**  
**CPL**  
**CRH Americas Materials**  
**CRI Inc.**  
**CSI**  
**CVER**  
**Cache County Fire District**  
**Cache County School District**  
**Cache Valley Electric**  
**Cache Valley Glass**  
**Cache Valley Specialty Hospital**  
**Canyon Pipeline Construction**  
**Canyon School District**  
**Capital Investigating**  
**Capital Safety Training**  
**Capitol Hill Construction, Inc.**  
**Capstone Research & Development**  
**Captain Chemical**  
**Carbon School District**  
**CarbonX**  
**Cardno**  
**Cardno ACT**  
**Carpenter, McCadden & Lane, LLP**  
**Carpet Barber Flooring, LLC**  
**Carpet Giant**  
**Carpet Giant/Carpet One**  
**Cascade Stucco & Exteriors**  
**Casey Industrial**  
**Castle Valley Restoration**  
**Castlegate Builders**  
**Castleview Hospital**  
**Ceiling Systems Inc.**  
**Central Glass**  
**Centerville City**  
**Central Utah Clinic**  
**Central Utah Clinic – NowCare**

Central Utah Public Health Department  
Central Valley Water Reclamation  
CertaPro Painters  
Certified Disaster Services, Inc.  
Certified Safety Professionals  
Champion Inspect  
Champion Windows of Salt Lake City  
Charles Abbott Associates  
Chartwell Law  
Chenega Facilities Management  
Chep USA  
Chevron Texaco Pipeline Co.  
Chevron/Trans Field Services  
Chris & Dick's  
Chromalox  
Cincinnati Insurance Company  
Cintas First Aid and Safety  
City of Bountiful  
City of Erie  
City of Logan  
City of Moab  
City of Orem  
City of Pittsburgh  
City of South Salt Lake – Public Works  
City of West Jordan  
Civil Construction Services, LLC  
Clarks Quality Roofing  
Claude H Nix  
Clean Harbors Environmental Services  
Clearfield Job Corp  
Clearfield Job Corps Center  
Cliff's Home Repair  
Cobb Fendley and Associates  
ColdSweep  
Coldsweep, Inc.  
Collaborant  
Collins Roofing, Inc.  
Comfort Systems USA International  
Community Development  
Community Nursing Services  
Compass Minerals  
Complete Restoration  
Complete Restoration of Salt Lake  
Comptoday  
Comtempo Ceramic Tile  
Concentra Medical Center  
Concurrent Technologies  
Consolidated Paving & Concrete, Inc.

Conwest, Inc.  
Copperview Consulting & Inspections  
CorVel Corporation  
Cornerstone  
Conora Deck  
Countertop Source  
County Commissioners Association of PA  
Coventry Workers (Compensation Services)  
Crawford Door Sales  
Creative Installations, Inc.  
Creative Times Incorp.  
Cripple Creek Consulting and Env.  
Culp Commercial Construction  
Cupertino Electric  
Curtis Engineering and Mngmt. Services  
Custom Electrical Service  
DAS Fleet Operations  
D.C. Restoration LLC  
DCM Mining Services  
DLM Inc.  
DOI Bureau of Land  
DOD  
D.O. Richardson & Associates  
DPC Utah Corporation  
DP Industrial  
DPS/UHP  
D-Vign Plus Builders, LLC  
DWMRC-Utah DEQ  
Daily's Premium Meats  
Darrell Anderson Construction  
David Weekly Homes  
Davis Applied Technology College  
Davis County Environmental Health  
Davis County Health Department  
Davis School District  
Daw Construction Group  
De La Rue Authentication Solutions  
Dean Fluor  
Dean Foods  
Deans Food/Meadow Gold  
Defense Logistics Agency  
Dell Moser Lane Loughney LLC  
Delta Airlines  
Delta Fire Systems, Inc.  
Delta Group  
Delta Painting  
Delta Plan One, LLC

**DeltaValve LLC**  
**Deluxe Corp.**  
**Demco, LLC**  
**Department of Defense-AirForce**  
**Department of Environmental Quality**  
**Dept. of Env. Response and Remediation**  
**Department of Health**  
**Department of Interior/BLM**  
**Department of Veteran Affairs**  
**Deseret Manufacturing**  
**Deseret Power Electric Cooperative**  
**Detroit Diesel Remanufacturing**  
**Diamant Environmental**  
**Diamond-S-Company**  
**Diantonio Painting**  
**DigiStream Investigations**  
**Disaster Doctors**  
**Disaster Professionals**  
**Disaster Pros**  
**Division of Air Quality**  
**Division of Forestry Fire**  
**Division of Wildlife**  
**Dixie Applied Technology College**  
**Dixie State College**  
**Dixon Information**  
**Dominion Energy (formerly Qwest)**  
**Door Solutions**  
**doTERRA**  
**Draper City**  
**Dream Maker Bath & Kitchen**  
**Drill Rite**  
**Dry Creek Structures**  
**Duchesne County School District**  
**Dugway Fire Department**  
**Dugway Proving Grounds**  
**Duncan Aviation**  
**Dunkin and Bush**  
**Dunkley Company, LLC.**  
**Dunkley Excavating, Inc.**  
**DuPont Holgraphics, Inc.**  
**Dura-Line**  
**Dynamic Safety and Environmental**  
**E2 Optics**  
**E & J Restoration Services**  
**EC Source Services**  
**ECR Management**  
**EE Health and Safety LLC**  
**EHS, Inc.**

**EJ USA, Inc.**  
**EMCOR Group**  
**EMG**  
**EPG Testing and Safety Training**  
**ERM Rocky Mountain**  
**ERS**  
**ESIS**  
**Eagle Environmental Inc.**  
**Earthtech Engineering**  
**Eat'n Park Hospitality Group**  
**Edge Eyewear**  
**Edwards Lifescience Research Medical**  
**Electric Asset Company**  
**Elias Mickle Kennedy LLC**  
**Elite Properties of Utah**  
**Elwood Staffing**  
**Emery County School District**  
**Emery County Sheriff's Office**  
**Empire Solar Group LLC**  
**EmployBridge**  
**Employer Solutions Group**  
**Energi**  
**Energy Solutions**  
**Enervest**  
**Engineered Wall Systems**  
**Enviro Care, Inc.**  
**Environmental Abatement Inc.**  
**Environmental Health Services**  
**Environmental Services**  
**Environmental Solutions, Inc.**  
**Envirospec, LLC**  
**Envision Mechanical**  
**Epic Engineering, P.C.**  
**Erichsen Research & Development**  
**Evaluation Specialists, LLC**  
**Evelar Solar**  
**Everest Care Management**  
**Evergreen North America**  
**Exelis Inc**  
**Expert Environmental, LLC**  
**Exponent EHF**  
**Extra Space Storage**  
**FAA – Federal Aviation Administration**  
**FBI Salt Lake Field Office**  
**FLSmith Salt Lake City, Inc.**  
**Falcon Electric, LLC**  
**Farmington Fire Department**  
**Fastenal**

**Federal Occupational Health  
Fetzer Architectural Woodwork  
Fillmore Community Hospital  
Finley Resources  
Fire Engineering Company, Inc.  
First Med Urgent Care  
First Medical Advisory Group  
Fit Environmental  
Five County Association of Governments  
Five Point Restoration  
Fixnou LLP  
Flare Construction Inc.  
Flatiron  
Flight Safety International  
Flood Impact Xperts  
Flood Pros LLC  
Fluor Industrial Services  
Flying J/Big West Oil  
Forest Service  
Forrest Nunley Painting  
Fox 13  
Fox Face Inc.  
Freeport Center Associates  
Fresenius Medical Care  
Fresh Air Environmental Solutions Inc.  
Frontier Drilling  
Frontier Specialty Chemicals  
Functional Assessment Rehab  
GBS Benefits  
GE Healthcare  
GE Healthcare, Hyclone  
GRME  
GS Distributing  
GSH Geotechnical  
GSL Electric  
Gallagher  
Gallagher Bassett  
Gardner & Boswell Construction  
Garkane Energy  
Gem Buildings Inc.  
General Dynamics Corporation  
General Electric  
General Electric Healthcare  
General Services Administration  
Genesis Asset Protection  
Geneva Nitrogen, LLC  
Geneva Rock Products, Inc.  
George E. Wahlen VA Medical Center**

**GeoStrata  
Gerber Construction, Inc.  
Gilbert Development  
Glo Germ Company  
Goldenwest Painting  
Goodfellow  
Gordons Glass  
GotSafety, LLC  
Grand County Sheriff's Office  
Granger-Hunter Improvement District  
Granite Construction Inc.  
Granite School District  
Grant Mackay Company  
Graymont  
Great Basin Industrial  
Great Salt Lake Electric  
Green Cleaning Solutions  
Green Light Business Solutions  
Greene's Inc.  
Greenleaf Utah Consulting  
Gunthers  
H2O  
H2O Environmental Inc.  
HBI  
HILTI  
HR Advantages  
HSEPRO, LLC  
Habitat For Humanity Utah  
Hadco Construction  
Haemonetics Corp.  
Halverson Company  
Harbertson Construction  
Harmon City, Inc.  
Harmons, Inc.  
Harris  
Harris and Hart  
Harris Corporation  
Harris Davis Rebar  
Harvard Medtech  
Hazwoper Training Solutions  
Health & Safety Service  
  
Health Network Laboratories  
HealthSmart Casualty Claims Solutions  
Hedrick Vocational Consulting  
Helpside Inc.  
Henkel  
Herriman City**

Hexcel Corporation  
High Caliber Services  
LLC  
High Country Line Construction  
Highway 89 Safety & Environmental  
Hill Air Force Base (HAFB)  
HAFB UTTR  
Hill West  
Hilton Salt Lake City Center  
Historical Arts & Casting  
Hoj Engineering  
Holcim US  
Holder Construction Co.  
Holly Corporation  
Holly Frontier  
Holly Refining & Marketing Company  
Holm Consulting  
HomeGuard Inspections  
Horizon Health Care Consultants  
House Inspect  
Housing and Neighborhood  
Housing Authority of the County of Salt  
Lake  
Housing Authority of Utah  
Housing Authority of Utah County  
Hoyt Archery, Inc.  
Huffaker Construction  
Hughes General Contractors  
Hunt Electric, Inc.  
Hunter Douglas  
Huntsman Heating  
I-DOhC  
ICU Medical, Inc.  
ICW Group  
IEC, Inc.  
IES  
IGES  
IHC  
IHC WorkMed  
IHC Work Med – Layton  
IHC – Work Med/Ogden  
IHI Environmental  
IHS  
IM Flash Technologies  
IPSC  
Iasis Healthcare  
Ideal Homes & Development Inc.  
In and Out Inspections  
Independent Safety

Industrial Accidents Division  
Industrial Ergonomics, Inc.  
Industrial Piping & Welding  
Industrial Safety & Training  
Industrial Safety Equipment, LLC  
Industrial Scientific Corporation  
Industrial Supply Company  
Industrial Training & Consulting  
Injure Care Work Group  
Inline Plastics Corp.  
Innophos Nutrition Inc.  
Innovative Claims Strategies LLC  
Innovative Flexpak  
Innovative Marking Systems, Inc.  
Innovative Woodworks, LLC  
Inservco Insurance Service Inc.  
InSight Investigations  
Integrated Employer Solutions  
Integrated Project Solutions, LLC  
Intellegis, LLC  
Interior Logic Group  
Intermountain Claims, Inc.  
Intermountain Electronics  
Intermountain Environmental  
Consultants  
Intermountain GeoEnvironmental  
Services, Inc.  
Intermountain HealthCare  
Intermountain Healthcare Workmed  
Intermountain MRO  
Intermountain Medical Group  
Intermountain Orem Workmed  
Intermountain Power Service Corp.  
Intermountain Safety Solutions  
Intermountain Safety  
Training/Consulting  
Intermountain Slurry Seal  
Intermountain Technical Solution  
Intermountain Work Med  
Intermountain WorkMed-Ogden  
Intermountain WorkMed – Springville  
Interstate Rock Products, Inc.  
Intrepid Potash  
Intrepid Potash – Moab, LLC  
Iron County School District  
Iron Horse  
Ive, Inc.  
J & K Environmental, LLC

**J & M Steel Solutions**  
**JBR Environmental Consultants**  
**JBS Hyrum**  
**JBT Aerotech**  
**JBT Corp.**  
**JBT Jetway**  
**JD Steel Company, Inc.**  
**JDC Builders, LLC**  
**JKL Asbestos Inc.**  
**JP Excavating, Inc.**  
**J.P. Mascaro**  
**JR Merit**  
**JS Redpath Corp.**  
**JT3 – LLC**  
**Jacobs Technology**  
**Jacobsen Construction**  
**Jane LLC**  
**Jerry Whetstone Construction**  
**Johns Eastern**  
**Johnson & Johnson**  
**Johnson Consulting & Training, LLC**  
**Johnson Matthely Corp.**  
**Johnson Matthely Inc.**  
**Jones Excavating**  
**Jordan School District**  
**Jordan School District Auxiliary Services**  
**Jordan Valley Construction Dist.**  
**Jordan Valley Water Conservancy**  
**District**  
**Judge Memorial Catholic High**  
**K&G Blue**  
**K&L Acoustic & Drywall**  
**K. Grimes Builders**  
**KBRwyle**  
**KEMRON Environmental Services**  
**KLN Flooring**  
**KNODEL Construction**  
**KV Electric**  
**Kapp Construction**  
**Kearns Improvement District**  
**Keith Barton Construction**  
**Ken Garff Automotive Group**  
**Kennametal**  
**Kennecott**  
**Kennedy/Jenks Consultants**  
**Kenyon Consulting**  
**Kevin Stephens Construction**  
**KeyScripts**

**Kier Construction**  
**Kier Property Management**  
**Kiewit Mass Electric**  
**Kilgore Companies**  
**Kimberly-Clark**  
**Kimberly Sellers Solutions, LLC**  
**Kings Flooring Systems**  
**Klein Custom Countertops**  
**Kroger Bakery**  
**Kunz Boyz Construction**  
**Kurt Thornton Construction**  
**L-3 Communications**  
**L3 Harris Corp**  
**L3 Technologies**  
**LA Installers**  
**LS Finishing, Inc.**  
**La Port Construction**  
**Landmark Testing and Engineering**  
**Larry Hall & Associates**  
**Larson Davis**  
**Laser Industrial Services**  
**Lauren Engineering & Constructors**  
**Layton Construction**  
**Leadership Solution**  
**Leading Edge Chiropractic**  
**Learning Services**  
**LeValley Adjusting**  
**Lewco Services, LLC**  
**Liberty Mutual**  
**Liberty Mutual Insurance Risk Control**  
**Liberty Restoration**  
**Lifetime Products**  
**Lisbon Valley Mining LLC**  
**Lister Construction**  
**Little Debbie**  
**Lockheed Martin**  
**Logan Regional Hospital**  
**Lone Peak Conservation Center**  
**Loyal Source**  
**Ludvik Electric**  
**LynnRuss Aluminum Foundry**  
**MAC**  
**MAU Workforce Solutions**  
**MB Construction**  
**M.C. Dean, Inc.**  
**MDM Utah, LLC**  
**MEI, LLC (Rigging & Crating)**  
**MRA Forensic Sciences**



**MST Builders LLC**  
**MTC, Clearfield JCC**  
**MWI**  
**MXDPTB**  
**MYR Group Inc. / Sturgeon Electric**  
**Maddox Construction**  
**Magee Rehabilitation Hospital Jefferson Health**  
**Main Line Health**  
**Major Drilling**  
**Mallory Safety and Supply**  
**Malnove Inc. of Utah**  
**Mancilla Custom Mill Door**  
**Manti-LaSal National Forest**  
**Manwill Plumbing**  
**Mapleleaf Cabinets**  
**Marathon Petroleum**  
**Master Lock Safety Solutions**  
**Materion Natural Resources**  
**Maxam North America Inc.**  
**Maximum Function Physical Therapy**  
**Maverik Center**  
**Maywood Development**  
**McKay-Dee Hospital**  
**McM Installations, LLC**  
**McWane Ductile**  
**Mechanical Services & Systems**  
**MegaDiamond**  
**Mel Clark, Inc.**  
**Merge Investigations, Inc.**  
**Merit Medical Systems**  
**Metropolitan Water District of Micron**  
**Millard County School District**  
**Millard County Sheriff's Office**  
**Millennium Laboratories**  
**Millcreek City**  
**Mint Restoration**  
**Moab Salt/Intrepid Potash**  
**Mold Solutions**  
**Mondi Group**  
**Monkey Dad Rescue & Training**  
**Moreton and Company**  
**Morgan Asphalt**  
**Morton Salt, Inc.**  
**Mountain Crane Services**  
**Mountain States Line Construction JATC**  
**Mountain West OSHA Education Center**

**Mountainland AOG/Weatherization**  
**MountainSide Plumbing**  
**Mr. Window Inc.**  
**Murphy Brown**  
**Murray City Corporation**  
**Murray Glass**  
**My Patch Guy**  
**myMatrixx**  
**NOV-IntelliServ**  
**NPL Construction Company**  
**NRGY Safety**  
**NWP**  
**Namba Services Inc.**  
**Nammo Composite Solutions**  
**National Guard**  
**National Nuclear Security Administration**  
**Navy**  
**Nebo School District**  
**Neighborhood Housing Service**  
**NeighborWorks Provo**  
**NeighborWorks Salt Lake**  
**Neils Fugal Sons Company**  
**Nelson Laboratories, Inc.**  
**Nephi City**  
**Nestle Prepared Foods**  
**Newfield**  
**Newfield Exploration**  
**Newman Construction**  
**Nicolson Construction, Inc.**  
**Niels Fugal Sons Company**  
**Nielson Construction**  
**Noorda BEC**  
**Norbest**  
**Norco Welding & Safety Supplies**  
**North American Industrial**  
**North Face Roofing, Inc.**  
**Northern Pipeline Construction**  
**Northeastern Rehabilitation**  
**Northrop Grumman**  
**NorthStar Alarm/Peak Safety**  
**Northwind Portage**  
**Nova Consulting**  
**Nova Consulting Group**  
**Nova Environmental Consulting, Inc.**  
**NovaCare Rehabilitation**  
**NowCare**  
**Nucor Building Systems – Utah LLC**  
**Nucor Cold Finish**

**Nucor Onsite Care Clinics**  
**Nucor Steel**  
**Nucor Vulcraft/Cold Finish & Mesh Products**  
**OC Tanner**  
**OHS International**  
**OS&H Solutions**  
**OSHA**  
**OSHA Health Response Team**  
**OSHA Technical Center (USA)**  
**OSI**  
**OVIVO**  
**OWATC**  
**Occupational Safety & Health Solutions, LLC**  
**Ogden City Corporation**  
**Ogden City School District**  
**Ogden Weber Technology College**  
**Okland Construction**  
**Oldcastel Materials**  
**Oldcastle Marinas**  
**Olympus**  
**Onsite Care Clinics**  
**OnSite Care, Inc.**  
**Operating Engineers Local 3 JATC**  
**Optum**  
**Orchard Medical Consulting**  
**Orcutt Construction, Inc.**  
**Orica, USA**  
**Osprey Packs Inc.**  
**Overstock.com**  
**PA Bureau of Workers' Compensation**  
**PA Chamber of Business and Industry**  
**PCA Packaging Corporation of America**  
**PCC Structurals, Inc.**  
**PD-RX PHARMACEUTICALS INC.**  
**P.J. Builders, Inc.**  
**P2S Plant Performance Services**  
**PM & Sons**  
**PMA Companies**  
**PRO Inc.**  
**PRT Builders**  
**PSC Industrial**  
**Pacificorp**  
**Pacific Power**  
**Pacific States Cast Iron Pipe Company**  
**Pacific West LLC**  
**Palmer Christiansen Co.**

**Pappa's Brick and Stone**  
**Paradigm**  
**Paradigm-Complex Care Solutions**  
**Paradigm Outcomes**  
**Park City Building Department**  
**Park City Mountain Resort**  
**Park City Municipal Corp.**  
**Park City School District**  
**Parsons Brinkerhoff**  
**Parsons Engineering Sciences, Inc.**  
**Partner Engineering and Science**  
**Paul Davis Restoration (of Utah)**  
**Pauls Flooring Inc.**  
**Paulsen Construction**  
**Peachtree**  
**Peak Asphalt LLC**  
**Peak Well Service, LLC**  
**Peck's Painting, LLC**  
**Pediatric Administration**  
**Pella Windows & Doors**  
**Pentz Law**  
**PeopleReady, Inc.**  
**Pete King Commercial, LLC**  
**Pete Morrison Construction, Inc.**  
**Peterson Inc.**  
**Petrochem Insulation, Inc.**  
**Philadelphia Gas Works**  
**Pine Tree Construction**  
**Pine Tree Power**  
**Pine Valley Power**  
**Pinnacle Solutions**  
**Pinnacle Risk Management**  
**Port Authority of Allegheny County**  
**Portage Inc.**  
**Portage North Wind**  
**Posterity Group, LLC**  
**Powers Engineering & Inspection, Inc.**  
**Precise Inspection Services**  
**Preferred Case Management Services**  
**Preferred Environmental**  
**Premier Cleaning**  
**Premier Employees Solutions**  
**Premier Environmental**  
**Primary Children's Medical Center**  
**Primary Residential Mortgage**  
**Prime Excavating**  
**Prime Industrial**  
**Prime Thermal Solutions**

Pristine Painting LLC Five Star Painting  
Pro Build Construction  
Probar  
Probst Electric  
Proctor & Gamble  
Profire Energy  
Property Medics  
ProSource of Utah  
ProTech Coatings Inc.  
Provo City Corporation  
Provo School District  
Prows Development Inc.  
Pure Air Solutions  
Pure Enviro Management  
Purple  
QSI  
Quality Computer Consulting  
Quality Disaster Cleanup  
Quality Electrical Systems  
Quality Excavation, Inc.  
Questar Corporation  
Questar Gas Management  
Questar Pipeline Company  
R&A Environmental  
R & R Environmental  
R Chapman Construction  
R&O Construction  
RAM Enterprise, Inc.  
RB Manufacturing  
RC Hunt Electric  
RJ Taylor – Wyatt, LLC  
RK Mechanical  
RMCOEH  
RMEC Environmental, Inc.  
RMTS  
ROC Equipment, Inc.  
Raass Brothers  
Ralph L. Wadsworth  
Ramboll  
Ramco Restoration  
Raytheon Oakley Systems  
Re-Bath of Utah  
Readerlink  
Realco Development  
Realine Steel  
Reconstructive Dental  
Redd Roofing Company  
Redi Insulation

Redi Services, LLC  
Redi Solutions  
Redline Consulting, LLC  
Reed Group  
Regenexx  
Rehab Without Walls NeuroSolutions  
Reladyne West  
Reliance Electric, Inc.  
ReMed  
Restoremasters  
Revere Health  
Reynolds Cycling  
Rich School District  
Richards, Brandt, Miller & Nelson  
Rimrock Construction  
Ringler Associates  
Robinson Construction  
Rocky Mountain Care Clinic, Inc.  
Rocky Mountain Fabrication  
Rocky Mountain Industrial Construction Services  
Rocky Mountain Power  
Rocky Mountain Property  
Rocky Mountain Rebar, LLC  
Rocky Mountain TPA, LLC  
Rocky Mountain Therapy Services  
Rocky Ridge Rock/Roll-Offs Inc.  
Rocmont Industrial Corporation  
Rolling Stone Consulting, LLC  
Romco Flooring LLC  
Romer Safety Consulting  
Roofing Supply, Inc.  
Room Here  
Rowland Consulting, Inc.  
Royal T Enterprises  
Royalty Services Group  
Ruf Construction Safety  
Running Horse Pipeline  
S1 Medical  
S&C Claims Services Inc.  
S&N/Stake Center Locating  
SAC Incorporated  
SBWRD  
SEUALG  
SISCO  
SJHS/Blanding Clinic  
SLC Housing & Neighborhood Development

**SLC Mosquito Abatement  
SME Steel  
SOCOM Restoration  
SOS Property Solutions  
SWC Healthworks  
SWCA Environmental Consultants  
Safehouse Abatement  
Safety & Fire Protection  
Safety Consortium  
Safety Creatives  
Safety Management Services  
Safety Management and Training  
Solutions LLC  
Safety National  
Safety Services, LLC  
Safety Training Solutions  
Safework Essentials  
Safway Services  
Sage Construction  
Sage Environmental, LLC  
Sage Safety Services  
Sahara Inc.  
Sala – Shur Sales & Marketing  
Salmon Electrical Contractors LLC  
Salt Lake City Department of Airports  
Salt Lake City Airport Authority  
Salt Lake City Corporation  
Salt Lake City – Department of Housing  
Rehabilitation  
Salt Lake City Dept. of Public Services  
Salt Lake City Public Utilities  
Salt Lake City School District  
Salt Lake City VA  
Salt Lake City Water  
Salt Lake Community Action Program  
Salt Lake Community College  
Salt Lake County  
Salt Lake County District Attorney’s  
Office  
Salt Lake County Community  
Development  
Salt Lake County Health Department  
Salt Lake County – Housing &  
Community Development  
Salt Lake Environmental  
Salt Lake Orthopaedic Clinic  
Salt Lake Valley Health Dept.  
Salt Lake WorkMed**

**Salty Logs, Inc.  
San Juan Clinic  
San Juan Health District  
San Juan Public Health  
San Juan School District  
Sanders Glass  
Sandy City  
Sarcos  
Savage Pipe Solutions Unit  
Savage Services  
Sawtooth Caverns  
Scamp Excavation  
Schneider Electric  
Schreiber Foods, Inc.  
Schuff Steel  
Sedgwick  
Select Engineering Services  
Select Health  
Select Physical Therapy  
Sentinel Safety Consultants  
Serta Simmons Bedding  
Service King  
Service Master by Restoration Xperts  
Service Master Restoration & Cleaning  
Service  
ServiceMaster Clean  
ServiceMaster in Price  
Service Master Restoration & Cleaning  
Service  
Service Team of Professionals  
Servpro  
Sevier County Sheriff’s Office  
Sevier School District  
Sevier Valley Medical Center  
Shawcor Pipe Protection  
Shep’s Windows & Doors  
Shipex, Inc.  
Shivwits Band of Paiutes  
Sign Solutions, Inc.  
Silver Eagle Refining, Inc.  
Silver Leaf Partners, LLC  
Silver Spur Construction  
Simply Right Inc.  
Sinc Constructors, Co.  
Sinclair Oil Corporation  
Siri Contracting LLC  
Six County Association of Governments  
Skyline Electric Company**

Smart, Schofield, Shorter & Lunceford  
Smith Megadiamond/SII Megadiamond  
Smith's Food and Drug  
Smithfield Farmland  
Smithfield Foods  
Smoke & Fire  
Snow College  
Snowbird Ski and Summer Resort  
Snyderville Basin Water Reclamation  
District  
Sorenson Communications  
South Eastern Utah District Health Dept.  
South Summit School District  
South Valley ENT  
South Valley Sewer District  
Southeastern Utah Association Local  
Government  
Southeastern Utah District Health  
Department  
Southern Utah University  
Southern Unique Custom Exteriors  
Southwest Applied Tech  
Southwest Technical College  
Southwest Utah Public Health  
Department  
Space Dynamics Laboratory  
Spartan Recoveries  
Springcreek Construction  
Springville WorkMed  
Square D by Schneider Electric  
Squires Construction  
Stacy and Witbeck, Inc.  
St. Mark's Hospital  
Stadler US Inc.  
Staker Parsons Company  
Standard Drywall  
Standby Safety Services, Inc.  
Stantec Consulting  
Stapp Construction, Inc.  
State of Utah  
Steam King  
Sterling and Wilson Solar Solutions  
Steve McClure Home Inspections  
Steve W. Harper  
Stotz Equipment  
Strategic Safety Consulting  
Sturgeon Electric Company, Inc.  
Subzero Engineering

Sugar House Veterinary Hospital  
Sullivan Builders  
Sullivan Construction, Inc.  
Summit Contracting, LLC  
Summit County Public Health  
Department  
Summit Mining International  
Sun Products Corporation  
Sunrise Engineering  
Sunrise Personnel  
Sunroc Corporation  
Sunstar Construction  
Superior Roofing & Sheetmetal  
Support Claims Services  
Sure Steel  
Swanson Industries  
Swartz Campbell LLC  
Swift Restoration and Remodeling  
Swire Coca Cola  
Sysco Intermountain Food Services  
T-Squared Power  
TMC/Southland  
TCR Composites  
TIC The Industrial Company  
TID, Inc.  
TOSH  
TS Safety Group  
TTM Technologies, Inc.  
TTW Construction, LLC  
Tarter Gate West  
Tate's Construction, LLC  
Taylor Electric  
Taylor Flooring  
Taylor Mediator  
Tekko, Inc.  
Terra Linda Services  
Terracon Consultants, Inc.  
TerraTek / A Schlumberger  
Tesoro Refining and Marketing  
Teter Safety Services  
Teva Pharmaceuticals  
Textron Systems  
That Asbestos Guy Environmental  
The Buckner Company  
The Canyons School District  
The Church of Jesus Christ of Latter Day  
Saints (LDS)  
The Cincinnati Insurance Co.

**The Disaster Company**  
**The Flood Company**  
**The Gateway Company of Utah**  
**The Glass Company**  
**The Lead Inspectors, LLC**  
**The More than Giving Company**  
**The Perforators LLC**  
**The Premier Group**  
**The Presidio Group**  
**The Spine, Orthopedic & Pain Center**  
**Thermaglass Windows & Doors**  
**Thermal West Industrial**  
**Thermo Fisher Scientific**  
**Tintic School District**  
**Tonatec Exploration**  
**Tony's Handyman Services**  
**Tooele County Health Department**  
**Tooele County Housing**  
**Tooele School District**  
**Total Excavation & Construction**  
**Total Rehab**  
**Total Safety**  
**Tradesmen International**  
**Transfield Services**  
**Trans-Jordan Cities**  
**Travelers**  
**Tri County Health Department**  
**Tri-County Weatherization**  
**Tri-State Electric & Utility, Inc.**  
**Triple D Commercial Painting**  
**Tristar Risk Management**  
**Triumph Gear Systems**  
**U.S. Dept. of Interior – Bureau of Reclamation**  
**U.S.W. Local 8319**  
**UAMPS**  
**UAOHN**  
**UBIC**  
**UBMC**  
**UBTech**  
**UDOH**  
**UDOT**  
**UDOT Cedar District**  
**UDOT Complex**  
**UDOT Price District**  
**UDOT Region One**  
**UDOT Region Three**  
**UDOT Region Four**

**UOVC**  
**UPMC**  
**UPMA Centers for Rehab Services**  
**UPRR**  
**UPS**  
**URS Corporation**  
**US Army Corps of Engineers – Sacramento District**  
**US Dept. of Health & Human Services**  
**US Department of Labor**  
**US Development**  
**USDA Dixie National Forest**  
**USDA Forest Service**  
**US Geological Survey**  
**US Magnesium LLC**  
**US NDT**  
**US Oil Sands**  
**US Public Health Service**  
**US Ski & Snowboard**  
**US Synthenic**  
**USACE**  
**USDA**  
**USAG Dugway Proving Ground,**  
**USANA**  
**USBA**  
**USDOL/OSHA**  
**USPHS**  
**UTARNG**  
**Uintah Basin Applied Technology College**  
**Uintah Basin Association of Governments (UBAOG)**  
**Uintah Basin Healthcare**  
**Uintah Basin Technical College**  
**Uintah County Emergency Management**  
**Uintah School District**  
**Ultradent Products**  
**Unified Fire Authority**  
**Unique Custom Exteriors**  
**United States Air Force**  
**United States Army**  
    Department of Army  
    MEDCOM (Army)  
    Tooele Army Depot  
    US Army Health Clinic  
    Dugway Proving Grounds  
    US Army Medical Command  
**United Team Mechanical**  
**University Communities**

**University Health Care/OccMed Clinic at Redwood**  
**University of Pennsylvania**  
**University of Pittsburgh**  
**University of Pittsburgh Medical Center**  
**University of Utah**  
**University of Utah Hospital**  
**Unlimited Steel**  
**Utah Air National Guard**  
**Utah Army National Guard**  
**Utah Business Insurance**  
**Utah Career Center**  
**Utah Commission on Services & Volunteerism**  
**Utah Community Action**  
**Utah Correctional Industries**  
**Utah County Fire Marshall**  
**Utah County Health Department**  
**Utah County Sheriff Office**  
**Utah DAQ**  
**Utah DFCM Matheson Courts Complex**  
**Utah Department of**  
     **Agriculture & Food**  
     **Corrections**  
     **Health**  
     **Heritage and Arts**  
     **Environmental**  
     **Transportation**  
**Utah Disaster Kleenup**  
**Utah Divisions**  
     **Admin. Services**  
     **of Air Quality**  
     **of Emergency Management**  
     **of Environmental**  
     **of Oil, Gas & Mining**  
     **of Radiation Control**  
     **of Solid & Hazardous Waste**  
     **of Water Qualit**  
**Utah Electrical JATC**  
**Utah Electrical Training Alliance**  
**Utah Elevated Home Inspections**  
**Utah Environmental Consultants**  
**Utah Flood and Fire Network**  
**Utah Labor Commission**  
**Utah Local Governments Trust**  
**Utah Mechanical Contractors**  
**Utah National Guard**  
**Utah OSHA**

**Utah OSHA Consultation Program**  
**Utah OSHA Consultation & Education Services**  
**Utah Pipe Trades Education Programs**  
**Utah Property & Casualty**  
**Utah Public Health Laboratories**  
**Utah Retirement Systems**  
**Utah Safety Council**  
**Utah School Boards Insurance Association**  
**Utah Schools for the Deaf & Blind**  
**Utah State**  
**Utah State Attorney Generals**  
**Utah State Development Center**  
**Utah State Fire Marshall's Office**  
**Utah State Hospital**  
**Utah State University**  
**Utah State University Bingham Research Center**  
**Utah State University – Eastern**  
**Utah Tile & Roofing, Inc.**  
**Utah Transit Authority (UTA)**  
**Utah Valley University**  
**Ute Tribe**  
**Utility Trailer Manufacturing Co.**  
**VA Salt Lake City Healthcare System**  
**VA Vocational Rehab**  
**VOC Rehab**  
**VPPA Region VIII**  
**Vail Resorts**  
**Van Con Construction**  
**Varex Imaging**  
**VarianMed**  
**Veolia Environmental Services (ES)**  
**Veristride**  
**Veriten Consulting LLC**  
**Vernal Winnelson**  
**Versar, Inc.**  
**Versar Waller**  
**Verscend**  
**Versla Pro**  
**Veterans Healthcare System-SLC**  
**Vivint Solar**  
**Vona Case Management**  
**Vortex Companies**  
**Vulcraft**  
**W.W. Clyde & Company**  
**WGC, LLC**

WL Plastics  
WMI Inc.  
Wadman Corporation  
Wadsworth Brothers Construction  
Wallaby Industrial Safety  
Walmart Logistics  
Wasatch Academy  
Wasatch County Health Department  
Wasatch County School District  
Wasatch Electric  
Wasatch Environmental, Inc.  
Wasatch Medical Services  
Wasatch Mountain Contracting  
Wasatch Pro Services, LLC  
Wasatch Product Development  
Wasatch Safety Group  
Wasatch Tile Removal  
Wasatch Training Specialists  
Washington County  
Washington County School District  
Water Damage Specialist  
Water & Waste Logistics  
Weatherization  
Weber Basin Job Corps  
Weber County  
Weber County Health Department  
Weber Gallagher  
Weber School District  
Weber State University  
Weber – Morgan Health Department  
Weir Group  
Weir Minerals  
Weir Specialty Pumps  
weMFG  
West Liberty Foods  
West Roc  
West Roc Trucking Inc.  
West Valley City  
West Valley City Fire Department  
Westech Engineering, Inc.  
Western Legacy  
Western Mutual Insurance Co.  
Western Partitions  
Western Pipe Fabrication, Inc.  
Western Rock Products  
Western States Crane Consulting LLC  
Western Technologies, Inc.  
Western Wholesale Flooring

Western Wholesale Floors  
Western Wholesale Floorway  
Westinghouse Electric Co. LLC  
Westinghouse Western Zirconium  
Westlake Construction  
Westland Construction  
Westroc Oilfield  
Wheeler Machinery  
Whitaker Construction Co. Inc.  
Wilkinson Carpentry & Cabinets LLC  
Wilson Consulting Services  
Wings Over Wasatch  
Wise Safety & Environmental  
Wollam Construction  
Wood Environment & Infrastructure  
Solutions  
Wongan Enterprise  
Work Care, Inc  
Work Care Occupational Clinic  
Work Care Site Medical Services, LLC  
Work Point Occ. Med  
WorkAbility Centers, LLC  
WorkCare Industrial Clinic  
Workers Compensation Fund Insurance  
(WCF)  
Workmed  
WorkPartners Claims Mgmt.  
WorkPoint  
WorkPoint Ashley Valley  
Worksite Health & Wellness  
Wyatt Field Services  
X3 Tradesmen  
Xcel General Contracting  
York Risk Services  
Young Electric Sign Company YESCO  
LLC  
Young Living Essential Oils  
Younique Products  
ZR Associated, Inc.  
Zachery Construction Corporation  
Zachry Industrial  
Zane Church, LLC  
Zenith Insurance Company  
Zien Medical Technologies  
Zions National Park





## National Institute for Occupational Safety & Health (NIOSH)

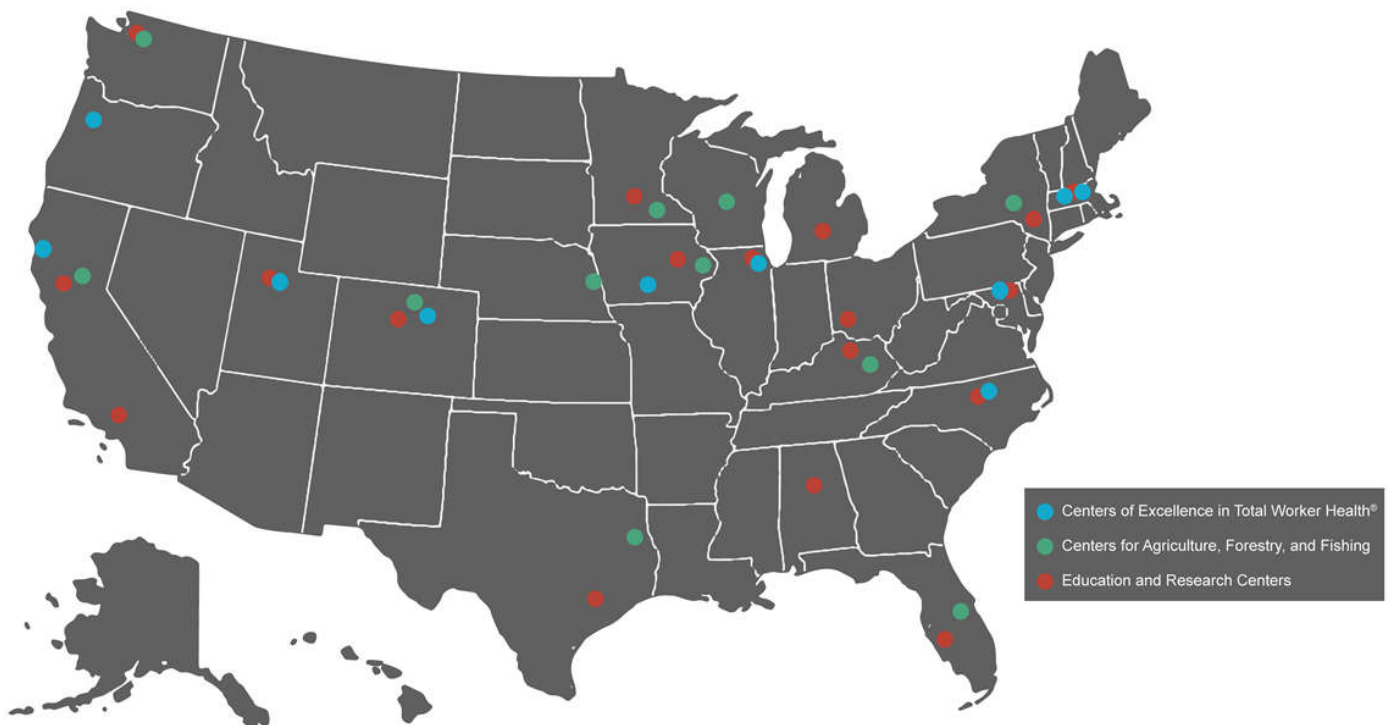
NIOSH is part of the U.S. Centers for Disease Control and Prevention, in the U.S. Department of Health and Human Services. **Its mission is to develop new knowledge in the field of occupational safety and health and to transfer that knowledge into practice.** The [Occupational Safety and Health Act of 1970](#) established NIOSH as a research agency focused on the study of worker safety and health, and empowered employers and workers to create safe and healthy workplaces. It included the mandate to assure “every working man and woman in the Nation safe and healthful working conditions and to preserve our human resources.”

## Association of University Programs in Occupational Health and Safety (AUPOHS)

A significant portion of the total NIOSH budget is allocated to 39 university-based centers (see map below). The directors of those centers advocate for the occupational safety and health concerns facing this country as the Association of University Programs in Occupational Health and Safety (AUPOHS).

In the Fiscal Year **2023** Labor, Health and Human Services (LHHS) Appropriations bill, AUPOHS respectfully **requests \$375.3 million** for NIOSH, including at least **\$34 million** for the Education and Research Centers (ERCs), **\$30.5 million** for the Centers for Agricultural Safety and Health (AgFF), and a **\$4 million increase** for the *Total Worker Health*<sup>®</sup> (TWH) Centers.

*In addition, in conference of the Fiscal Year **2022** LHHS bill, we request the House passed level of \$360.3 million for NIOSH, including \$32 million for the ERCs, \$28.5 million for the AgFF Centers and a \$4 million increase for the TWH Centers.*



## Centers for Agricultural Safety and Health

- The Centers protect the health and safety of workers in the AgFF sector. AgFF workers experience the highest fatal injury rate at 23.4 deaths per 100,000 full-time workers, compared to a rate of 3.5 deaths per 100,000 workers for all U.S. industries.
- The Centers were established in 1990 to **conduct research, education, and prevention projects to address the nation's pressing AgFF health and safety problems.** The Centers are responsive to the AgFF health and safety issues unique to their regions and collaborate on national projects. The Centers also work in collaboration with NIOSH AgFF program areas, such as commercial fishing safety and Cost-effective Rollover Protective Structures (CROPS).

## Centers of Excellence for Total Worker Health®

- The TWH Centers **conduct research that generates new knowledge and offers practical solutions that keep workers safe and healthy and help employers build and retain a productive workforce.** TWH Centers are hubs for TWH-related research and practice that builds the scientific evidence base necessary to develop new solutions for complex occupational safety and health problems.
- TWH Centers use multidisciplinary research projects, including intervention-focused research, outreach and education, and evaluation activities to improve our understanding of which solutions work. Their novel research has the potential to improve the safety and health of workers, employers, and communities.

## Education and Research Centers

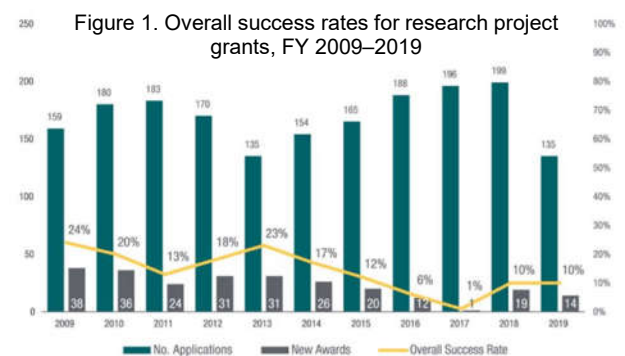
- The ERCs provide state-of-the-art interdisciplinary training to produce the next generation of occupational safety and health (OSH) practitioners and researchers. **ERCs prepare the future OSH workforce to respond to new challenges posed by the changing nature of work.**
- ERC graduates help meet the national demand for a diverse, skilled, knowledgeable, professional OSH workforce for federal, state, and local government agencies; not-for-profit agencies; industry; academia; business; healthcare; and labor organizations. ERCs help translate scientific discoveries into practice through effective education, training, and outreach.

While funding for these NIOSH Centers is crucially important, overall funding levels for NIOSH are also critical. These funds support NIOSH intramural research, investigator-initiated awards, and other key programs that fall outside of the NIOSH Centers. An increase in the NIOSH topline budget will benefit:

**NIOSH Intramural Research:** Funding for the NIOSH personal protective equipment program, which develops and monitors N95s, PAPRs, and other respiratory protection, led to crucial solutions in the fight against COVID-19. Other examples: Research on Disaster Response, Mental Health, Per- and Polyfluoroalkyl Substances (PFAS), Substance Use Disorders and Work.

**Investigator-initiated Awards** are grants that support new investigators, address emerging issues, or test novel OSH solutions. These funds have led to the development of germ-fighting fabrics for healthcare workers, investigations of silicosis outbreaks among stone fabrication workers, and training programs that protect emergency responders.

Minimal topline funding increases for NIOSH have led to a decrease in funding for NIOSH intramural research and investigator-initiated awards, which impacts NIOSH's ability to react quickly to emerging issues and develop innovative solutions. The number of awards has declined since 2013 (Figure 1).





## Education and Research Centers

The National Institute for Occupational Safety and Health (NIOSH), within the Centers for Disease Control and Prevention, supports the Education and Research Centers (ERCs). The ERCs provide funds for graduate students to obtain interdisciplinary occupational safety and health (OSH) training to meet the urgent need for OSH professionals in the U.S.

There are 18 ERCs at leading universities in 17 states around the country, serving all 50 states through their regional stakeholders. ERCs support academic and research training of over 900 trainees annually in specialized areas of OSH in addition to the core areas of industrial hygiene, occupational safety, occupational medicine, and occupational health nursing.

The ERCs also serve the nation by providing continuing education and outreach programs for over 46,000 occupational safety and health professionals and others with worker health and safety responsibilities in thousands of U.S. businesses.

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## Current and the continued need to ensure the health, safety, and productivity of U.S. workers

### Each Year

**2.8 million** workers are seriously injured on the job with 1/3 of those workers requiring time off  
**5,000** workers lose their lives to job injuries

U.S. businesses spent more than **\$55 billion in 2019** on serious, nonfatal workplace injuries

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The Association of University Programs in Occupational Health and Safety (AUPOHS) respectfully requests **\$375.3 million** for the National Institute for Occupational Safety and Health (NIOSH), including no less than **\$34 million** for the for the Education and Research Centers (ERCs), in the Fiscal Year 2023 Labor, Health and Human Services Appropriations bill.

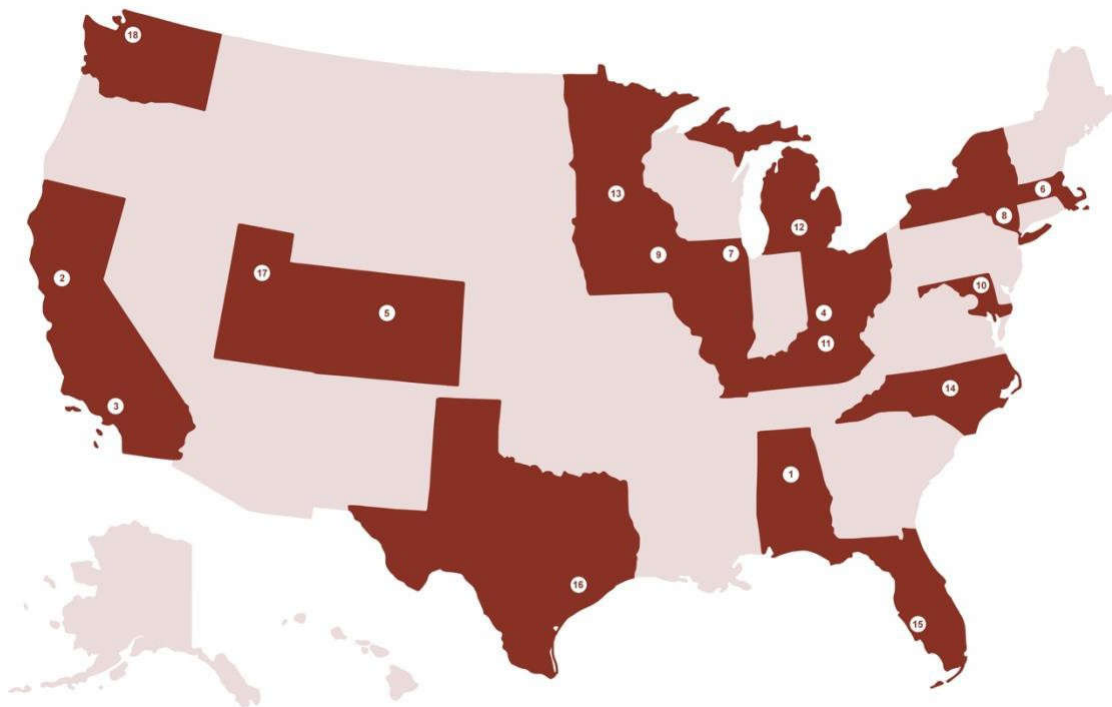
*In addition, in conference of the Fiscal Year 2022 Labor, Health and Human Services Appropriations bill, we respectfully request the House passed level of **\$360.3 million** for NIOSH, including **\$32 million** for the ERCs.*



## The mission of the ERCs is to protect workers, save lives, and reduce work-related injuries and illnesses throughout the U.S.

### Impacts: Education, Research, and Service

- Provide benefits to employers in every state.
- Prepare graduates for careers in institutions including: businesses, industries, academia, government, labor organizations and health care.
- Supply more than 75% of the U.S.'s occupational safety and health in critical specialty areas like occupational medicine and workplace injury prevention.
- Provide over 350,000 person-hours of professional development training for practicing safety and health professionals.
- Develop major research innovations that prevent occupational injuries and diseases.
- Work regionally and nationally to develop and bring best practices to the workplace to reduce or eliminate workplace injuries, illnesses, and deaths.
- Serve as the primary source of accessible experts to the public and government leaders for occupational safety and health issues.
- Does not duplicate any other U.S. government program.
- Help minimize costs of occupational injury and illness.



- |  |   |  |
|--|---|--|
| 1. University of Alabama at Birmingham   | 7. University of Illinois at Chicago    | 13. University of Minnesota                                  |
| 2. University of California, Berkeley    | 8. Icahn Mount Sinai School of Medicine | 14. University of North Carolina at Chapel Hill              |
| 3. University of California, Los Angeles | 9. University of Iowa                   | 15. University of South Florida                              |
| 4. University of Cincinnati              | 10. Johns Hopkins University            | 16. University of Texas Health and Science Center at Houston |
| 5. University of Colorado Denver         | 11. University of Kentucky              | 17. University of Utah                                       |
| 6. Harvard University                    | 12. University of Michigan              | 18. University of Washington                                 |



## Agricultural Safety & Health Centers & NIOSH AgFF Program

NIOSH Agriculture, Forestry and Fishing (AgFF) program is the **only** federal public health program working to ensure the safety and health for **millions of essential workers** in some of our nation's most dangerous and important production sectors.

The Association of University Programs in Occupational Health and Safety (AUPOHS) respectfully requests **\$375.3 million** for the National Institute for Occupational Safety and Health (NIOSH), including no less than **\$30.5 million** for the Agriculture, Forestry and Fishing (AgFF) Program, in the Fiscal Year 2023 Labor, Health and Human Services Appropriations bill. *In addition, in conference of the Fiscal Year 2022 Labor, Health and Human Services Appropriations bill, we respectfully request the House passed level of **\$360.3 million** for NIOSH, including **\$28.5 million** for the AgFF Program.*

### SAVING LIVES. SAVING MONEY.

Compared to the average U.S. worker, AgFF workers are **more likely to die** on the job by:<sup>1</sup>

**6x**



**AGRICULTURE**

**29x**



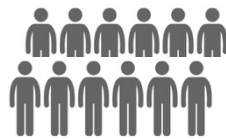
**FORESTRY**

**23x**



**FISHING**

The number of jobs speaks to the **need in agriculture.**<sup>2</sup>



**2,023,000**  
**AGRICULTURE**



**166,000**  
**FORESTRY**



**36,000**  
**FISHING**

Agricultural deaths and injuries cost the U.S. an estimated **\$9 billion** in annual medical and lost productivity costs.<sup>3</sup>

### ECONOMIC COSTS FROM:



**DEATHS (6%)**  
**INJURIES (94%)**



**\$9**  
**BILLION**  
AgFF  
Injuries & Deaths

**\$28.5**  
**MILLION**  
AgFF  
Program  
(FY21)

## 2020-21 EMERGING ISSUES RESPONSE



### COVID-19

The agricultural workforce consists of frontline, essential workers who have been disproportionately impacted by COVID-19. Our collective expertise in epidemiology, exposure science, and medicine was the basis for CDC’s Guidelines for Agricultural Workers and Employers. AgFF programs have worked to **increase access to health care, address PPE needs, and provide culturally responsive education.**



### NATURAL DISASTERS

AgFF communities need preparedness resources. With increased **wildfire and exposure to smoke, ash, and heat**, we are developing management tools to pinpoint local conditions, communicate risks, and provide simple solutions for traditionally complex respiratory protection. For **flooding**, we have developed safe clean-up methods and guidance on water contamination and disease risks.



### MENTAL HEALTH

To address critical needs for rural mental health services, a collaborative campaign launched: **“Seasons Change, You Remain.”** Our programs are developing audience-tested messages and strategic campaigns that bridge with industry and mental health partners. **Nineteen new mental health pilot projects** have been awarded to address gaps and grow networks that serve at-risk communities.

## REGIONAL CENTERS. NATIONAL PROGRAMS.



- **PNASH** - Pacific Northwest Agricultural Safety and Health Center, [deohs.washington.edu/pnash](http://deohs.washington.edu/pnash)
- **WCAHS** - Western Center for Agricultural Health and Safety, [aghealth.ucdavis.edu](http://aghealth.ucdavis.edu)
- **HICAHS** - High Plains Intermountain Center for Agricultural Health and Safety, [vetmedbiosci.colostate.edu/hicahs](http://vetmedbiosci.colostate.edu/hicahs)
- **CS-CASH** - Central States Center for Agricultural Safety and Health, [unmc.edu/publichealth/cscash](http://unmc.edu/publichealth/cscash)
- **UMASH** - Upper Midwest Agricultural Safety and Health Center, [umash.umn.edu](http://umash.umn.edu)
- **GPCAH** - Great Plains Center for Agricultural Health, [gpcah.public-health.uiowa.edu](http://gpcah.public-health.uiowa.edu)
- **SW Ag Center** - Southwest Center for Agricultural Health, Injury Prevention and Education, [www.swagcenter.org](http://www.swagcenter.org)
- **SCCAHS** - Southeastern Coastal Center for Agricultural Health and Safety, [sccaahs.org](http://sccaahs.org)
- **SCAHIP** - Southeast Center for Agricultural Health and Injury Prevention, [uky.edu/scahip](http://uky.edu/scahip)
- **NEC** - Northeast Center for Occupational Health and Safety, [necenter.org](http://necenter.org)
- ★ **NCCRAHS** - National Children's Center for Rural and Ag Health and Safety, [marshfieldresearch.org/nccrahs](http://marshfieldresearch.org/nccrahs)
- ★ **NIOSH AgFF** – NIOSH Office of AgFF Safety and Health, [cdc.gov/niosh/programs/agff](http://cdc.gov/niosh/programs/agff)
- ★ **NIOSH CMSHS** – NIOSH Center for Maritime Safety and Health Studies, [cdc.gov/niosh/programs/cmshs](http://cdc.gov/niosh/programs/cmshs)

1. U.S. Bureau of Labor Statistics, Census of Fatal Occupational Injuries (CFOI) – Civilian Occupational Death Rates. Average over 2019, 2018, 2017. [www.bls.gov/iif/oshcfoi1.htm](http://www.bls.gov/iif/oshcfoi1.htm).  
 2. U.S. Bureau of Labor Statistics, Labor Force Statistics from the Current Population Survey, Industry, 2019. [www.bls.gov/cps..](http://www.bls.gov/cps..)  
 3. Rautianianen, R (2021) Personal correspondence. Inflation-adjusted estimate of the 1992 estimates of \$4.57 billion that appeared in Leigh, J., McCurdy, S., & Schenker, M. (2001). Costs of Occupational Injuries in Agriculture. Public Health Report, 116(3), 235-248.



## Centers of Excellence in *Total Worker Health*<sup>®</sup>

### **Why *Total Worker Health* (TWH)? Work impacts worker health and well-being**

both positively and negatively. Beyond the physical demands of work, other job-related factors impact health such as work hours, wages, work organization and pace, interactions with coworkers, access to leave, job stress, and job security.

### **Health impacts business**

Occupational disease, injury, and death cost \$250 billion annually: 1.8% of the U.S. GDP. Companies recognized for having a culture of worker safety outperform the S&P 500 market performance. Other indirect costs of unhealthy work, financial and otherwise, impact

workers' families, communities, and healthcare systems.

### **Gaps exist in research and knowledge**

We know investments in employee health can generate returns. The hidden costs of worker poor health are enormous. More research is needed to understand the best ways to address the safety and health of all workers including low-wage workers, those without fixed workplaces, and people employed by small businesses.

### **Research addresses these gaps**

American businesses need a resilient, vital, and energetic workforce to compete in today's global economy. High quality

studies from the TWH Centers of Excellence provide the evidence needed for businesses to invest wisely and efficiently in innovative programs that work.

### **TWH offers innovation**

TWH programs focus on making work and the working environment more health promoting. TWH addresses workforce health comprehensively, focusing on issues such as mental health, opioids, stress related illnesses and other costly chronic conditions. These issues are a high priority for a healthy economy and are relevant for researchers and leaders from business, labor, and government agencies alike.

The Association of University Programs in Occupational Health and Safety (AUPOHS) respectfully requests **\$375.3 million** for the National Institute for Occupational Safety and Health (NIOSH), including at least a **\$4 million increase** for the TWH Centers, in the Fiscal Year 2023 Labor, Health and Human Services Appropriations bill. *In addition, in conference of the Fiscal Year 2022 Labor, Health and Human Services Appropriations bill, we respectfully request the House passed level of **\$360.3 million** for NIOSH, including a **\$4 million increase** for TWH.*

## **What have we accomplished?**

- In a state prison system, a new correctional officer mentoring program resulted in better biomarkers of cardiovascular disease, and reduced workplace burn-out in officers.
- Smoking quit rates among blue collar workers doubled when workplace tobacco cessation programs were combined with workplace safety and health programs and practices addressing adverse work conditions.
- In acute care hospitals, a combined employee work and health database revealed the effects of harassment and bullying on workplace injury and mental health care costs for patient care workers.
- A supervisor training and team process intervention targeting construction worker health and safety led to reduced blood pressure and improved worker perceptions of team effectiveness and support.



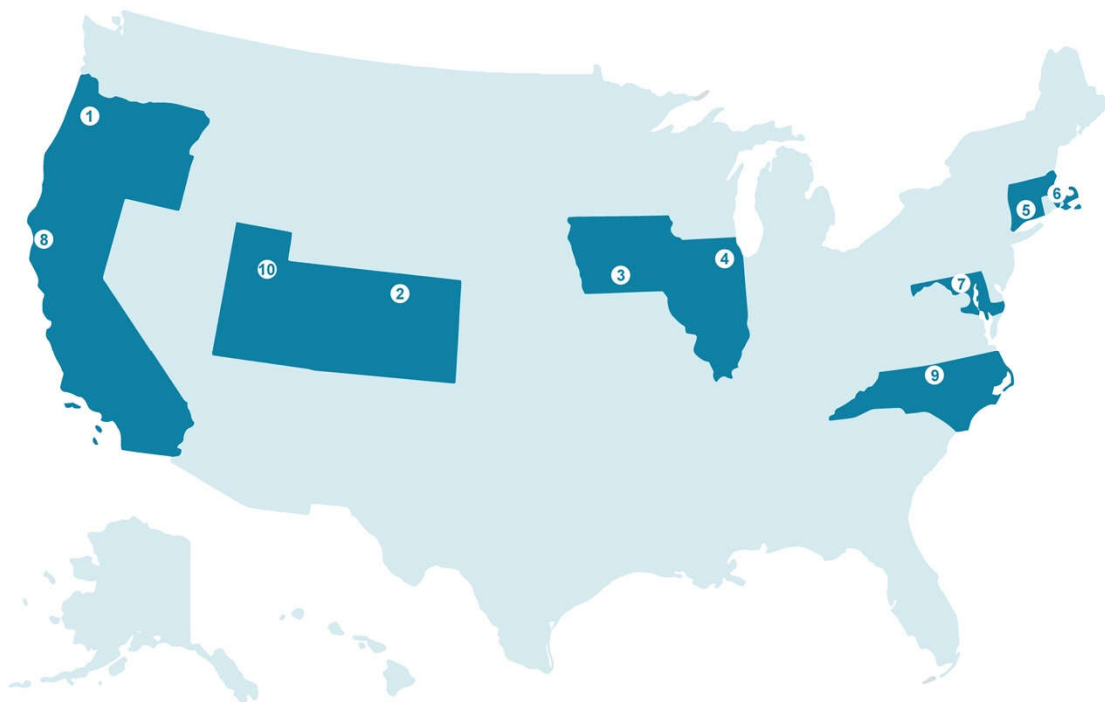


- Integrating active workstations with ergonomic adjustments for sedentary workers increased their physical activity and positively impacted resting heart rate, weight and percent body fat.
- Based on their research, the Centers continue to produce, evaluate, and refine evidence-based practice guidelines and assessment tools for adoption by businesses, government, and labor.  
<https://www.cdc.gov/niosh/twh/letsgetstarted.html>

## Centers of Excellence for TWH and TWH Affiliates

Ten Centers of Excellence across the country lead the research and practice in TWH. The Centers receive funding from the National Institute for Occupational Safety and Health (NIOSH), the only federal agency directed to conduct research for the prevention of work-related injuries and illnesses. Center investigators, in partnership with government agencies, businesses, labor groups, and communities, are the conduits for research to practice impacting the safety, health and productivity of American workers.

In addition, the *Total Worker Health*<sup>®</sup> Affiliate Program aims to foster an integrated approach to protecting and promoting worker well-being through collaborations with not-for-profit and government organizations. Currently, there are a total of 47 Affiliates across the country.



***Total Worker Health* Centers of Excellence:** 1-Oregon Healthy Workforce Center; 2-Center for Health, Work & Environment; 3-Healthier Workforce Center of the Midwest; 4-University of Illinois at Chicago Center for Healthy Work; 5-Center for the Promotion of Health in the New England Workplace; 6-The Harvard T.H. Chan School of Public Health Center for Work, Health, & Well-being; 7-Johns Hopkins P.O.E. *Total Worker Health*<sup>®</sup> Center in Mental Health; 8-California Labor Laboratory; 9-Carolina Center for *Total Worker Health*<sup>®</sup> and Well-being; 10-Utah Center for Promotion of Work Equity

## Support Occupational Safety and Health Funding in FY2023

Dear Colleague:

Please join us in supporting occupational safety and health funding for Fiscal Year 2023 by requesting at least \$375.3 million for the National Institute for Occupational Safety and Health (NIOSH). The National Institute for Occupational Safety and Health (NIOSH), part of the Centers for Disease Control and Prevention, is the primary federal agency responsible for conducting research and making recommendations for the prevention of work-related illness and injury. NIOSH supports 39 Centers of Excellence, including the Education and Research Centers, the Centers for Agricultural Safety and Health, and the Centers of Excellence for Total Worker Health. NIOSH is the only federal research agency responsible for protecting the nation's workers through evidence-based solutions, and this has been critical during the COVID-19 pandemic. NIOSH has been the authority on respiratory protection, including testing and certifying newly available respirators, as well as providing guidance for employers and to the public on how to operate safely during the pandemic or reopen with appropriate precautions in place.

Education and Research Centers (ERC) provide state-of-the-art interdisciplinary training and play a significant role in preparing the future occupational safety and health (OSH) workforce to respond to new challenges posed by the changing nature of work. There are 18 ERCs at leading universities in 17 states around the country, serving all 50 states through their regional stakeholders. ERCs help translate scientific discoveries into practice through effective education, training, and outreach. ERC trainees and key personnel collaborate with stakeholders to develop innovative approaches to improving workplace safety and health.

The Centers for Agricultural Safety and Health conduct research, education, and prevention projects to address the nation's pressing agriculture, forestry and fishing (AgFF) health and safety problems. Geographically, the Centers are distributed throughout the nation to be responsive to the health and safety issues in the AgFF Sector unique to the different regions but collaborate on national projects and have one Center focused on children's farm safety. The AgFF program is the only federal public health program working to ensure the safety and health for millions of essential workers in some of our nation's most dangerous and important production sectors.

Centers of Excellence for Total Worker Health (TWH) conduct research that generates new knowledge and offers practical solutions that keep workers safe and healthy and help employers build and retain a productive workforce. TWH Centers use multidisciplinary research projects, including intervention-focused research, outreach and education, and evaluation activities to improve our understanding of which solutions work. Their novel research has the potential to improve the safety and health of workers, employers, and communities.

We invite you to join us in sending this letter requesting funding for NIOSH, including the Education and Research Centers (ERCs), the Agriculture, Forestry and Fishing Program (AgFF), and the Total Worker Health Program in the FY23 Labor, Health and Human Services Appropriations bill.

**To sign the Senate or House letters please contact the following offices:**

Senator Tammy Baldwin (D-WI)  
Senator Angus King (I-VT)  
Rep. Peter Welch (D-VT)  
Rep. Joe Courtney (D-CT)  
Rep. Don Young (R-AK)

## DRAFT SUBCOMMITTEE LETTER

We are writing to respectfully request that the Fiscal Year 2023 Labor, Health and Human Services Appropriations bill include at least \$375.3 million for the National Institute for Occupational Safety and Health (NIOSH), and within that amount at least \$34 million for the Education and Research Centers (ERCs), \$30.5 million for the Agriculture, Forestry and Fishing (AgFF) Program and at least a \$4 million increase for the Total Worker Health Program. NIOSH supports 18 university-based Education and Research Centers in 17 states, ten regional Centers for Agricultural Safety and Health and a National Children's Center for Rural and Agricultural Health and Safety, and ten Centers of Excellence in Total Worker Health.

NIOSH is the only federal agency with an occupational health and safety mission and provides the only dedicated federal investment for research needed to prevent workplace injuries and illnesses that cost the United States \$250 billion annually. Different than the regulatory approach to safety and health, NIOSH works cooperatively with employers and employees to adapt research findings into workable solutions. NIOSH is the only federal research agency responsible for protecting the nation's workers through evidence-based solutions, and this has been critical during the COVID-19 pandemic. NIOSH has been the authority on respiratory protection—testing and certifying newly available respirators, providing guidance for employers and to the public on how to operate safely during the pandemic or reopen with appropriate precautions in place.

NIOSH supports programs in every state to improve the health and safety of workers, such as the Education and Research Centers (ERCs), the Agriculture, Forestry and Fishing (AgFF) Program, and the Total Worker Health (TWH) Program. Additional funding for these programs is critical and would allow workers to avoid exposures that can result in injury or illnesses, improve working conditions, and provide occupational safety and health services to U.S. businesses, all vitally important functions during the COVID-19 pandemic.

While funding for the ERCs, the AgFF and the TWH Programs is crucially important to maintaining funding for resources, staff and long-term investments in extramural occupational safety and health research, overall funding levels for NIOSH are also crucial. An increase in NIOSH topline funding levels supports NIOSH intramural research, investigator-initiated awards and other key programs, including the NIOSH personal protective equipment program, which develops and monitors N95s, PAPRs, and other respiratory protection; disaster response research; mental health research; Per- and Polyfluoroalkyl Substance (PFAS) research; and research on substance use disorders and work.

We urge you to recognize the important contribution of NIOSH, including the ERCs, the AgFF Program, and the TWH Program, to the health and productivity of our nation's workforce by providing at least \$375.3 million for NIOSH, including at least a \$4 million increase for the ERCs, AgFF Program, and the TWH Program in the FY 2023 Labor, Health and Human Services Appropriations bill.

Sincerely,

DEPARTMENTS OF LABOR, HEALTH AND HUMAN SERVICES, AND EDUCATION, AND RELATED AGENCIES APPROPRIATIONS BILL, 2022

ment treatments and services as well as indirect costs related to pain. Finally, the Committee directs CDC to report on the status of these activities in the fiscal year 2023 Congressional Budget Justification.

*Rape Prevention.*—The Committee includes an increase of \$50,000,000 to support rape prevention and education programs.

*Suicide.*—The Committee includes an increase of \$2,000,000 to expand surveillance and comprehensive prevention efforts, as suicide is devastating communities across the U.S.

*Traumatic Brain Injury.*—The Committee provides an increase of \$2,000,000 to begin to address concussion surveillance, particularly among children and youth.

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

Appropriation, fiscal year 2021 .....	\$345,300,000
Budget request, fiscal year 2022 .....	345,300,000
Committee Recommendation .....	360,300,000
Change from enacted level .....	+15,000,000
Change from budget request .....	+15,000,000

The National Institute for Occupational Safety and Health (NIOSH) conducts applied research, develops criteria for occupational safety and health standards, and provides technical services to government, labor, and industry, including training for the prevention of work-related diseases and injuries. This appropriation supports surveillance, health hazard evaluations, intramural and extramural research, instrument and methods development, dissemination, and training grants.

Within the total for NIOSH, the Committee recommends the following amounts:

Budget Activity	FY 2022 Committee
National Occupational Research Agenda .....	\$123,000,000
<i>Agricultural, Forestry, and Fishing</i> .....	28,500,000
Education and Research Centers .....	32,000,000
Personal Protective Technology .....	23,000,000
Mining Research .....	61,500,000
National Mesothelioma Registry and Tissue Bank .....	1,200,000
Firefighter Cancer Registry .....	2,500,000
Other Occupational Safety and Health Research .....	117,100,000

*Agricultural, Forestry, and Fishing.*—The Committee includes an increase of \$2,000,000 to expand efforts to protect workers in this sector by providing leadership in applied research, disease and injury surveillance, education and prevention.

*Assessment of the Extent of COVID-19 Infections and Deaths Among Workers.*—The Committee is aware that many groups of essential workers faced higher rates of COVID-19 infections and death during the pandemic, such as those employed in health care, first responders, meat and poultry, corrections, grocery, corrections, and transit industries. Many of these are low wage workers of color, whose jobs required them to report to work in person throughout the pandemic. In order to fully assess the extent and impact of the COVID-19 pandemic on workers and to protect them from unnecessary future exposure and infection, the Committee directs CDC to prepare: (1.) A study quantifying COVID-19 deaths by occupation and industry based upon an analysis of death certifi-

cates. Such report shall compare the higher risk occupations and the rate of COVID–19 deaths in the general population. Such report shall be provided to the Committee on Appropriations and the public 180 days from the date of enactment of this Act; and (2.) A report on the extent of COVID–19 infections among working populations by occupation, the factors that contribute to this increased risk, and a description of disparate impacts by race and ethnicity. The report should include an assessment of the adequacy of reporting and data collection of COVID–19 infections, outbreaks and deaths among workers, and recommendations and a professional budget justification for improvements in data collection and reporting by employers, localities, States and the Federal government for COVID–19 and future epidemics. Such report shall be provided to the Committee on Appropriations and the public within 180 days of enactment of this Act.

*Education and Research Centers.*—The Committee includes an increase of \$2,000,000 to support efforts to reduce work-related injuries and illnesses through prevention research, education, and implementation of programs to improve occupational health and safety and minimize the dangers faced by workers across the country.

*Mining Program.*—The Committee commends CDC for the progress outlined in the 2019–2023 mining program strategic plan to reduce overexposure to hazardous airborne contaminants in the mining environment by conducting studies to: (1) improve measurement of exposures to hazardous dusts, and to better understand the risks for respiratory diseases among mine workers; (2) develop and assess the effectiveness of interventions and technologies to prevent overexposure to hazardous dusts; and (3) to improve the adoption of control interventions and technologies.

*Personal Protective Technologies.*—The Committee recognizes the important role that CDC continues to provide regarding personal protective technologies in response to the COVID–19 pandemic and to protect workers every day and includes an increase of \$3,000,000 to support these efforts. The Committee directs CDC to review and report back to the Committee within 180 days of enactment of this Act, a consideration of how technology, including voice-activated technology, could save PPE and clinicians’ lives. This review should include specific analysis of the impact on nurses employed in acute care hospitals.

*Total Worker Health.*—The Committee includes an increase of \$4,000,000 to expand the Total Worker Health program, which supports and conducts ground-breaking research to advance the overall safety, health, and well-being of U.S. workers.

ENERGY EMPLOYEES OCCUPATIONAL ILLNESS COMPENSATION PROGRAM

Appropriation, fiscal year 2021 .....	\$55,358,000
Budget request, fiscal year 2022 .....	55,358,000
Committee Recommendation .....	55,358,000
Change from enacted level .....	---
Change from budget request .....	---

The Energy Employees Occupational Illness Compensation Program provides compensation to employees and survivors of employees of Department of Energy facilities and private contractors who

EXPLANATORY STATEMENT FOR DEPARTMENTS OF LABOR,  
HEALTH AND HUMAN SERVICES, AND EDUCATION, AND  
RELATED AGENCIES APPROPRIATIONS BILL, 2022

SUMMARY OF BUDGET ESTIMATES AND COMMITTEE  
RECOMMENDATIONS

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*Public Safety Officer Suicide Reporting System.*—The Committee continues \$1,000,000 for the National Violent Death Reporting System for CDC to maintain a Public Safety Officer Suicide Reporting System to collect data on the suicide incidence among public safety officers and facilitate the study of successful interventions to reduce suicide among public safety officers as described in the Helping Emergency Responders Overcome Act of 2020.

*Rape Prevention.*—The Committee includes an increase of \$50,000,000, consistent with the budget request, to support rape prevention and education programs. In granting funds to states, the Secretary shall set forth procedures designed to ensure meaningful involvement of the State or territorial sexual assault coalitions and representatives from underserved communities in the application for and implementation of funding.

*Suicide Prevention.*—The Committee is concerned about findings from an August 2020 Morbidity and Mortality Weekly Report that showed 40 percent of U.S. adults were struggling with mental health or substance use during the height of the COVID–19 pandemic, with 11 percent seriously considering suicide in the 30 days prior to completing a web-based survey. This report indicated that suicidal ideation was significantly higher among young adults, people of color, unpaid caregivers for adults, and essential workers. Given that approximately twice as many respondents reported serious consideration of suicide in the report compared to adults in 2018, these findings highlight the urgent need to enhance and expand CDC’s suicide prevention efforts. The Committee provides \$24,000,000, an increase of \$12,000,000, and directs CDC to expand its comprehensive suicide prevention program to implement and evaluate an evidence-based public health approach to suicide prevention with attention to high-risk, vulnerable populations, including LGBTQIA+ youth and increase research to understand how certain factors, including access to mental health services, contribute to the risk of or protect against suicidal behaviors in different populations. CDC is also directed to expand and enhance its emergency department syndromic surveillance on suicidal behavior and nonfatal suicide-related outcomes to provide near real-time data on suicidal ideation and attempts, disaggregated by race and ethnicity, age, disability status, and sex, including sexual orientation and gender identity, as available, in order to inform community-based suicide prevention efforts. CDC is strongly encouraged to use this funding to expand research, increase data collection to inform local responses, and support State health departments and other stakeholders as they develop and implement comprehensive suicide prevention plans.

*Traumatic Brain Injury.*—The Committee includes an increase of \$1,000,000 to begin to address concussion surveillance, particularly among children and youth.

OCCUPATIONAL SAFETY AND HEALTH [NIOSH]

Appropriations, 2021 .....	\$345,300,000
Budget estimate, 2022 .....	345,300,000
Committee recommendation .....	347,300,000

The Committee recommendation for the National Institute for Occupational Safety and Health [NIOSH] programs is

\$347,300,000. The Committee recognizes that NIOSH is the only Federal agency responsible for conducting research and making recommendations for the prevention of work-related illness and injury. The NIOSH mission is implemented by conducting basic and applied scientific research and translating the knowledge gained into products and services that impact workers in settings from corporate offices to construction sites to coal mines. Further, the Committee acknowledges that NIOSH continues to protect American workers through its work-related illness and injury research. The Committee encourages NIOSH to continue its objectivity so as to ensure the highest professional and ethical standards are maintained.

The Committee recommendation includes funding for the following activities in the following amounts:

(In thousands of dollars)

Budget activity	Fiscal year 2021 appropriation	Committee recommendation
National Occupational Research Agenda .....	117,000	118,000
Agriculture, Forestry, Fishing (non-add) .....	26,500	27,500
Education and Research Centers .....	30,000	30,000
Personal Protective Technology .....	20,000	20,000
Mining Research .....	61,500	62,500
National Mesothelioma Registry and Tissue Bank .....	1,200	1,200
Firefighter Cancer Registry .....	2,500	2,500
Other Occupational Safety and Health Research .....	113,100	113,100

*Agriculture, Forestry and Fishing Program [AgFF].*—The Committee includes an increase of \$1,000,000 for the AgFF program. AgFF workers experience the highest fatal injury rate at 23.4 deaths per 100,000 full-time workers, compared to a rate of 3.5 deaths per 100,000 workers for all U.S. industries. The AgFF centers conduct research, education, and prevention projects to address the nation's pressing agriculture, forestry and fishing health and safety problems.

*Coal Workers' Health Surveillance Program Mobile Medical Unit.*—The Committee is concerned about the recent increase in cases of coal workers' pneumoconiosis, also known as black lung. According to NIOSH, one in ten underground coal miners who have worked in mines for at least 25 years were identified as having black lung. Coal miners in central Appalachia are disproportionately affected with as many as 1 in 5 having evidence of black lung, the highest level recorded in 25 years. Early screening and detection of black lung can improve health outcomes and reduce mortality. However, a NIOSH report has identified several potential barriers to screening for miners—including the ability to participate in screening. To improve access to screening for miners, the Committee directs CDC to prioritize the maintenance of existing mobile medical units and urges CDC to consider the purchase of an additional mobile medical unit.

*Firefighter Cancer Registry.*—The Committee continues to support CDC's Firefighter Cancer Registry. This voluntary, anonymous registry system will enable researchers to better understand why firefighters are at an increased risk of developing certain types of cancer, and identify ways to mitigate firefighters' risk of cancer through best practices and advanced equipment.

*Robotic and Intelligent Mining Technology and Workplace Safety Research.*—The Committee provides an increase of \$1,000,000 for the NIOSH Mining Program to expand grant opportunities to universities with graduate programs in mining and explosives engineering to fund additional research initiatives in automation, robotics and intelligent mining systems to improve workplace safety and health in U.S. mining operations and that can contribute to the goal of completely eliminating mining fatalities within the next two decades.

ENERGY EMPLOYEES OCCUPATIONAL INJURY COMPENSATION ACT

Appropriations, 2021 .....	\$55,358,000
Budget estimate, 2022 .....	55,358,000
Committee recommendation .....	55,358,000

The Committee recommendation for the Energy Employees Occupational Illness Compensation Program Act [EEOICPA] (Public Law 106–398) is \$55,358,000. This mandatory funding supports NIOSH scientists who reconstruct radiation dose levels to inform compensation decisions.

GLOBAL HEALTH

Appropriations, 2021 .....	\$592,843,000
Budget estimate, 2022 .....	697,843,000
Committee recommendation .....	597,843,000

The Committee recommends \$597,843,000 for global health-related activities at CDC.

The Center for Global Health leads international programs and coordinates CDC’s global efforts with the goal of promoting health and preventing disease in the United States and abroad. The Center has a particular focus on ensuring rapid detection and response to emerging health threats.

The Committee recommendation includes funding for the following activities in the following amounts:

[In thousands of dollars]

Budget activity	Fiscal year 2021 appropriation	Committee recommendation
Global HIV/AIDS Program .....	128,421	128,421
Global Tuberculosis .....	9,222	9,222
Global Immunization Program .....	226,000	231,000
Polio Eradication .....	176,000	181,000
Measles and Other Vaccine Preventable Diseases .....	50,000	50,000
Parasitic Diseases and Malaria .....	26,000	26,000
Global Public Health Protection .....	203,200	203,200

*Global Public Health Protection.*—The Committee commends CDC for its continued leadership in global health by working closely with U.S. government agencies, ministries of health, and other partners to stop diseases where they occur around the world, while also protecting the health and livelihoods of the American people at home. The Committee recognizes CDC’s unique role in supporting public health capacity development both domestically and globally, to ensure that disease threats anywhere are prevented if possible, detected early and responded to robustly through a coordinated, multisectoral approach. In fiscal years 2020 and 2021, Con-



# Congress of the United States

## Washington, DC 20515

April 28, 2021

The Honorable Rosa DeLauro  
Chairwoman  
House Appropriations Subcommittee on  
Labor, HHS, Education  
H-307, The Capitol  
Washington, D.C. 20515

The Honorable Tom Cole  
Ranking Member  
House Appropriation Subcommittee on  
Labor, HHS, Education  
1016 Longworth House Office Building  
Washington, DC 20515

Dear Chairwoman DeLauro and Ranking Member Cole:

We are writing to respectfully request that the Fiscal Year 2022 (FY22) Labor, Health and Human Services Appropriations bill include at least \$375.3 million for the National Institute for Occupational Safety and Health (NIOSH), and within that amount at least \$34 million for the Education and Research Centers (ERCs), \$30.5 million for the Agriculture, Forestry and Fishing (AgFF) Program and at least a \$4 million increase over the Fiscal 2021 level for the Total Worker Health Program. NIOSH supports 18 university-based Education and Research Centers in 17 states, ten regional Centers for Agricultural Safety and Health and a National Children's Center for Rural and Agricultural Health and Safety, and six Centers of Excellence in Total Worker Health.

Annually, 2.8 million workers are seriously injured on the job with one third of those workers requiring time off. In addition, 5,000 workers lose their lives annually to job injuries. The mission of the ERCs is to reduce these work-related injuries through research, training and programs to improve occupational health and safety. Collectively, the ERCs provide training and research resources to every Public Health Region in the United States.

Agriculture, Forestry and Fishing (AgFF) workers experience the highest fatal injury rate at 23.4 deaths per 100,000 full-time workers, compared to a rate of 3.5 deaths per 100,000 workers for all U.S. industries. In addition, agricultural injuries cost the U.S. an estimated \$7.6 billion in medical and lost productivity costs. The AgFF Program serves as a resource for agricultural safety and health and works closely with major agricultural industries, including the forestry and fishing sectors, to understand related health risks, develop and evaluate interventions, and build capacity to address health and safety needs of agricultural businesses. The AgFF program is the only federal public health program working to ensure the safety and health for millions of essential workers in some of our nation's most dangerous and important production sectors.

Total Worker Health (TWH) is a comprehensive approach designed to protect the safety and health and to advance the overall well-being of workers. NIOSH funds six Centers of Excellence for TWH that complete multidisciplinary research, intervention, outreach and education, and evaluation activities advancing the overall safety, health, and well-being of the diverse population of workers in our nation. The TWH Centers, along with their partners in government, business, labor, and community, conduct and disseminate scientific, evidence-based research and practices with the goal of improving the overall safety, health, well-being and the productivity of the American workforce.

NIOSH is the only federal research agency responsible for protecting the nation's workers through evidence-based solutions, and this has been critical during the COVID-19 pandemic. NIOSH has been the authority on respiratory protection, including testing and certifying newly available respirators, as well as providing guidance for employers and to the public on how to operate safely during the pandemic or reopen with appropriate precautions in place. We urge you to recognize the important contribution of NIOSH, including the ERCs, the AgFF Program, and the TWH Program to the health and productivity of our nation's workforce by providing at least \$375.3 million for NIOSH, including at least a \$4 million increase over the fiscal year 2021 level for each the ERCs, AgFF Program, and the TWH Program in the FY22 Labor, Health and Human Services Appropriations bill.

Sincerely,



Peter Welch  
Member of Congress



Don Young  
Member of Congress



Joe Courtney  
Member of Congress

Member of Congress

## List of Signatories:

/s/ Alma S. Adams, Ph.D.  
/s/ Cindy Axne  
/s/ Joyce Beatty  
/s/ Ami Bera, M.D.  
/s/ Earl Blumenauer  
/s/ Suzanne Bonamici  
/s/ Cheri Bustos  
/s/ G. K. Butterfield  
/s/ Salud Carbajal  
/s/ Sean Casten  
/s/ Steve Chabot  
/s/ Angie Craig  
/s/ Jason Crow  
/s/ Danny K. Davis  
/s/ Peter A. DeFazio  
/s/ Diana DeGette  
/s/ Suzan K. DelBene  
/s/ Antonio Delgado  
/s/ Mark DeSaulnier  
/s/ Debbie Dingell  
/s/ John Garamendi  
/s/ Louie Gohmert  
/s/ Jared Golden  
/s/ Jahana Hayes  
/s/ Jim Himes  
/s/ Sheila Jackson Lee  
/s/ Pramila Jayapal  
/s/ John Katko  
/s/ William R. Keating  
/s/ Ron Kind  
/s/ Raja Krishnamoorthi  
/s/ Ann McLane Kuster  
/s/ Rick Larsen  
/s/ Teresa Leger Fernández  
/s/ Andy Levin  
/s/ Ted W. Lieu  
/s/ Stephen F. Lynch  
/s/ Tom Malinowski  
/s/ A. Donald McEachin  
/s/ James P. McGovern  
/s/ Seth Moulton  
/s/ Richard E. Neal  
/s/ Joe Neguse  
/s/ Tom O'Halleran  
/s/ Ilhan Omar  
/s/ Chris Pappas  
/s/ Bill Pascrell, Jr.  
/s/ Donald M. Payne, Jr.  
/s/ Dean Phillips  
/s/ Chellie Pingree  
/s/ Katie Porter  
/s/ Jamie Raskin  
/s/ Linda T. Sánchez  
/s/ Jan Schakowsky  
/s/ Kim Schrier, M.D.  
/s/ Elissa Slotkin  
/s/ Adam Smith  
/s/ Christopher H. Smith  
/s/ Pete Stauber  
/s/ Elise M. Stefanik  
/s/ Mark Takano  
/s/ Nikema Williams  
/s/ John Yarmuth

United States Senate  
WASHINGTON, DC 20510

June 11, 2021

The Honorable Patty Murray  
Chair  
Subcommittee on Labor-HHS-Education  
Senate Appropriations Committee

The Honorable Roy Blunt  
Ranking Member  
Subcommittee on Labor-HHS-Education  
Senate Appropriations Committee

Dear Chair Murray and Ranking Member Blunt:

We are writing to respectfully request that the Fiscal Year (FY) 2022 Labor, Health and Human Services, Education and Related Agencies Appropriations bill include robust funding for the National Institute for Occupational Safety and Health (NIOSH) within the Centers for Disease Control and Prevention (CDC). Specifically, we request \$375.3 million for NIOSH, and within that amount, \$34 million for the Education and Research Centers (ERCs), \$30.5 million for the Agriculture, Forestry and Fishing (AgFF) Program and a \$4 million increase over the FY 2021 level for the Total Worker Health Program. NIOSH supports 18 university-based ERCs in 17 states, six Centers of Excellence in Total Worker Health, ten regional Centers for Agricultural Safety and Health and the National Children's Center for Rural and Agricultural Health and Safety.

Annually, 2.8 million workers are seriously injured on the job, with one third of those workers requiring time off. In addition, 5,000 workers lose their lives annually to job injuries. The mission of the ERCs is to reduce these work-related injuries through research, training and programs to improve occupational health and safety. Collectively, the ERCs provide training and research resources to every region in the United States.

Agriculture, Forestry and Fishing (AgFF) workers experience the highest fatal injury rate at 23.4 deaths per 100,000 full-time workers, compared to a rate of 3.5 deaths per 100,000 workers for all U.S. industries. In addition, agricultural injuries cost the U.S. an estimated \$7.6 billion in medical and lost productivity costs. The ten regional Centers for Agricultural Safety and Health and the National Children's Center for Rural and Agricultural Health and Safety within the AgFF Program serve as a resource for agricultural safety and health and work closely with major agricultural industries, including the forestry and fishing sectors, to understand related health risks, develop and evaluate interventions and build capacity to address health and safety needs of agricultural businesses. The AgFF program is the only federal public health program working to ensure the safety and health for millions of essential workers in some of our nation's most important but dangerous production sectors. And given that during the past decade, youth worker fatalities in agriculture have exceeded those of all other industries combined, the work of the National Children's Center for Rural and Agricultural Health and Safety is of particular importance.

Total Worker Health (TWH) is a comprehensive approach designed to protect the safety and health and to advance the overall wellbeing of workers. NIOSH funds six Centers of Excellence

for TWH that complete multidisciplinary research, outreach and education, intervention and evaluation activities advancing the overall safety, health and wellbeing of the diverse population of workers in our nation. The TWH Centers, along with their partners in government, business, labor and community, conduct and disseminate scientific, evidence-based research and practices with the goal of improving the overall health and productivity of the American workforce.

We urge you to recognize the important contribution of NIOSH, including the ERCs, the AgFF Program and the TWH Program to our nation's workers by providing strong funding for NIOSH in the FY 2022 Labor, Health and Human Services, Education and Related Agencies Appropriations bill.

Sincerely,

/s/ Tammy Baldwin  
Tammy Baldwin  
United States Senator

/s/ Tina Smith  
Tina Smith  
United States Senator

/s/ Jeanne Shaheen  
Jeanne Shaheen  
United States Senator

/s/ Edward J. Markey  
Edward J. Markey  
United States Senator

/s/ Christopher S. Murphy  
Christopher S. Murphy  
United States Senator

/s/ Tammy Duckworth  
Tammy Duckworth  
United States Senator

/s/ Debbie Stabenow  
Debbie Stabenow  
United States Senator

/s/ Robert Menendez  
Robert Menendez  
United States Senator

/s/ Angus S. King, Jr.  
Angus S. King, Jr.  
United States Senator

/s/ Margaret Wood Hassan  
Margaret Wood Hassan  
United States Senator

/s/ Chris Van Hollen  
Chris Van Hollen  
United States Senator

/s/ Dianne Feinstein  
Dianne Feinstein  
United States Senator

/s/ Cory A. Booker  
Cory A. Booker  
United States Senator

/s/ Kirsten Gillibrand  
Kirsten Gillibrand  
United States Senator

/s/ Gary C. Peters  
Gary C. Peters  
United States Senator

/s/ Jeffrey A. Merkley  
Jeffrey A. Merkley  
United States Senator

/s/ Richard Blumenthal  
Richard Blumenthal  
United States Senator

/s/ Ron Wyden  
Ron Wyden  
United States Senator

/s/ Sherrod Brown  
Sherrod Brown  
United States Senator

/s/ Joe Manchin III  
Joe Manchin III  
United States Senator

/s/ Michael F. Bennet  
Michael F. Bennet  
United States Senator

/s/ Elizabeth Warren  
Elizabeth Warren  
United States Senator

/s/ Jack Reed  
Jack Reed  
United States Senator

/s/ Bernard Sanders  
Bernard Sanders  
United States Senator

/s/ Alex Padilla  
Alex Padilla  
United States Senator

## ORIGINAL ARTICLE

# Prevention and Attenuation of Covid-19 with the BNT162b2 and mRNA-1273 Vaccines

M.G. Thompson, J.L. Burgess, A.L. Naleway, H. Tyner, S.K. Yoon, J. Meece, L.E.W. Olsho, A.J. Caban-Martinez, A.L. Fowlkes, K. Lutrick, H.C. Groom, K. Dunnigan, M.J. Odean, K. Hegmann, E. Stefanski, L.J. Edwards, N. Schaefer-Solle, L. Grant, K. Ellingson, J.L. Kuntz, T. Zunie, M.S. Thiese, L. Ivacic, M.G. Wesley, J. Mayo Lamberte, X. Sun, M.E. Smith, A.L. Phillips, K.D. Groover, Y.M. Yoo, J. Gerald, R.T. Brown, M.K. Herring, G. Joseph, S. Beitel, T.C. Morrill, J. Mak, P. Rivers, B.P. Poe, B. Lynch, Y. Zhou, J. Zhang, A. Kelleher, Y. Li, M. Dickerson, E. Hanson, K. Guenther, S. Tong, A. Bateman, E. Reisdorf, J. Barnes, E. Azziz-Baumgartner, D.R. Hunt, M.L. Arvay, P. Kutty, A.M. Fry, and M. Gaglani

## ABSTRACT

**BACKGROUND**

Information is limited regarding the effectiveness of the two-dose messenger RNA (mRNA) vaccines BNT162b2 (Pfizer–BioNTech) and mRNA-1273 (Moderna) in preventing infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and in attenuating coronavirus disease 2019 (Covid-19) when administered in real-world conditions.

**METHODS**

We conducted a prospective cohort study involving 3975 health care personnel, first responders, and other essential and frontline workers. From December 14, 2020, to April 10, 2021, the participants completed weekly SARS-CoV-2 testing by providing mid-turbinate nasal swabs for qualitative and quantitative reverse-transcriptase–polymerase-chain-reaction (RT-PCR) analysis. The formula for calculating vaccine effectiveness was  $100\% \times (1 - \text{hazard ratio for SARS-CoV-2 infection in vaccinated vs. unvaccinated participants})$ , with adjustments for the propensity to be vaccinated, study site, occupation, and local viral circulation.

**RESULTS**

SARS-CoV-2 was detected in 204 participants (5%), of whom 5 were fully vaccinated ( $\geq 14$  days after dose 2), 11 partially vaccinated ( $\geq 14$  days after dose 1 and  $< 14$  days after dose 2), and 156 unvaccinated; the 32 participants with indeterminate vaccination status ( $< 14$  days after dose 1) were excluded. Adjusted vaccine effectiveness was 91% (95% confidence interval [CI], 76 to 97) with full vaccination and 81% (95% CI, 64 to 90) with partial vaccination. Among participants with SARS-CoV-2 infection, the mean viral RNA load was 40% lower (95% CI, 16 to 57) in partially or fully vaccinated participants than in unvaccinated participants. In addition, the risk of febrile symptoms was 58% lower (relative risk, 0.42; 95% CI, 0.18 to 0.98) and the duration of illness was shorter, with 2.3 fewer days spent sick in bed (95% CI, 0.8 to 3.7).

**CONCLUSIONS**

Authorized mRNA vaccines were highly effective among working-age adults in preventing SARS-CoV-2 infection when administered in real-world conditions, and the vaccines attenuated the viral RNA load, risk of febrile symptoms, and duration of illness among those who had breakthrough infection despite vaccination. (Funded by the National Center for Immunization and Respiratory Diseases and the Centers for Disease Control and Prevention.)

The authors' full names, academic degrees, and affiliations are listed in the Appendix. Address reprint requests to Dr. Thompson at the Centers for Disease Control and Prevention, 1600 Clifton Rd. NE, Mailstop H24-7, Atlanta, GA 30333, or at isq8@cdc.gov.

This article was published on June 30, 2021, and updated on September 30, 2021, at NEJM.org.

N Engl J Med 2021;385:320-9.  
DOI: 10.1056/NEJMoa2107058

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**T**HE TWO-DOSE MESSENGER RNA (MRNA) vaccines BNT162b2 (Pfizer–BioNTech) and mRNA-1273 (Moderna) were shown to be highly effective in preventing symptomatic infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in randomized, placebo-controlled, phase 3 efficacy trials.<sup>1,2</sup> Recently, we reported interim estimates of the effectiveness of mRNA vaccines in preventing symptomatic and asymptomatic SARS-CoV-2 infection when administered in real-world conditions, which showed benefits similar to those observed in the efficacy trials.<sup>3</sup> Less is known about the potentially important secondary benefits of mRNA vaccines, including possible reductions in the severity of coronavirus disease 2019 (Covid-19), viral RNA load, and duration of viral RNA detection.

In conducting a prospective cohort study involving health care personnel, first responders, and other essential and frontline workers in six U.S. states, we had three aims. First, we estimated the effectiveness of mRNA vaccines in preventing SARS-CoV-2 infection with partial and full vaccination, with adjustments for the propensity to be vaccinated and local viral circulation. Second, among participants with laboratory-confirmed SARS-CoV-2 infection, we compared the mean viral RNA load in participants who were partially or fully vaccinated with the level in participants who were unvaccinated. Third, among participants with SARS-CoV-2 infection, we compared the frequency of febrile symptoms and the duration of illness in partially or fully vaccinated participants with those outcomes in unvaccinated participants.

## METHODS

### STUDY POPULATION

The HEROES-RECOVER network includes prospective cohorts from two studies: HEROES (the Arizona Healthcare, Emergency Response, and Other Essential Workers Surveillance Study) and RECOVER (Research on the Epidemiology of SARS-CoV-2 in Essential Response Personnel). The network was initiated in July 2020 and has a shared protocol, described previously and outlined in the Methods section of the Supplementary Appendix (available with the full text of this article at NEJM.org). Participants were enrolled in six U.S. states: Arizona (Phoenix, Tucson, and other areas), Florida (Miami), Minnesota (Duluth), Oregon (Portland), Texas (Temple), and Utah (Salt

Lake City). To minimize potential selection biases, recruitment of participants was stratified according to site, sex, age group, and occupation. The data for this analysis were collected from December 14, 2020, to April 10, 2021. All participants provided written informed consent. The individual protocols for the RECOVER study and the HEROES study were reviewed and approved by the institutional review boards at participating sites or under a reliance agreement.

### PARTICIPANT-REPORTED OUTCOME MEASURES

Sociodemographic and health characteristics were reported by the participants in electronic surveys completed at enrollment. Each month, participants reported their potential exposure to SARS-CoV-2 and their use of face masks and other employer-recommended personal protective equipment (PPE) according to four measures: hours of close contact with (within 3 feet [1 m] of) others at work (coworkers, customers, patients, or the public) in the previous 7 days; the percentage of time using PPE during those hours of close contact at work; hours of close contact with someone suspected or confirmed to have Covid-19 at work, at home, or in the community in the previous 7 days; and the percentage of time using PPE during those hours of close contact with the virus.

Active surveillance for symptoms associated with Covid-19 — defined as fever, chills, cough, shortness of breath, sore throat, diarrhea, muscle aches, or a change in smell or taste — was conducted through weekly text messages, emails, and reports obtained directly from the participant or from medical records. When a Covid-19–like illness was identified, participants completed electronic surveys at the beginning and end of the illness to indicate the date of symptom onset, symptoms, temperatures, the number of days spent sick in bed for at least half the day, the receipt of medical care, and the last day of symptoms. Febrile symptoms associated with Covid-19 were defined as fever, feverishness, chills, or a measured temperature higher than 38°C.

### LABORATORY METHODS

Participants provided a mid-turbinate nasal swab weekly, regardless of whether they had symptoms associated with Covid-19, and provided an additional nasal swab and saliva specimen at the onset of a Covid-19–like illness. Supplies and instructions for participants were standardized across sites. Specimens were shipped on weekdays



on cold packs and were tested by means of qualitative reverse-transcriptase–polymerase-chain-reaction (RT-PCR) assay at the Marshfield Clinic Research Institute (Marshfield, WI). Quantitative RT-PCR assays were conducted at the Wisconsin State Laboratory of Hygiene (Madison, WI). SARS-CoV-2 whole-genome sequencing was conducted at the Centers for Disease Control and Prevention, in accordance with previously published protocols,<sup>4</sup> for viruses detected in 22 participants who were infected at least 7 days after vaccine dose 1 (through March 3, 2021), as well as for viruses detected in 3 or 4 unvaccinated participants matched to each of those 22 participants in terms of site and testing date, as available (71 total matched participants). Viral lineages were categorized as variants of concern, variants of interest, or other. We compared the percentage of variants of concern (excluding variants of interest) in participants who were at least partially vaccinated ( $\geq 14$  days after dose 1) with the percentage in participants who were unvaccinated.

#### VACCINATION STATUS

Covid-19 vaccination status was reported by the participants in electronic and telephone surveys and through direct upload of images of vaccination cards. In addition, data from electronic medical records, occupational health records, or state immunization registries were reviewed at the sites in Minnesota, Oregon, Texas, and Utah. At the time of specimen collection, participants were considered to be fully vaccinated ( $\geq 14$  days after dose 2), partially vaccinated ( $\geq 14$  days after dose 1 and  $< 14$  days after dose 2), or unvaccinated or to have indeterminate vaccination status ( $< 14$  days after dose 1).

#### STATISTICAL ANALYSIS

The primary outcome was the time to RT-PCR–confirmed SARS-CoV-2 infection in vaccinated participants as compared with unvaccinated participants. Secondary outcomes included the viral RNA load, frequency of febrile symptoms, and duration of illness among participants with SARS-CoV-2 infection.

The effectiveness of mRNA vaccines was estimated for full vaccination and partial vaccination. Participants with indeterminate vaccination status were excluded from the analysis. Hazard ratios for SARS-CoV-2 infection in vaccinated

participants as compared with unvaccinated participants were estimated with the Andersen–Gill extension of the Cox proportional hazards model, which accounted for time-varying vaccination status. Unadjusted vaccine effectiveness was calculated with the following formula:  $100\% \times (1 - \text{hazard ratio})$ . An adjusted vaccine effectiveness model accounted for potential confounding in vaccination status with the use of an inverse probability of treatment weighting approach.<sup>5</sup> Generalized boosted regression trees were used to estimate individual propensities to be at least partially vaccinated during each study week, on the basis of baseline sociodemographic and health characteristics and the most recent reports of potential virus exposure and PPE use (Table 1 and Table S2 in the Supplementary Appendix).<sup>6</sup> Predicted propensities were then used to calculate stabilized weights. Cox proportional hazards models incorporated these stabilized weights, as well as covariates for site, occupation, and a daily indicator of local viral circulation, which was the percentage positive of all SARS-CoV-2 tests performed in the local county (Fig. S1). A sensitivity analysis removed person-days when participants had possible misclassification of vaccination status or infection or when the local viral circulation fell below 3%.

Because there was a relatively small number of breakthrough infections, for the evaluation of possible attenuation effects of vaccination, participants with RT-PCR–confirmed SARS-CoV-2 infection who were partially vaccinated and those who were fully vaccinated were combined into a single vaccinated group, and results for this group were compared with results for participants with SARS-CoV-2 infection who were unvaccinated. Means for the highest viral RNA load measured during infection were compared with the use of a Poisson model adjusted for days from symptom onset to specimen collection and for days with the specimen in transit to the laboratory. Dichotomous outcomes were compared with the use of binary log-logistic regression for the calculation of relative risks. Means for the duration of illness were compared with the use of Student's *t*-test under the assumption of unequal variances. All analyses were conducted with SAS software, version 9.4 (SAS Institute), and R software, version 4.0.2 (R Foundation for Statistical Computing).

## RESULTS

## PARTICIPANT CHARACTERISTICS

After the exclusion of 1147 participants who had laboratory documentation of SARS-CoV-2 infection before the start of the study period, the study sample consisted of 3975 participants (Fig. S2). Approximately half the participants (51%) were from the three study sites in Arizona (Table 1). Most participants were female (62%), 18 to 49 years of age (72%), White (86%), and non-Hispanic (83%) and had no chronic medical conditions (69%). The participants included primary health care providers (20%), such as physicians and other clinical leads; nurses and other allied health care personnel (33%); first responders (21%); and other essential and frontline workers (26%). Over the 17-week study period, adherence to weekly surveillance reporting and specimen collection was high (median, 100%; interquartile range, 82 to 100).

## VACCINATION

A total of 3179 participants (80%) had received at least one dose of an authorized mRNA vaccine by April 10, 2021 (Table 1), and 2686 of those participants (84%) had received both recommended doses. Of the vaccine products administered, 67% were the BNT162b2 vaccine, 33% were the mRNA-1273 vaccine, and less than 1% were an unspecified mRNA vaccine. Because only 39 participants received the Ad26.COV2.S vaccine (Johnson & Johnson–Janssen), results for those participants could not be compared with results for participants who received the mRNA vaccines; therefore, person-time for those 39 participants was censored at vaccination, and they contributed only person-time associated with unvaccinated status. Participants most likely to have received at least one vaccine dose were located in Minnesota or Oregon, female, 50 years of age or older, White, non-Hispanic, or health care personnel or had at least one chronic medical condition. The mean number of hours of close contact with someone suspected or confirmed to have Covid-19 was lower and the percentage of time using PPE was higher among vaccinated participants (Table 1). Associations with additional covariates included in the vaccination-probability model are shown in Table S2. Standardized mean differences between vaccinated and unvaccinated

participants for all covariates were well balanced after propensity weighting, with a maximum difference of 0.09 (Fig. S3).

## SARS-COV-2 INFECTIONS CONFIRMED BY RT-PCR ASSAY

SARS-CoV-2 infection was detected by means of RT-PCR assay in 204 participants (5%), of whom 5 were fully vaccinated, 11 partially vaccinated, and 156 unvaccinated; the 32 participants with indeterminate vaccination status were excluded. Of the 93 genetically sequenced viruses, 12 were detected in participants with indeterminate vaccination status and were excluded. Of the remaining viruses, 10 were variants of concern (8 were the B.1.429 variant and 1 was the B.1.427 variant [epsilon] and 1 was the B.1.1.7 variant [alpha]); 1 was a variant of interest (the P.2 variant [zeta]) (Table S3). There were 10 genetically sequenced viruses detected in partially or fully vaccinated participants; 3 of these 10 viruses (30%) were variants of concern (all the B.1.429 variant [epsilon]), as compared with 7 of the 70 viruses (10%) detected in unvaccinated participants (excluding the variant of interest).

RT-PCR–confirmed SARS-CoV-2 infection was most frequently detected in participants who were located in Arizona, Florida, or Texas or were male, Hispanic, or a first responder (Table 1). However, the frequency of infection did not differ according to reported hours of potential virus exposure or PPE use. Most participants with RT-PCR–confirmed SARS-CoV-2 infection had symptoms associated with Covid-19 before or within 1 day after specimen collection (74%) or within 2 to 14 days after specimen collection (13%); the remainder had other symptoms (2%) or were asymptomatic within the 14 days before and after specimen collection (11%). Only 26% of the participants with RT-PCR–confirmed infection received medical care, including 3 unvaccinated participants who were hospitalized; no deaths were reported.

Characteristics of the 16 participants who were partially or fully vaccinated at the time of SARS-CoV-2 infection and the 156 participants who were unvaccinated at the time of infection are shown in Table S5. The percentage who were infected while partially or fully vaccinated was highest among participants in Arizona, Minnesota, and Utah and among health care personnel; there

**Table 1. Characteristics of the Participants According to SARS-CoV-2 Test Results and Vaccination Status.\***

Characteristic	Overall†	Results of RT-PCR Assay for SARS-CoV-2		Vaccination Status	
		Negative	Positive	Unvaccinated	Received ≥1 Dose of mRNA Vaccine
Total participants — no. (%)	3975 (100)	3771 (95)	204 (5)	796 (20)	3179 (80)
Cohort location — no. (%)‡					
Phoenix, AZ	504 (13)	461 (91)	43 (9)	105 (21)	399 (79)
Tucson, AZ	1223 (31)	1148 (94)	75 (6)	274 (22)	949 (78)
Other areas in Arizona	291 (7)	276 (95)	15 (5)	70 (24)	221 (76)
Miami, FL	239 (6)	216 (90)	23 (10)	111 (46)	128 (54)
Duluth, MN	456 (11)	445 (98)	11 (2)	32 (7)	424 (93)
Portland, OR	491 (12)	486 (99)	5 (1)	44 (9)	447 (91)
Temple, TX	302 (8)	284 (94)	18 (6)	66 (22)	236 (78)
Salt Lake City, UT	469 (12)	455 (97)	14 (3)	94 (20)	375 (80)
Sex — no. (%)§					
Female	2464 (62)	2349 (95)	111 (5)	423 (17)	2037 (83)
Male	1511 (38)	1422 (94)	93 (6)	373 (25)	1142 (76)
Age group — no. (%)					
18–49 yr	2847 (72)	2705 (95)	142 (5)	602 (21)	2245 (79)
≥50 yr	1128 (28)	1066 (95)	62 (5)	194 (17)	934 (83)
Race — no. (%)¶					
White	3431 (86)	3253 (95)	178 (5)	659 (19)	2772 (81)
Other	544 (14)	518 (95)	26 (5)	137 (25)	407 (75)
Ethnic group — no. (%)¶					
Hispanic	685 (17)	625 (91)	60 (9)	198 (29)	487 (71)
Non-Hispanic	3290 (83)	3146 (96)	144 (4)	598 (18)	2692 (82)
Occupation — no. (%)					
Primary health care provider	809 (20)	793 (98)	16 (2)	45 (6)	764 (94)
Nurse or other allied health care personnel	1310 (33)	1244 (95)	66 (5)	204 (16)	1106 (84)
First responder	818 (21)	745 (91)	73 (9)	257 (31)	561 (69)
Other essential or frontline worker	1038 (26)	989 (95)	49 (5)	290 (28)	748 (72)
Chronic conditions — no. (%)**					
None	2728 (69)	2589 (95)	139 (5)	582 (21)	2146 (79)
≥1	1247 (31)	1182 (95)	65 (5)	214 (17)	1033 (83)
Potential virus exposure and use of PPE — median (IQR) per participant					
Hours within 3 ft (1 m) of others at work in previous 7 days	27 (20–35)	27 (20–35)	25 (20–38)	26 (20–36)	27 (20–35)
Percentage of time using PPE among those reporting close contact at work	99 (90–100)	99 (90–100)	100 (89–100)	96 (79–100)	99 (99–100)
Hours within 3 ft of someone suspected or confirmed to have Covid-19 at work, at home, or in the community in previous 7 days	8 (2–24)	8 (2–24)	6 (2–23)	10 (3–27)	7 (2–23)
Percentage of time using PPE among those reporting close contact with the virus	100 (97–100)	100 (97–100)	100 (95–100)	100 (90–100)	100 (98–100)

**Table 1. (Continued.)**

- \* Percentages may not total 100 because of rounding. Covid-19 denotes coronavirus disease 2019, IQR interquartile range, mRNA messenger RNA, RT-PCR reverse-transcriptase–polymerase-chain-reaction, PPE personal protective equipment, and SARS-CoV-2 severe acute respiratory syndrome coronavirus 2.
- † The percentages in this column are based on the total number of participants in the study; all other percentages are based on the total number of participants with the given characteristic, which is provided in this column. The study sample excluded 1147 participants with laboratory documentation of SARS-CoV-2 infection before the start of the study period.
- ‡ The percentage of participants who received at least one dose of vaccine across sites with the highest observed vaccination rates (Portland, OR, Duluth, MN, and Salt Lake City, UT) was compared with the percentage across sites with the lowest observed vaccination rates (Phoenix, AZ, Tucson, AZ, other areas in Arizona, Miami, FL, and Temple, TX), with a chi-square value of 88.3 ( $P < 0.001$ ).
- § For the 15 participants with missing data regarding biologic sex, the data were imputed as the most common category (female).
- ¶ Race and ethnic group were reported by the participant.
- || Primary health care providers included physicians, physician assistants, nurse practitioners, and dentists; allied health care personnel included nurses, therapists, technicians, medical assistants, orderlies, and all others providing clinical support in inpatient or outpatient settings; first responders included firefighters, law enforcement, corrections officers, and emergency medical technicians; and other essential and frontline workers included teachers and hospitality, delivery, and retail workers, as well as all other occupations that require routine close contact with the public, customers, or coworkers.
- \*\* For the 77 participants who did not provide a response, the data were imputed as none, pending further verification.

were no substantial differences according to other sociodemographic or health characteristics or according to potential virus exposure or PPE use.

#### EFFECTIVENESS OF MRNA VACCINES AGAINST SARS-COV-2 INFECTION

During the 17-week study period, a total of 3964 participants contributed a median of 19 unvaccinated days per participant (interquartile range, 8 to 41; total days, 127,971), during which 156 RT-PCR–confirmed SARS-CoV-2 infections were identified. A total of 3001 participants contributed a median of 22 partially vaccinated days (interquartile range, 21 to 28; total days, 81,168), during which 11 RT-PCR–confirmed infections were identified. A total of 2510 participants contributed a median of 69 fully vaccinated days (interquartile range, 53 to 81; total days, 161,613), during which 5 RT-PCR–confirmed infections were identified. Results of vaccination-propensity weight calculations are shown in Figure S3.

Estimated adjusted vaccine effectiveness against RT-PCR–confirmed SARS-CoV-2 infection was 91% (95% confidence interval [CI], 76 to 97) with full vaccination and 81% (95% CI, 64 to 90) with partial vaccination (Table 2). Estimates of vaccine effectiveness according to mRNA vaccine product and age group are shown in Table 2. Point estimates of vaccine effectiveness were unchanged in a sensitivity analysis that excluded periods of low local viral circulation (Table S4).

#### ATTENUATION OF VIRAL RNA LOAD WITH VACCINATION

There were no substantial associations between the mean viral RNA load and participant charac-

teristics, except for a somewhat lower viral RNA load among first responders (Table S6). The mean viral RNA load was 3.8  $\log_{10}$  copies per microliter among unvaccinated participants and 2.3  $\log_{10}$  copies per microliter among partially or fully vaccinated participants; in an adjusted model, the viral RNA load was 40% lower (95% CI, 16.3 to 57.3) with at least partial vaccination than with no vaccination (Table 3). Among vaccinated participants, the mean viral RNA load decreased after receipt of dose 1 (Fig. S4). Viral RNA was detected for only 1 week in most partially or fully vaccinated participants (75%) and was detected for more than 1 week in most unvaccinated participants (72%); the risk of viral RNA detection for more than 1 week was 66% lower with at least partial vaccination (Table 3).

#### ATTENUATION OF FEBRILE SYMPTOMS AND DURATION OF ILLNESS WITH VACCINATION

There were no substantial associations between measures of the severity and duration of Covid-19 and participant characteristics, except for a lower mean duration of illness among participants located in Texas and Utah and a lower frequency of febrile symptoms among participants located in Florida and Utah (Table S6). Among participants with RT-PCR–confirmed SARS-CoV-2 infection, only 25% of those who were partially or fully vaccinated reported febrile symptoms, as compared with 63% of those who were unvaccinated; the risk of febrile symptoms was 58% lower with at least partial vaccination (Table 3). Vaccinated participants also reported 6.4 fewer total days of symptoms (95% CI, 0.4 to 12.3) and 2.3 fewer

**Table 2. Effectiveness of mRNA Vaccines in Preventing SARS-CoV-2 Infection with Full and Partial Vaccination.\***

Characteristic and Vaccination Status	Contributing Participants†		Person-Days		SARS-CoV-2 Infections	Vaccine Effectiveness‡	
	no.	total no.	median (IQR)	no.	Unadjusted	Adjusted	
					percent (95% CI)		
<b>Overall</b>							
Unvaccinated	3964	127,971	19 (8–41)	156	—	—	
Partially vaccinated	3001	81,168	22 (21–28)	11	86 (74–93)	81 (64–90)	
Fully vaccinated	2510	161,613	69 (53–81)	5	92 (80–97)	91 (76–97)	
<b>mRNA vaccine product</b>							
<b>BNT162b2 vaccine</b>							
Unvaccinated	3964	127,971	19 (8–41)	156	—	—	
Partially vaccinated	2005	49,516	21 (21–22)	8	85 (69–93)	80 (60–90)	
Fully vaccinated	1731	120,653	77 (64–82)	3	94 (82–98)	93 (78–98)	
<b>mRNA-1273 vaccine</b>							
Unvaccinated	3964	127,971	19 (8–41)	156	—	—	
Partially vaccinated	982	31,231	28 (28–31)	3	88 (61–96)	83 (40–95)	
Fully vaccinated	770	40,394	58 (44–66)	2	84 (31–96)	82 (20–96)	
<b>Age group</b>							
<b>&lt;50 yr</b>							
Unvaccinated	2838	90,768	18 (8–42)	107	—	—	
Partially vaccinated	2116	57,064	22 (21–28)	8	87 (72–94)	81 (59–91)	
Fully vaccinated	1760	114,676	72 (55–81)	4	91 (75–97)	90 (69–97)	
<b>≥50 yr</b>							
Unvaccinated	1126	37,203	21 (9–40)	49	—	—	
Partially vaccinated	885	24,104	22 (21–28)	3	84 (46–95)	78 (28–93)	
Fully vaccinated	750	46,937	68 (50–80)	1	95 (59–99)	94 (51–99)	

\* At the time of specimen collection, participants were considered to be fully vaccinated ( $\geq 14$  days after dose 2), partially vaccinated ( $\geq 14$  days after dose 1 and  $< 14$  days after dose 2), or unvaccinated or to have indeterminate vaccination status ( $< 14$  days after dose 1). The 32 participants with SARS-CoV-2 infection who had indeterminate vaccination status were excluded, as were all person-days associated with indeterminate vaccination status.

† The number of contributing participants does not equal the total number of participants in the study because contributing participants were required to be in active surveillance and to have met the vaccination criteria.

‡ Vaccine effectiveness was calculated with the following formula:  $100\% \times (1 - \text{hazard ratio for SARS-CoV-2 infection in vaccinated vs. unvaccinated participants})$ . Adjusted vaccine effectiveness was inversely weighted for the propensity to be vaccinated, with doubly robust adjustment for local viral circulation, site, and occupation.

days spent sick in bed with Covid-19 (95% CI, 0.8 to 3.7) than unvaccinated participants.

## DISCUSSION

In a prospective cohort study involving 3975 health care personnel, first responders, and other essential and frontline workers followed over 17 weeks in six U.S. states, the effectiveness of the mRNA vaccines BNT162b2 and mRNA-1273 in

preventing symptomatic and asymptomatic RT-PCR–confirmed SARS-CoV-2 infection was 91% (95% CI, 76 to 97) with full vaccination; vaccine effectiveness was 81% with partial vaccination. These estimates of vaccine effectiveness in real-world conditions are consistent with findings from efficacy trials<sup>1,2</sup> and from a similar prospective study involving health care personnel in which routine SARS-CoV-2 testing was also conducted.<sup>7</sup>

**Table 3. Viral RNA Load, Duration of Viral RNA Detection, Frequency of Febrile Symptoms, and Duration of Illness in Vaccinated and Unvaccinated Participants with SARS-CoV-2 Infection.\***

Variable	Unvaccinated	Partially or Fully Vaccinated	Difference (95% CI)
Viral RNA load			
No. assessed	155	16	—
Mean — log <sub>10</sub> copies/μl†	3.8±1.7	2.3±1.7	40.2 (16.3–57.3)‡
Duration of viral RNA detection			
No. assessed	155	16	—
Mean — days	8.9±10.2	2.7±3.0	6.2 (4.0–8.4)
Detection of viral RNA for >1 week — no./total no. (%)	113/156 (72.4)	4/16 (25.0)	0.34 (0.15–0.81)§
Febrile symptoms — no./total no. (%)¶	94/149 (63.1)	4/16 (25.0)	0.42 (0.18–0.98)
Total days of symptoms			
No. assessed	148	16	—
Mean — days	16.7±15.7	10.3±10.3	6.4 (0.4–12.3)
Days spent sick in bed			
No. assessed	147	15	—
Mean — days	3.8±5.9	1.5±2.1	2.3 (0.8–3.7)

\* Plus–minus values are means ±SD. The following unvaccinated participants were excluded from the total number assessed: 1 participant for viral RNA load and duration of viral RNA detection (the specimen could not be tested because of insufficient volume), 7 for febrile symptoms (they did not complete an illness survey to document symptoms), 8 for total days of symptoms (7 did not complete an illness survey and 1 had an illness that had not resolved by April 10, 2021), and 9 for days spent sick in bed (7 did not complete an illness survey, 1 had an illness that had not resolved by April 10, 2021, and 1 did not provide a response on the illness survey). In addition, 1 vaccinated participant was excluded from the total number assessed for days spent sick in bed (that person did not provide a response on the illness survey).

† Means were based on the maximum viral load measured among all mid-turbinate nasal swabs from each participant with RT-PCR–confirmed SARS-CoV-2 infection and were compared with the use of a Poisson model adjusted for days from symptom onset to specimen collection and days with the specimen in transit to the laboratory.

‡ The value is a relative difference (percent).

§ The value is a relative risk, indicating 66% lower risk in vaccinated participants.

¶ Febrile symptoms were defined as fever, feverishness, chills, or a measured temperature higher than 38°C.

|| The value is a relative risk, indicating 58% lower risk in vaccinated participants.

Among the small number of participants with breakthrough RT-PCR–confirmed SARS-CoV-2 infection despite vaccination, the mRNA vaccines appeared to attenuate infection and disease in multiple ways. Participants who were partially or fully vaccinated at the time of infection had a 40% lower viral RNA load and a 66% lower risk of viral RNA detection for more than 1 week than participants who were unvaccinated at infection. Partially or fully vaccinated participants also had a 58% lower risk of febrile symptoms and a shorter duration of illness, with approximately 6 fewer days of symptoms and 2 fewer days spent sick in bed, than unvaccinated participants. The observed presence of a reduced viral RNA load after the administration of mRNA

vaccines is consistent with findings in a recent report,<sup>8</sup> and the observed combination of virologic and clinical effects is consistent with previous findings of a lower level and shorter duration of viral RNA detection with milder Covid-19.<sup>9</sup>

The mechanisms by which vaccination attenuates Covid-19 are largely unknown, but the effect is probably due to recall of immunologic memory responses that reduce viral replication and accelerate the elimination of virally infected cells.<sup>10</sup> The biologic plausibility of these benefits is supported by the observation of similar phenomena in studies of other vaccines.<sup>10–19</sup> Our findings are also consistent with reports of less severe symptoms in patients with moderate Covid-19 who received the Ad26.COV2.S vaccine

than in those who received placebo in a randomized, controlled trial.<sup>20</sup>

Strengths of this study include the focus on working-age adults without previous laboratory-documented SARS-CoV-2 infection, the use of weekly testing for SARS-CoV-2 infection and illness with high adherence to surveillance, the multimethod documentation of vaccination status, and the estimation of vaccine effectiveness with vaccination-propensity weighting, continuous updates regarding local viral circulation, and reports of potential virus exposure and PPE use. The use of a standard synthetic RNA to conduct quantitative RT-PCR assays improves on the methods used in many previous studies, which relied on cycle thresholds from real-time RT-PCR assays as a proxy for viral RNA loads.<sup>9</sup>

This study also has several limitations. First, although our estimate of 81% vaccine effectiveness with partial vaccination is similar to results provided in other reports,<sup>1,2,7,21,22</sup> this estimate is based on a relatively brief follow-up period (with a median of 22 partially vaccinated days, as compared with 69 fully vaccinated days, per participant). Second, we could have overestimated vaccine effectiveness if we disproportionately failed to detect infections among vaccinated participants because of attenuation of viral RNA load after vaccination or because of reductions in the sensitivity of RT-PCR assays associated with specimen collection by participants and shipping of specimens.<sup>23</sup> Third, we have not completed genetic sequencing for all viruses. Fourth, because there was a relatively small number of breakthrough infections, we could not differentiate attenuation effects associated with partial vaccination from effects associated with full vaccination. Similarly, sparse data reduced the precision of estimates, although the consistency of trends across measures affirms the direction of the overall effect. Fifth, because of the sparse data and limited racial and ethnic diversity among participants, we were unable to fully examine or adjust for potential confounders of vaccine attenuation effects. Nonetheless, we stratified our participant recruitment to ensure a combination of participant characteristics according to occu-

pation, age, and sex; we did not observe consistent associations of sociodemographic or health characteristics or reported virus exposure or PPE use with vaccination status, viral RNA load, or duration of illness. Sixth, results for febrile symptoms and duration of illness were based on participant-reported data, which can be subject to recall and confirmation biases. Yet, the findings for these measures were consistent with the virologic findings of a reduced viral RNA load and duration of viral RNA detection among vaccinated participants. Finally, the detection of viral RNA is not equivalent to isolation of an infectious virus; however, low cycle thresholds on RT-PCR assay have been associated with the ability to isolate SARS-CoV-2 in culture,<sup>9</sup> and both the level and the duration of viral RNA detection are associated with infectivity and transmission in other viral infections.<sup>19,24-26</sup>

If further data confirm that the administration of mRNA vaccines reduces the number of viral RNA particles and the duration of viral RNA detection, thereby blunting the infectivity of SARS-CoV-2, then the overall results support that mRNA vaccines not only are highly effective in preventing SARS-CoV-2 infection but also may mitigate the effects of breakthrough infections — a finding that is especially important to essential and frontline workers, given their potential to transmit the virus through frequent close contact with patients, coworkers, and the public.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Supported by the National Center for Immunization and Respiratory Diseases and the Centers for Disease Control and Prevention (contracts 75D30120R68013 to Marshfield Clinic Research Institute, 75D30120C08379 to the University of Arizona, and 75D30120C08150 to Abt Associates).

Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.

A data sharing statement provided by the authors is available with the full text of this article at NEJM.org.

We thank the participants involved in the study, as well as our colleagues at the Centers for Disease Control and Prevention; the University of Arizona, Arizona Department of Health Services, and the University of Miami; Kaiser Permanente Northwest; St. Luke's Regional Health Care System; the University of Utah; Marshfield Clinic Research Institute; Abt Associates; and Baylor Scott and White Health.

#### APPENDIX

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## Invasive Treatments for Low Back Disorders

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**Objective:** This abbreviated version of the American College of Occupational and Environmental Medicine's Low Back Disorders guideline reviews the evidence and recommendations developed for invasive treatments used to manage low back disorders. **Methods:** Comprehensive systematic literature reviews were accomplished with article abstraction, critiquing, grading, evidence table compilation, and guideline finalization by a multidisciplinary expert panel and extensive peer-review to develop evidence-based guidance. Consensus recommendations were formulated when evidence was lacking and often relied on analogy to other disorders for which evidence exists. A total of 47 high-quality and 321 moderate-quality trials were identified for invasive management of low back disorders. **Results:** Guidance has been developed for the invasive management of acute, subacute, and chronic low back disorders and rehabilitation. This includes 49 specific recommendations. **Conclusion:** Quality evidence should guide invasive treatment for all phases of managing low back disorders.

This is the third article summarizing findings for low back disorders from the ACOEM's Low Back Disorders Guideline. This article focuses on the invasive treatment sections from the 862-page ACOEM Low Back Disorders Guideline (2456 references). The first article<sup>1</sup> addresses assessment and diagnostic evaluation and the second article<sup>2</sup> addresses non-invasive and minimally invasive treatments. Three algorithms are provided as figures to a prior publication.<sup>2</sup>

The ACOEM's Low Back Disorders Guideline is designed to provide health care

providers with evidence-based guidance for management of low back disorders among working-age adults. Guidance in this report has been developed for acute (up to 1 month duration), subacute (1 to 3 months' duration), and chronic (more than 3 months' duration) clinical timeframes. Evidence for, and guidance development, was sought for the treatment of several spine disorders including: low back pain (LBP), sciatica/radiculopathy, spondylolisthesis, facet arthrosis, degeneration of the disc, failed back surgery syndrome, and spinal stenosis. This guideline does not address several broad categories including congenital disorders or malignancies. It also does not address specific intraoperative procedures. This article includes addressing the following multi-part questions by treatment phase (acute, subacute, chronic, postoperative) by the Evidence-based Practice Spine Panel:

- When, and for what conditions are invasive procedures recommended?
- When, and for what conditions is surgery recommended?
- Which surgeries are recommended for which conditions?
- What management options are recommended for delayed recovery?

The following topics which may be relevant to patients with low back disorders are addressed in the Chronic Pain Guideline<sup>3</sup> and thus are not reviewed below: rehabilitation for delayed recovery; biofeedback; behavioral interventions for chronic pain; work conditioning, work hardening, early intervention programs and back schools for chronic pain; tertiary pain programs; interdisciplinary pain rehabilitation programs, multidisciplinary rehabilitation programs, chronic pain management programs, and functional restoration programs; and participatory ergonomics programs for patients with chronic pain.

The search strategies used 10 databases (PubMed, Scopus, Google Scholar, Medline, EBM Online, Cochrane, TRIP, CINAHL, AMBASE, and PEDro). A total of 309,035 articles were screened, with all potentially relevant study abstracts

reviewed and evaluated against specified inclusion and exclusion criteria. A total of 1128 articles were included in these guidelines that addressed invasive treatment of low back disorders, with 368 moderate- or high-quality. Low-quality studies are cited elsewhere.<sup>4</sup> Evidence-based recommendations were developed and graded from (A) to (C) in favor and against the specific invasive procedures, with (A) level recommendations having the highest quality literature. Expert consensus was employed for insufficient evidence (I) to develop consensus guidance. This guideline achieved 100% Panel agreement for all developed guidance with two exceptions noted below.

Guidance was developed with sufficient detail to facilitate assessment of compliance (Institute of Medicine [IOM]) and auditing/monitoring (Appraisal of Guidelines for Research and Evaluation [AGREE]).<sup>5</sup> Alternative options to manage conditions are provided when comparative trials are available.<sup>3</sup> All AGREE,<sup>6</sup> IOM,<sup>5</sup> AMSTAR,<sup>7</sup> and GRADE<sup>8</sup> criteria were adhered to.<sup>9</sup> In accordance with the IOM's Standards for Developing Trustworthy Clinical Practice Guidelines, this guideline underwent external peer review, and detailed records of the peer review processes are kept, including responses to external peer reviewers.<sup>5</sup>

The Evidence-based Practice Spine Panel and the Research Team have complete editorial independence from ACOEM and Reed Group, which have not influenced the guideline. The literature is continuously monitored and formally appraised for evidence that would materially affect this guidance. This guideline is planned to be comprehensively updated at least every 5 years or more frequently should evidence require it. Focused updates occur approximately annually as evidence requires. All treatment recommendations are guidance based on synthesis of the evidence plus expert consensus. These are recommendations for practitioners, and decisions to adopt a particular course of action must be made by trained practitioners on the basis of available resources and the particular circumstances presented by the individual patient.

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The authors declare no conflicts of interest.

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DOI: 10.1097/JOM.0000000000001983

## PSYCHOLOGICAL EVALUATION

The patient presenting with acute, subacute, and chronic pain should generally be evaluated psychologically to explore factors either affecting the presentation of pain and/or maintaining subacute/chronic pain and disability and to facilitate recovery and restoration of function. In the acute phase, this is usually a cursory evaluation of prior psychosocial issues. Yet, psychological evaluations should be considered in all pain presentations as analogous to other diagnostic methods. This is despite the implications of requesting a psychological evaluation that are often misconstrued to imply that the purpose is to rule out or affirm a mental disorder. Though such diagnoses may be rendered, this does not necessarily imply a “psychological” or “mental” cause for the symptoms. Reports of pain and functional problems are usually maintained by a variety of medical, physical, social, psychological, and occupational factors; and the general purpose of psychological evaluation is to comprehensively evaluate these influences. However, most pain and functional deficits arising from musculoskeletal injuries resolve spontaneously or respond adequately to initial conservative treatment.

The general purpose of the psychological evaluation is to: (1) describe and diagnose the current psychological and psychosocial dysfunctions; (2) elucidate the current psychological and behavioral factors which are salient in maintaining the symptoms and dysfunction; (3) assess the likely premorbid factors which may be contributory; and (4) recommend treatment, management, and/or occupational/vocational options.

Psychological evaluation for chronic LBP disorders is Recommended (I), Low Confidence as part of the evaluation and management of patients with chronic pain in order to assess whether psychological factors will need to be considered and treated as part of the overall treatment plan. Indications, frequency and components of a psychological evaluation in these patients is provided in Table 1. Psychological evaluation is also Recommended (I), Moderate Confidence prior to consideration of back surgery in patients with chronic benign pain, with indications particularly including: patients' responses to prior therapeutic interventions and/or their level of disability (given objective findings) suggests that psychological factors may affect the clinical course postoperatively; histories of excessive numbers of prior health care providers; prior history of substance(s) use/abuse; and prior psychiatric disorders.

## Invasive Clinical Treatment Recommendations Overview

Quality evidence indicates that patient outcomes are not adversely affected by delaying non-emergent surgery for weeks or a few months and continued nonoperative care is encouraged in patients with stable or improving deficits who desire to avoid surgery.<sup>16</sup> In the absence of red flags,<sup>1,4</sup> patients with radicular pain and other potential surgical conditions are treated with non-invasive treatments for typically at least 4 to 6 weeks. However, patients with either moderate to severe neurological deficits that are either not improving or not trending to improvement at 4 to 6 weeks may benefit from earlier surgical intervention. Those with progressive neurological deficit(s) are believed to have indications for immediate surgery. Those with severe deficits that do not rapidly improve are also candidates for earlier testing and surgery.

## INJECTIONS

There are several types of injections including epidural injections (caudal, interlaminar, and transforaminal), intradiscal injections, ketamine, clonidine, chemonucleolysis, tender or “trigger point” injections, facet joint injections, sacroiliac joint injections, intrathecal drugs, ligamentous injections (prolotherapy), and botulinum injections.

## LUMBAR EPIDURAL INJECTIONS

A total of 18 high-quality and 41 moderate-quality studies were included in this analysis.<sup>17–41</sup> Epidural glucocorticosteroid injections (ESIs) have long been used to deliver glucocorticosteroid close to the herniated disc or area of spinal stenosis.<sup>42</sup> The three approaches most commonly used are caudal, interlaminar, and transforaminal.<sup>43–46</sup> The technical performance including precise placement of these injections is reportedly related to the efficacy.<sup>47</sup> Interlaminar ESIs are the least technically demanding to perform and place the steroid immediately adjacent to the dural sac in the posterior spinal column. Fluoroscopic guidance improves the placement accuracy of injection, as blind targeting has been shown to be 77% accurate.<sup>48</sup> Transforaminal ESIs most closely target the herniated disc and neurological impingement with the least volume of agent,<sup>43,49</sup> but are technically more difficult and fluoroscopic or computed tomography (CT) guidance is usually used.<sup>50</sup> Transforaminal ESIs also necessitate better diagnostic precision to ensure proximity to the affected level.<sup>46</sup> As ESIs are most frequently performed as a combination of a glucocorticoid with an anesthetic, they are considered both diagnostic and therapeutic.<sup>51</sup>

Evidence is consistent that ESIs result in up to 6 weeks of modest improvement compared with placebo injections.<sup>52</sup> The combination of minimal, short-term benefits, and risks<sup>53</sup> has resulted in the American Academy of Neurology Guideline recommending against the routine performance of ESIs.<sup>54</sup> As the main alternative is surgery, this Spine Panel's opinion is that an ESI is Recommended (I), Moderate Confidence for select circumstances as an option for treatment of acute or subacute radicular pain syndromes, typically after treatment with NSAID and waiting at least 3 weeks. Its purpose is to provide a few weeks of partial pain relief while awaiting spontaneous improvement and remaining as active as practical. Effects of an injection should be assessed, and there should not be a series of injections (eg, three) ordered. Epidural glucocorticosteroid injections are Moderately Not Recommended (B), Moderate Confidence for treatment of spinal stenosis.<sup>56</sup> Epidural glucocorticosteroid injections are Not Recommended, Evidence (C), High Confidence for treatment of acute, subacute, or chronic low back pain in the absence of significant radicular symptoms.

## INTRADISCAL STEROIDS

A total of five moderate-quality studies were included in this analysis.<sup>55–59</sup> Injections of glucocorticoids into the intervertebral disc, often performed under fluoroscopy or other imaging modalities, are classified as “intradiscal steroids.”<sup>41,60,61</sup> These injections are theorized to help reduce the degree to which the disc is both herniated and/or producing an inflammatory response. For radicular pain and herniated discs, one study is available but it did not include a placebo group, thus there is no quality evidence regarding efficacy.<sup>58</sup> For chronic LBP, two moderate-quality trials suggest lack of efficacy<sup>55,59</sup> and one suggests efficacy.<sup>57</sup> Thus, there is no clear evidence that these injections improve on the natural history of acute LBP. Benefits have not been demonstrated compared with epidural injections or to no treatment. Thus, intradiscal steroid injections are Not Recommended (I), Moderate Confidence for treatment of acute LBP and are Not Recommended, (C), Moderate Confidence for treatment of subacute or chronic LBP.

## KETAMINE

There are two high-quality<sup>62,63</sup> and three moderate-quality<sup>64–66</sup> studies incorporated into this analysis. Ketamine infusions do not have quality evidence of efficacy and are Not Recommended (I), High Confidence for treatment of chronic LBP.<sup>62–66</sup>

**TABLE 1.** Indications, Frequency, and Components of Psychological Evaluation in Patients With Chronic Pain

A psychological evaluation is recommended as part of the evaluation and management of patients with chronic pain in order to identify psychosocial barriers that are contributing to disability and inhibiting function and to assess whether psychological factors will need to be considered and treated as part of the overall treatment plan. Psychological evaluation should be considered for patients with moderate to severe chronic pain. Indications are:

1. Cases in which significant psychosocial dysfunction is observed or suspected.
2. The provider has need to understand psychosocial factors contributing to the patient's pain reports and disability behaviors.
3. Inadequate recovery: This includes continued dysfunctional status despite a duration which exceeds the typical course of recovery; failure to benefit from indicated therapies or to return to work when medically indicated; or a persistent pain problem which is inadequately explained by the patient's physical findings.
4. Medication issues and/or drug problems: This includes any suspicion of drug overuse or misuse, aberrant drug behavior, substance abuse, addiction, or use of illicit substance, or for consideration of chronic use of opioids.
5. Current or premorbid history of major psychiatric symptoms or disorder.
6. Problems with compliance/adherence with prescribed medical treatment or rehabilitation program: For evaluation of candidacy for or potential benefit from a proposed functional restoration program, for example, comprehensive occupational rehabilitation or interdisciplinary pain rehabilitation (see Functional Restoration).
7. Evidence of possible cognitive impairment which is associated with related significant activities of daily living (ADL) dysfunction: This may be secondary to injury and/or possible adverse effects of medical therapies initiated for the chronic pain.
8. Catastrophic injuries with significant pain related or other dysfunction, for example, spinal cord injury.<sup>10</sup>
9. Cases for which certain procedures are contemplated, for example, back surgery or spinal cord stimulation.

There are various known styles and components to a comprehensive psychological evaluation of a patient with chronic nonmalignant pain.<sup>11</sup> However, the following are the key components which should be addressed in any such evaluation.

1. Appropriate review of records: The referring provider should assist in providing medical record documentation. Other information is sometimes reviewed, as necessary, for example, from a family assessment, job description, etc.
2. Clinical interview with the patient: The following parameters should be described from this interaction and other data obtained: history (including mental health, physical health, work, educational, legal, and substance use history), description of the pain, disability and/or other clinical problem, analysis of medication usage, social history, mental status, and behavioral assessment (including, as necessary, ADL, functional issues, and operant parameters, eg, pain/illness, behavior, and environmental influences).
3. Psychologic testing: A battery of appropriate diagnostic psychological tests should be administered and interpreted, as necessary. This should include instruments with evidence of validity and/or appropriate normative data for the condition or problems being assessed and have known value in differential diagnosis or treatment planning.<sup>12</sup> In selecting test instruments, the clinician should consider: (1) the appropriateness of the test(s) for the patient's presenting complaints and condition; (2) the appropriateness of a test(s) given the degree to which the patient's medical, sex, race/ethnicity, age, educational, and other group status was represented during the test(s) development; (3) how a patient's performance in comparison to normative data will be useful in diagnosis or treatment planning; (4) the prognostic value of interpreted test data for certain treatments; and/or (5) whether the sensitivity and specificity will enhance the accuracy of a diagnosis (more specific test information may be found in Chronic Pain Guideline<sup>3</sup>). Indications for psychological test may include circumstances when:

Understanding factors contributing to the patient's pain reports and disability behaviors;

- A mental disorder is suspected;
- Evaluating for a functional restoration program;
- The evaluation is part of a presurgical assessment;
- There is suspicion of cognitive impairment;
- The veracity of the complaint is at issue.

The test battery for evaluation of patients with chronic nonmalignant pain includes, but is not limited to:

1. Test(s) for assessment of the presenting pain, and/or other related health disorders or dysfunction;
2. Test(s) of personality and psychopathology;
3. Brief cognitive testing, when there is suspicion of central nervous system (CNS) impairment;
4. Diagnostic impressions: These should be inferred according to the ICD-10;
5. Summary: The psychological evaluation should provide both cogent explanations for the identified complaints and dysfunction, and recommendations for management.

More detailed descriptions of a psychological evaluation for patients with chronic pain and report format recommendations can be found elsewhere.<sup>13</sup>

Clinical and forensic standards for psychological evaluations of patient with pain have been recently reviewed, and those should be noted.<sup>14,15</sup> Standardized psychological testing should be done as a part of a comprehensive mental health evaluation. In addition, a review of appropriate records should be completed. Properly performed psychological testing enhances the reliability and value of a psychological evaluation. Psychometric testing conducted outside the context of a qualified mental health evaluation has not been evaluated in quality studies and is believed to either provide little if any helpful information for the treating provider, may be potentially misleading, and psychological test results outside settings comparable to those used for standardization may be uninterpretable. Tests used in isolation provide questionable clinically useful diagnoses or prognostic information for various procedures.<sup>3</sup>

## CLONIDINE

There are one high-quality<sup>67</sup> and one moderate-quality<sup>68</sup> RCTs incorporated into this analysis. Clonidine is an  $\alpha_2$ -agonist most typically used as an anti-hypertensive, yet as an  $\alpha_2$  adrenoceptor agonist, it may affect nociceptive processing,<sup>69</sup> and has been used to treat complex regional pain syndrome (see Chronic Pain Guideline<sup>3</sup>). There is evidence epidural clonidine is

inferior to epidural steroid injection for radicular pain,<sup>68</sup> and thus, epidural clonidine is Not Recommended (C), Moderate Confidence for treatment of radicular pain. There is No Recommendation (I), Low Confidence for or against the use of epidural clonidine for treatment of chronic LBP. There is No Recommendation (I), Low Confidence for or against the use of intramuscular clonidine for treatment of

pyriformis syndrome or other low back conditions.

## CHEMONUCLEOLYSIS (CHYMOPAPAIN AND COLLAGENASE)

Chymopapain is an enzyme that has long been used to successfully treat herniated discs.<sup>70–72</sup> While collagenase has been

utilized more recently,<sup>73</sup> both enzymes are injected into the disc. Chymopapain is no longer available in the United States due to reimbursement problems. Caution is warranted in those increasingly limited numbers of countries that allow this procedure.<sup>74</sup>

## TRIGGER AND TENDER POINT INJECTIONS

There is one high-quality,<sup>75</sup> and five moderate-quality studies<sup>76–80</sup> incorporated into this analysis. Trigger points involve an examiner's opinion that the degree of tenderness on palpating a muscle is abnormally great.<sup>81</sup> Ideally, examiners seek a palpable “knot” or nodule of muscle tissue with palpation both reproducing the patient's symptoms and distal radiation of symptoms, such as tingling in the extremity denoting a trigger point. However, most patients have tender points which are defined as tenderness without radiating symptoms. In common usage, the terms “trigger” and “tender” are often used interchangeably. Studies have attempted to address both findings, although research methods have not been particularly clear on distinguishing these conditions from each other. Tender and trigger points are primarily diagnosed in the periscapular area, although some may be found in the lumbosacral area. These points are integrally involved in “myofascial pain syndrome” and “fibromyalgia.” Most practitioners believe these are two distinct entities, while others believe that these are related conditions on a continuum of the same basic disorder.<sup>81</sup> Robust epidemiological and descriptive studies are lacking. It appears that many people are tender to palpation, thus what differentiates normal from abnormal is unclear. There are multiple weaknesses in these theories, including a lack of identification of how common these findings are in normal people, the lack of purely objective findings, subjectivity involved on the part of the examiner, and weaknesses in the pathophysiological theories.

Trigger and tender point injections into muscle “knots” may consist of an anesthetic with or without glucocorticoid.<sup>81,82</sup> The goals of injection are generally thought to involve anesthesia, anti-inflammatory medication, and allowing deep-tissue massage of the area to work out the muscle knot. There is one high-quality<sup>75</sup> and five<sup>76–80</sup> moderate-quality RCTs or crossover trials incorporated into this analysis. Trigger and/or tender point injections are Not Recommended (I), Moderate Confidence for treatment of acute LBP.<sup>75</sup> Trigger and/or tender point injections may be Recommended (C), Low

Confidence as a reasonable second or tertiary option for treatment of subacute or chronic LBP that is not resolving with progressive aerobic exercise, and other exercises and NSAIDs. These injections are recommended to consist either solely of a topical anesthetic (eg, bupivacaine) or dry needling without an injection. Repeated injections should be linked to subjective and objective improvements. The use of therapeutic injections without participation in an active therapy program or in the context of maintaining employment is not recommended. An alternative option to these injections is acupuncture. It is recommended to allow at least 3 to 4 weeks between injections. If results are not satisfactory after first set of injections, a second set is reasonable. If there are not subjective and objective improvements at that point, further injections are not recommended. Glucocorticosteroids are Not Recommended (C), Moderate Confidence for use in trigger point injections.<sup>83</sup>

## DIAGNOSTIC FACET JOINT INJECTIONS (INTRAARTICULAR AND NERVE BLOCKS)

There are zero high-quality and six moderate-quality studies incorporated into this analysis.<sup>84–89</sup> Facet (zygapophysial) joints are prone to degenerative joint disease, particularly osteoarthritis, and become ubiquitous with age.<sup>90–92</sup> These joints are also theorized by some to be pain-generating sources.<sup>93–106</sup> Facet joint pain prevalence estimates vary from 5% to 90%.<sup>97</sup> Because of the overlapping innervation of the facet joints themselves (each is served by two medial branch nerves—a given medial branch nerve innervates the caudal portion of the facet joint at its level, and the rostral portion of the next lower facet joint) there has been considerable debate regarding whether these injections are truly diagnostic of underlying pathology. Moreover, careful skin mapping shows that the area of skin served by the cervical and lumbar medial branch nerves is more cephalad (in the neck) and more lateral and caudad (in the low back) than the location of the joint itself. Thus, it is often difficult to correlate degenerative joint disease changes seen on imaging studies with the actual nerve involved.

Two types of diagnostic facet injections are performed, intra-articular and medial nerve branch block. Intra-articular injections are performed by injecting a local anesthetic under fluoroscopic or other imaging guidance directly into the facet joint. A medial nerve branch block is performed by injecting anesthetic along the nerves supplying the facet joints.<sup>107</sup> Either

can be used to attempt to diagnose facet syndrome, but a medial branch block has been used when rhizotomy procedures have been considered.<sup>96,101,108</sup> A positive block is considered to occur when there is complete, or nearly complete, relief of the pain the patient has been experiencing for the length of time expected for the anesthetic used.<sup>109–111</sup> Intra-articular blocks are sometimes combined with a glucocorticosteroid injection and thus, they are potentially a combined diagnostic and therapeutic intervention.<sup>112</sup> Nerve root blocks are often performed prior to attempts at radiofrequency lesioning.<sup>113</sup> The periprocedure administration of sedatives reportedly may confound the results of facet joint pain<sup>114</sup> and contribute to suboptimal results. Some have suggested a small minority of patients fulfill diagnostic criteria.<sup>87</sup>

There are six moderate-quality RCTs incorporated into this analysis.<sup>84,85,87–89,115</sup> Most quality studies now suggest a lack of utility of diagnostic facet joint injections.<sup>84,85,89</sup> Few studies suggest diagnostic utility of facet joint injections.<sup>86</sup> One study of medial branch blocks reported equal value of those blocks compared with peri-capsular blocks raising some question as to the efficacy versus inefficacy of either.<sup>88</sup> The results of a three-arm trial comparing intra-articular injection with periarticular injection with saline injection also raises concerns about the validity of this construct,<sup>89</sup> although the resulting short-term improvements in all three groups could be argued to be worth the intervention in select significantly affected patients with chronic LBP thought to be facet mediated. Diagnostic facet joint injections are Not Recommended (C), Low Confidence for evaluation of patients with chronic LBP, including that which is significantly exacerbated by extension and rotation or associated with lumbar rigidity. Diagnostic facet joint injections are Not Recommended (I), Low Confidence for acute or subacute LBP or radicular pain syndromes. Diagnostic medial branch blocks are Not Recommended (C), Low Confidence for acute or subacute LBP or radicular pain syndromes.<sup>88</sup>

## THERAPEUTIC FACET JOINT INJECTIONS

There are one high-quality<sup>116</sup> and 16 moderate-quality studies incorporated into this analysis.<sup>84,85,87,89,102,117–128</sup> Therapeutic facet joint injections involve a combination of a local anesthetic with glucocorticosteroids to attempt to relieve pain from the facet.<sup>84,94,96,106,112,113,129–132</sup>

They may be accomplished using various techniques either as an intra-articular or as a

pericapsular injection.<sup>88,89,133</sup> They also have been performed to address a purported cause of segmental rigidity.<sup>87,134</sup>

High- and moderate-quality studies suggest lack of efficacy of therapeutic facet joint injections for treatment of chronic LBP,<sup>89,102,118,119,135</sup> although one study suggested modest efficacy.<sup>116</sup> One comparative trial found comparable (in)efficacy with radiofrequency injections which also appear ineffective (see below).<sup>136,137</sup> Another moderate-quality trial found comparable (in)efficacy with intramuscular compared with facet joint injections with steroids for treatment of LBP.<sup>122</sup>

Both the American Pain Society and NICE guidelines recommend against these injections.<sup>138,139</sup> These injections are invasive, have relatively low adverse effects, but are costly. Most of the quality studies available on this topic do not support these injections. If they are performed highly selectively, there should be evidence of enduring reductions of pain plus objective functional benefits along with a lack of needing to repeat the treatment other than rarely.

Therapeutic facet joint injections are Not Recommended (I), Low Confidence for treatment of chronic LBP (62% Panel agreement; 19% agreed with Recommended and 19% agreed with No Recommendation.) Indications are nevertheless provided for the potential to seek approval from a workers' compensation carrier for highly select patients with chronic LBP thought to be isolated to one or at most two facet joints, generally with increased pain with extension and axial rotation; and failure to gain sufficient relief with non-invasive treatment options including at least multiple NSAID(s), aerobic exercise, and strengthening exercise. A trial of manipulation to assess functional gain is also generally warranted before consideration of therapeutic facet joint injection(s). If there is 80% relief and objective improvement in function, yet symptoms recur, a second injection may be reasonable; however, repeated, recurrent injections are not recommended.

Therapeutic facet joint injections are Not Recommended (I), Moderate Confidence for treatment of acute, subacute LBP or for any radicular pain syndrome. Therapeutic facet joint injections are Moderately Not Recommended (B), Moderate Confidence for routine treatment of chronic non-specific axial pain. Repeat use of intra-articular therapeutic facet joint injections are Moderately Not Recommended (B), Moderate Confidence for patients who have failed to achieve lasting functional improvements with a prior injection.

## FACET JOINT HYALURONIC ACID INJECTIONS

There is one moderate-quality RCT incorporated into this analysis.<sup>140</sup> Facet joint injections with hyaluronic acid have been attempted for treatment of facet degenerative joint disease. These injections are theoretically analogous to similar injections in the knee and other arthritic joints, although whether facet joints are pain generating sources is unclear (see above). There are no placebo- or sham-controlled trials in facet joints. Weekly injections of hyaluronic acid involving 18 injections at three levels have been studied in one moderate-quality study and appear to be largely ineffective compared with facet steroid injections that appear no more effective than placebo.<sup>140</sup> Thus, facet joint injections with hyaluronic acid are Not Recommended (I), Low Confidence for treatment of facet degenerative joint disease.

## SACROILIAC JOINT INJECTIONS

There are zero high-quality and nine moderate-quality RCTs incorporated into this analysis.<sup>117,141–148</sup> The sacroiliac joints (SIJs) are believed to cause a minority of chronic LBP cases, with estimates ranging from 10% to 26.6% and have been treated with SIJ injections either with or without fluoroscopic or other imaging guidance.<sup>106,149</sup> The injection typically targets the most tender area with a combination of a glucocorticosteroid and a local anesthetic, resulting in both a diagnostic and therapeutic injection. However, the diagnostic precision of these injections is likely limited by factors that include the inability to inject the joint directly without fluoroscopic or other imaging, as well as, the infiltration and diffusion of medication into surrounding tissues that could be potential pain generators.<sup>150</sup> The use of fluoroscopically guided, CT guided, or unguided SI joint corticosteroid injections have been suggested by some to be effective for LBP and spondyloarthropathy.<sup>151–153</sup> Other resources have found that evidence to be limited or poor.<sup>154–156</sup>

There are four moderate-quality RCTs incorporated into this analysis.<sup>117,145–147,157</sup> SIJ corticosteroid injections are Recommended (C), Low Confidence as a treatment option for patients with a specific known cause of sacroiliitis, that is, proven rheumatologic inflammatory arthritis (eg, rheumatoid arthritis, ankylosing spondylitis) involving the SIJs with symptoms of at least 1 to 2 months and prior treatment that has included NSAIDs. Each injection should be evaluated before additional injections

are scheduled, rather than scheduling a series of injections.

Regarding non-inflammatory pain, one study reported a short-term response to glucocorticoid injection into the soft tissue above the joint.<sup>147</sup> In limb joints, injection outside a joint has not been demonstrated to improve pain coming from a joint, so the mechanism for this finding is unclear. The other two quality studies were of spondyloarthropathy patient populations, thus applicability to working populations is unclear. Whether fluoroscopic guidance is needed is unclear and controversial.<sup>154</sup> Without fluoroscopic guidance, the joint itself is usually not injected as this is a difficult joint on which to perform arthrocentesis without imaging guidance. It is not clear if actual joint injection results in appreciably higher success rates as an injection in the local proximity may be just as effective. Injection in the local proximity should perhaps be classified as a tender point injection and not a sacroiliac joint injection. There are no quality studies showing a long-term improvement in pain or function in those receiving SIJ injections for chronic non-specific LBP. SIJ injections are Not Recommended (I), Low Confidence for treatment of acute LBP including LBP thought to be SIJ related; subacute or chronic non-specific LBP, including pain attributed to the sacroiliac joints, but without evidence of inflammatory sacroiliitis (rheumatologic disease); or any radicular pain syndrome.

## INTRATHECAL DRUGS

This subject has been reviewed in the Opioids Guidelines.<sup>158</sup> The body of quality literature does not support revising the prior guidance against use of these devices for treatment of LBP.

## PROLOTHERAPY INJECTIONS

There are two high-quality<sup>159,160</sup> and five moderate-quality<sup>117,161–164</sup> studies incorporated into this analysis. Prolotherapy injections attempt to address a theoretical cause for chronic LBP.<sup>161,165–170</sup> It involves repeated injections of irritating, osmotic, and chemotactic agents (eg, dextrose, glucose, glycerin, zinc sulphate, phenol, guaiacol, tannic acid, pumice flour, sodium morrhuate), combined with an injectable anesthetic agent to reduce pain, into back structures, especially ligaments, with the theoretical construct that they will strengthen these tissues.<sup>171,172</sup> There are two high-quality<sup>159,160</sup> and five moderate-quality<sup>117,161–164</sup> RCTs incorporated into this analysis; the highest quality studies in this considerably heterogeneous literature failed to show benefits.<sup>159–162</sup> Thus, prolotherapy injections are Strongly Not

Recommended (A), High Confidence for treatment of acute, subacute, or chronic LBP or radicular pain syndromes.

## BOTULINUM INJECTIONS

There are two high-quality<sup>173,174</sup> and two moderate-quality<sup>175,176</sup> studies incorporated into this analysis. Botulinum injections have been used to produce muscle paresis and have anti-nociceptive properties.<sup>177</sup> Adherents believe that this “rest through weakness” is useful as a treatment for a number of musculoskeletal disorders including LBP,<sup>178,179</sup> upper back pain, myofascial pain,<sup>160,180,181</sup> LBP,<sup>179,182–184</sup> and piriformis syndrome.<sup>173,175,178,185</sup> There are two high-quality<sup>173,174</sup> and two moderate-quality<sup>106,175,176,186–188</sup> RCTs incorporated into this analysis.<sup>185,189</sup> Two high-quality studies directly conflict, with one suggesting benefits<sup>174</sup> while the other suggesting no benefits.<sup>173</sup> One moderate-quality trial suggested benefits.<sup>175</sup> Thus, the quality data conflict and there are no sizable quality studies with long-term follow-up. It is concerning that these injections induce weakness, yet many of the most successful interventions identified in systematic reviews in other sections of this guideline build strength and/or endurance. Botulinum injections are invasive, have adverse effects that include fatalities,<sup>174</sup> are costly and with conflicting data, there is thus No Recommendation (I), Low Confidence for or against the use of botulinum injections for treatment of acute, subacute, or chronic LBP or radicular pain syndromes or other low back-related problems.

## RADIOFREQUENCY NEUROTOMY, NEUROTOMY, AND FACET RHIZOTOMY

There are four high-quality<sup>190–193</sup> and 23 moderate-quality studies incorporated into this analysis.<sup>88,102,136,137,194–212</sup> Facet joints are thought by some to be the source of pain for some patients with chronic LBP.<sup>203,213–217</sup> Patients who experience pain relief from the injection of anesthetic along the nerve roots innervating the joints (“diagnostic blocks”) have been considered candidates for various neurotomy procedures.<sup>218</sup> However, many patients thought to be candidates for the procedure do not have successful blocks (43.5%<sup>219</sup> to 54.3%).<sup>192</sup> Surgical neurotomy involves the transecting or cutting of the nerves supplying the facet joints. Radiofrequency neurotomy has largely replaced the surgical procedure and involves the use of a radiofrequency electrode to create a heat lesion to coagulate the nerve supplying the joint. If the theory is correct and the patient is correctly

diagnosed, the procedure will result in complete relief of LBP. If there are other sources of pain that have other nerves for conduction of pain impulses or the radiofrequency lesion does not encompass the nerve due to either anatomic variants or technical errors, the procedure is thought to be less successful or not at all successful.<sup>95,220</sup>

The theoretical basis of cutting or ablating nerve fibers seems sound as procedures that eliminate the pathway to conduct pain sensations should be effective for the treatment of chronic pain syndromes. However, the history of cutting or otherwise ablating nerves to treat numerous pain conditions throughout the body is suboptimal, with a not infrequent increased risk for developing additional chronic pain problems that were only widely recognized after long-term follow-up studies were reported.<sup>221</sup> There have been many attempts at this type of procedure over several decades. However, perhaps due to pain fiber regeneration, alternate pathways for conduction, phantom pain, ongoing neurological stimulation, and/or conduction from the transected or ablated nerve fibers, no procedure to date has been shown to be effective for the treatment of pain that involves cutting or ablating nerve fibers.

The highest quality, sham-controlled studies are largely negative.<sup>190,192</sup> A moderate-quality study of radiofrequency added to steroid injection also found nearly all measures were negative between groups.<sup>195</sup> The largest sized trial found neurotomy ineffective compared with an exercise program for treatment of LBP, SI joint pain or intervertebral disc pain.<sup>207</sup> The next lower quality study is more favorable, but used unconventional statistical testing with 90% confidence intervals, rendering it unusable,<sup>194</sup> and the next study suffered an apparent randomization failure.<sup>198</sup> Two comparative trials found comparable (in)efficacy with intraarticular glucocorticoid injections which also appear ineffective, which suggests the procedure may have no significant benefit (see above).<sup>136,137</sup> The lowest quality study had worrisome results in the placebo.<sup>199</sup> There is a poor correlation between pain relief from a block and relief from radiofrequency neurotomy.<sup>142</sup> Available systematic reviews also discuss additional significant methodological concerns.<sup>222</sup> These concerns further limit the robustness of conclusions. As results are permanent, there should be good evidence of long-term benefit prior to recommending this procedure. Permanently denervated joints in the appendicular skeleton are known as Charcot joints, and over long-term follow-up they do not do well. There are no long-term results reported for those potential adverse effects. All studies suggested the need for further research.

Radiofrequency neurotomy, neurotomy, or facet rhizotomy are Not Recommended (C), Low Confidence for treatment of patients with chronic LBP including that confirmed with diagnostic blocks.<sup>190,192,195,207</sup> (64% panel agreement, while 36% agreed with limited indications). Indications are nevertheless provided as a potential appeals process for workers’ compensation carriers: chronic LBP without radiculopathy with failure of conservative treatments including NSAIDs and a quality exercise program, and who have had a confirmed diagnosis by medial branch blocks.<sup>223</sup> There is no recommendation for repeated procedures. It is reasonable to attempt a second lesion after 26 weeks in patients who had greater than 80% improvement in pain from first procedure for the first 8 weeks with a late return of pain.<sup>224</sup> There is no recommendation for a third or for additional procedures. There is logically a limit as to how many times it is possible to permanently destroy the same nerve. Radiofrequency neurotomy, neurotomy, or facet rhizotomy are Not Recommended (C), Low Confidence for treatment of all other lumbar spinal conditions.

## DORSAL ROOT GANGLIA RADIOFREQUENCY LESIONING

There is one high-quality RCT incorporated into this analysis.<sup>225</sup> Radiofrequency lesioning of the dorsal root ganglia has been attempted for treatment of chronic sciatica and some other pain syndromes.<sup>213,216,226</sup> There is one high-quality RCT incorporated into this analysis and suggests lack of efficacy.<sup>225</sup> Thus, radiofrequency lesioning of the dorsal root ganglia is Moderately Not Recommended (B), Moderate Confidence for treatment of chronic sciatica.

## INTRADISCAL ELECTROTHERMAL THERAPY (IDET)

There are two high-quality studies incorporated into this analysis.<sup>227,228</sup> Intradiscal electrothermal therapy (IDET) involves the heating of an intradiscal probe through electrical current. The goal is to coagulate tissue and theoretically result in improvement in pain thought to be derived from the disc or surrounding structures.<sup>229–231</sup> There are two high-quality RCTs incorporated into this analysis<sup>227,228</sup> that conflict regarding whether IDET has any value in treating chronic LBP. It is unclear whether heterogeneity of patients’ clinical findings may in part explain these differences. Another problem is the reliance on discography as the primary diagnostic

requirement for IDET, as it has low diagnostic value.<sup>4,232</sup> As IDET has not been clearly shown to be beneficial, there is not adequate evidence to recommend IDET and it is Not Recommended (I), Low Confidence for treatment of acute, subacute, or chronic LBP or any other back-related disorder.

### PERCUTANEOUS INTRADISCAL RADIOFREQUENCY THERMOCOAGULATION (PIRFT)

There are one high-quality<sup>233</sup> and two moderate-quality<sup>234,235</sup> studies incorporated into this analysis. Percutaneous intradiscal radiofrequency thermocoagulation (PIRFT) involves the same principle as that of IDET.<sup>233,235,236</sup> However, the heating of an intradiscal probe is through radiofrequency instead of electrical current. There is one high-<sup>233</sup> and two moderate-quality<sup>234,235</sup> RCTs incorporated into this analysis. There is no evidence of efficacy in two quality studies, including one high-quality study.<sup>233,234</sup> Thus, PIRFT is Moderately Not Recommended (B), Moderate Confidence for treatment of acute, subacute, or chronic LBP particularly including discogenic LBP.

### SURGICAL CONSIDERATIONS

This guideline addresses only the non-emergent surgical treatment of the most common acute, subacute, and chronic back problems. This guideline discusses recognition of red flag conditions that require expedited referral to a surgeon qualified to deal with spine emergencies (see Red Flags<sup>4,232</sup>). The indications for emergent surgery for red flag conditions are outside the scope of this guideline, including spinal cord compression, cauda equina syndrome, unstable fractures, epidural abscess, or hematoma, as are other indications for surgery (eg, neoplasms).

Within the first 3 months after onset of acute low back symptoms, surgery is considered only for serious spinal pathology or nerve root compression not responsive to an adequate trial of conservative therapy. Disc herniation may impinge on a nerve root typically causing mostly lower extremity and sometimes lumbosacral symptoms accompanied by nerve root dysfunction. However, the presence of a herniated disc on an imaging study does not necessarily imply nerve root dysfunction. Studies of asymptomatic adults commonly demonstrate intervertebral disc herniations that apparently do not cause symptoms.<sup>237–260</sup> Some studies show spontaneous disc resorption without surgery. Many patients with strong clinical findings of nerve root

compression due to disc herniation and/or spinal stenosis recover activity tolerance within 1 month. There is no quality evidence that delaying surgery for this period worsens outcomes in the absence of progressive nerve root compromise.<sup>261</sup> With or without surgery, more than 70% of patients with apparent surgical indications eventually recover to their premorbid activity level, including those with severe initial presenting signs of neurological compromise.<sup>262,263</sup> Spine surgery for patients with clear indications appears to speed short- to mid-term recovery. However, surgery results in pain improvements in fewer than 40% of patients with questionable physiologic findings, which is the rate of response of pain to placebo surgery.<sup>264,265</sup> Surgery generally increases the risk for future spine procedures with higher complication rates especially associated with more invasive procedures such as fusion.<sup>266–269</sup> Yet, reoperation rates are reportedly lower after fusion compared with decompressive surgery for spinal spondylolisthesis.<sup>268</sup> In older patients and repeat procedures, the rate of complications is higher.<sup>270,271</sup> Patients with comorbid conditions such as cardiac or respiratory disease, diabetes, or mental illness, may be poor candidates for surgery. Comorbidity should be weighed and discussed carefully with the patient.

If surgery is a consideration, counseling regarding likely outcomes, risks, and benefits and especially expectations is important. Patients with acute LBP alone (in the absence of objective findings of radiculopathy), without findings of serious spinal pathology (such as tumor, fracture, infection, hematoma), rarely benefit from surgery, although a second opinion from a spine surgeon to the effect that surgery is not recommended and is unlikely to be helpful may be reassuring to the patient.

Before surgery, physicians may consider referral for psychological screening to improve surgical outcomes, possibly including standard tests such as the second edition of the Minnesota Multiphasic Personality Inventory (MMPI-2).<sup>272</sup> In addition, physicians may seek non-organic signs (eg, Waddell) during the physical examination as these have been shown to correlate with poorer surgical outcome.

Nerve root decompression is performed for symptomatic nerve root compression by disc herniation and/or spinal stenosis. Direct methods of nerve root decompression include standard open discectomy, laminotomy, foraminotomy, facetectomy, and laminectomy. The only indirect method of nerve root decompression shown to be potentially effective is chemonucleolysis with chymopapain.

Endoscopic removal of a herniated disc fragment, while performed percutaneously, is a similar operation to standard open discectomy and is considered below. Standard open discectomy can be done with or without the use of an operating microscope or loop magnification and with or without endoscopic “tubes” to minimize the size of the skin incision and muscle dissection.

### DISCECTOMY, MICRODISCECTOMY, SEQUESTRECTOMY, ENDOSCOPIC DECOMPRESSION

There are three high-quality and 31 moderate-quality studies incorporated into this analysis.<sup>16,72,261,273–302</sup> There are multiple surgical techniques that have been used to surgically relieve pressure on lumbosacral nerve roots causing radicular pain syndromes.<sup>285,303–306</sup> Techniques attempted include open discectomy (with or without microscope),<sup>307–312</sup> automated percutaneous discectomy,<sup>313–315</sup> epidural percutaneous discectomy,<sup>316</sup> sequestrectomy, and endoscopic procedures.<sup>317–321</sup> More recent techniques include percutaneous laser disc decompression,<sup>322</sup> automated percutaneous discectomies (also known as nucleoplasty),<sup>323,324</sup> disc coblation, and endoscopic approaches.<sup>325</sup> The same surgical approaches are also sometimes used to address less common spinal pathology (eg, facet joint arthropathy with consequent nerve root impingement). This section reviews the indications for discectomy for a herniated lumbar disc.

There are no sham-controlled discectomy trials. All moderate-quality comparative trials demonstrate short- to intermediate-benefits, but not long-term benefits from nerve root decompression surgery compared with nonoperative treatment for patients with radicular symptoms from disc herniation unresponsive to prior nonoperative treatment.<sup>16,261,273,274</sup> However, as up to 75% of patients with radicular symptoms from herniated discs may become minimally symptomatic or asymptomatic without surgery,<sup>16,261,273,274,326</sup> sufficient time should pass prior to considering surgery.

As there is consistent, moderate-quality evidence that lumbar discectomy is an effective operation to speed recovery in patients with radiculopathy due to ongoing nerve root compression who have not improved significantly after 4 to 6 weeks of time and appropriate conservative therapy, it is thus Moderately Recommended (B), High Confidence. Quality literature is insufficient on the comparative values of open discectomy, microdiscectomy, or

endoscopic discectomy. As open discectomy, microdiscectomy, and endoscopic discectomy are all potentially appropriate ways to perform discectomy, the decision as to which of these procedures to choose should be left to the surgeon and the patient until quality evidence becomes available to provide evidence-based guidance. Indications for discectomy are all of: (1) radicular pain syndrome with current dermatomal pain and/or numbness, or myotomal muscle weakness all consistent with a herniated disc; (2) imaging findings by MRI, or CT with or without myelography that confirm persisting nerve root compression at the level and on the side predicted by the history and clinical examination; and (3) continued significant pain and functional limitation after 4 to 6 weeks of time and appropriate nonoperative therapy that usually includes NSAID(s). Progressive neurological deficits are considered a separate indication for urgent surgery.

For patients who are candidates for discectomy (other than for cauda equina syndrome and the rare progressive major neurologic deficit), there is evidence that there is no need to rush patients into surgery as there is consistent evidence of a lack of differences in long-term functional recovery whether the surgery is performed early or delayed.<sup>16,261,273,274</sup> Other procedures such as laser discectomy and/or PERC involve indirect procedures with limited access to the disc contents.

Discectomy is Not Recommended (B), High Confidence for treatment of acute, subacute, or chronic LBP without radiculopathy. There is no quality evidence that automated percutaneous discectomy, laser discectomy, or coblation therapy are effective treatments for any back or radicular pain problem, and thus they are Not Recommended (I), Low Confidence.

## ADHESIOLYSIS

There is one high-quality<sup>327</sup> and four moderate-quality<sup>328–331</sup> studies incorporated into this analysis. Epidural adhesiolysis attempts to use hypertonic saline and glucocorticoids with a catheter and/or endoscopy to address adhesions that particularly develop after surgery and are proposed by some to be related to postoperative pain and failed back surgery syndrome.<sup>332,333</sup> Epidural adhesiolysis is also known as percutaneous lysis of epidural adhesions, epidural neurolysis, epidural decompressive neuroplasty, and Racz neurolysis.<sup>334–338</sup> There is one high-quality<sup>327</sup> and four moderate-quality<sup>328–331</sup> RCTs incorporated into this analysis.<sup>339</sup> There are no sham-controlled trials. All studies comparing different adhesiolysis techniques were conducted by the same research

group. The only other trial was an unblinded comparison of adhesiolysis with physiotherapy.<sup>329</sup> Complications include dural puncture, spinal cord compression, infection, catheter shearing, hematoma, cardiac dysrhythmias, myelopathy, paralysis, and blindness.<sup>328,336,339–342</sup> Independent, large-scales replication of the suggested modest benefits is needed before a recommendation may be made, and thus adhesiolysis is Not Recommended (I), Low Confidence for treatment of acute, subacute, or chronic LBP, or spinal stenosis or radicular pain syndromes.

## DECOMPRESSIVE SURGERY FOR SPINAL STENOSIS (LAMINOTOMY/FACETECTOMY, LAMINECTOMY)

There are three high-quality and 22 moderate-quality studies incorporated into this analysis.<sup>343–366</sup> Spinal stenosis involves insufficient room for neural elements in the spinal canal and/or neural foramina, whether it is congenital (eg, short pedicles, narrow canal diameter), acquired (degenerative enlargement of facets and ligaments and in addition the formation of osteophytes), or both. Stenosis can be in the central canal, in the lateral recess, or in the neural foramen. These degenerative changes are referred to as lumbar spondylosis. The typical symptom of lumbar spinal stenosis is neurogenic claudication, or leg pain that develops during walking and that is promptly relieved by rest. Standing may exacerbate the pain. Acquired lumbar spondylosis is a natural aging phenomenon with a strong genetic component that may become symptomatic.

Decompressive surgery for spinal stenosis involves various techniques that remove bone from one or more structures to expand a narrowed spinal canal/neural foramen that impinges on neural structures.<sup>367–378</sup> Laminotomy is removal of a portion of the lamina, usually to permit access to the central spinal canal to gain access to another structure such as a herniated disc or a neural foramen. Laminectomy refers to the complete removal of the lamina. It was traditionally performed as part of a discectomy, but is not performed any longer for that sole indication. Hemilaminectomy refers to removal of the left half or the right half of the lamina.<sup>379,380</sup> Facetectomy is removal of part or all of a facet joint. Posterior decompression is a term usually used to include any of the above surgeries for spinal stenosis. Fusion is sometimes recommended at the same time as a spinal stenosis decompression (see below for fusion indications).<sup>381</sup> These

procedures are commonly performed in settings of either central canal stenosis, lateral recess, or neuroforaminal stenosis.

The highest of the moderate-quality trials reported comparable results from physical therapy (PT) consisting of flexion exercises plus aerobic exercises versus decompressive surgery over 2 years,<sup>344</sup> although it is noteworthy that 57% of the PT group crossed over to surgery. One trial found no significant differences between a decompressive device and epidural steroid injection.<sup>37</sup> One moderate-quality trial comparing decompressive surgery with nonoperative management found superiority of decompression surgery for patients with symptomatic spinal stenosis (neurogenic claudication) that is intractable despite conservative management.<sup>343,346</sup> There is no quality evidence of benefit to adding lumbar fusion to decompression.<sup>354</sup> Fusion has no role in the surgical treatment of spinal stenosis, rather the role of fusion is to treat instability if proven to be present (see Fusion below).

Decompression surgery is thus Moderately Recommended (B), Moderate Confidence for treatment of patients with symptomatic spinal stenosis (neurogenic claudication) that is intractable to nonoperative management. Caution is warranted among elderly with multiple comorbidities.<sup>382</sup> Indications are all of: (1) radicular-type pain involving usually multiple dermatomes with pain and/or numbness, or myotomal muscle weakness all consistent with the nerve root levels affected; (2) imaging findings by MRI, or CT with or without myelography that confirm spinal stenosis and corroborate the dermatomal and myotomal findings predicted by the history and clinical examination; and (3) continued significant pain and functional limitation after at least 4 to 6 weeks of time and appropriate nonoperative therapy that usually includes flexion exercises plus aerobic exercise (walking or cycling),<sup>344</sup> and NSAIDs. Progressive neurological deficits are considered a separate indication for earlier surgery.

## SPINAL FUSION

There are one high-quality and 77 moderate-quality studies included in this analysis.<sup>128,280,290,347,383–451</sup> Lumbar fusion involves the surgical fusion of one or more vertebral segments by inserting bone grafts (with or without instrumentation) so that the previously mobile involved segment(s) heal together to form a single bone mass. The proposed goal of lumbar fusion is similar to that in fusing other joints in the body—that instability and pain will be significantly improved, if not resolved through preventing joint movement.<sup>452–486</sup>



The United States has the highest rate of lumbar fusion surgery in the world (twice that of Norway, 5-fold that of England). There has been a 55% increase in spine surgery rates in the 1980s, a 6-fold variation in spine surgery rates among US cities, and 10-fold variation in spine fusion rates<sup>487</sup> without evidence of beneficial outcomes. Compared with matched non-surgical controls, patients on workers' compensation reportedly have worse outcomes with over 5.5-fold greater permanent disability status, greater opioid use, greater than 3.6-fold days of work lost and 26% of surgical patients underwent a second surgery.<sup>456</sup> Risks of increased opioids use among those with prior use and 13% without preoperative use becoming chronic users after fusion surgery suggest risks are considerable.<sup>488</sup> Following lumbar fusion, reoperation rates within 2 years have been estimated to range from 5.4% to 22% in the recent well-designed RCTs.<sup>387,439</sup> A 1990s population-based study found the reoperation rate following lumbar fusion was 17% to 21% when assessed at 11-year follow-up.<sup>489</sup> There appears to be an increased risk of reoperation if the initial diagnosis is herniated disc, degenerative disc disease, or spinal stenosis. Patients subjected to more invasive procedures have increased blood loss, longer operative times, and/or poorer outcomes in all higher quality studies where such data have been reported.<sup>385,387,402,407,414,437,490,491</sup> Overall, reported complication rates range from 1.4% to 40% (excluding scoliosis).<sup>387,395,490,492</sup>

The terms "degenerative disc disease," "discogenic back pain," "black disc disease," "micro instability," and "lumbar spondylosis" are used interchangeably to describe the same group of patients with chronic LBP in whom the pain generating structure is not defined. Discography has been used to attempt to define the lower back disc structures as the pain source, but has been largely unsuccessful in so doing.<sup>4,232</sup> Chronic back pain theorized to arise from degeneration of the discs is complex and can be difficult to treat. Current surgical treatments are controversial. Since there is no reliable method to identify the source of a patient's pain, surgery for pain would presumably be unlikely to be helpful. Nevertheless, there have been attempts to test this theory.

There are numerous methodological issues affecting the quality of the literature on this subject and these methodological issues impair the ability to draw robust evidence-based conclusions. For example, chronic LBP patients can be extremely difficult to manage, particularly when the pain is severe, narcotics, and other drug issues are present, adherence to exercise

regimens is weak, psychosocial stressors are present, and coping skills are poor.<sup>493</sup> Patients without indications often come to view these surgical procedures as potential cures. These difficulties have been widely noted,<sup>452,458,483,492,494–498</sup> and these quality problems in the underlying original research are underscored by the sharply differing conclusions in the systematic reviews. Many of these conflicts likely originate from the problem that case series tend to show benefits while subsequent RCTs may or may not support the original impressions from the uncontrolled or less well designed studies. Although there are no quality studies, there are some diagnoses for which fusion is either non-controversial or less controversial, including unstable vertebral fractures or where surgery is being done for tumor, infection (osteomyelitis and/or discitis), or other disease processes that have led to spinal motion segment instability. There are many trials showing equivalent outcomes in nonoperatively managed, neurologically-intact patients with thoracolumbar burst fractures compared with various surgeries.<sup>349,499–501</sup> Treatment of those conditions is outside the scope of these guidelines.

There is controversy in the medical literature about the definition of proven spinal instability. The Evidence-based Practice Spine Panel recognizes the controversy<sup>502</sup> and recommends the following definition be used with flexion-extension bending films done standing with a 72 in. tube to film distance: these films should be taken digitally, and a CD with the films and the software to permit viewing and computer measurement of the translation distance should be retained and kept available for review. The first criterion is more than or equal to 5 mm of translation of the superior vertebral body on the inferior body from the full extension film to the full flexion films. The other criterion is having a total angular movement during flexion and extension at the unstable level that is at least 20° greater than the motion present at an adjacent disc.

For isthmic spondylolisthesis, there is one moderate-quality trial comparing fusion with nonoperative care that reported benefits of surgery.<sup>394</sup> The literature available pertains to lumbar fusion for treatment of Grade 1 and Grade 2 spondylolisthesis. There is no quality evidence on Grade 3, Grade 4, and Grade 5 spondylolisthesis, but these are rare conditions, and when nerve roots are compromised, fusion is indicated. Regarding isthmic spondylolisthesis, lumbar fusion is thus Recommended (C), Moderate Confidence.<sup>394</sup> Indications are: LBP with documented instability, with either: (1) more than or equal to 5 mm of translation of the superior vertebral body on the

inferior body from the full extension film to the full flexion films; and/or (2) a total angular movement during flexion and extension at the unstable level that is at least 20° greater than the motion present at an adjacent disc. Lumbar fusion is also indicated for grades 3, 4, and 5 spondylolisthesis; (2) a decompressive laminectomy at an area of degenerative instability as in the case of a coexisting spondylolisthesis or scoliosis when a discectomy is performed at the same level; (3) a decompressive laminectomy performed at an area of degenerative instability, as in the case of a coexisting spondylolisthesis or scoliosis where there is gross movement on flexion-extension radiographs; and (4) a decompressive laminectomy at an area of degenerative instability as in the case of a coexisting spondylolisthesis or scoliosis where an adequate decompression requires the removal of greater than 50% of both facets or the complete removal of a unilateral facet complex.<sup>503</sup>

Regarding degenerative spondylolisthesis, there is one moderate-quality trial comparing fusion with nonoperative care. This trial reported negative results. However, the trial reported approximately 40% crossovers and so it may have inadvertently negated the value of the trial as there were no differences in the intention to treat analysis, but better outcomes for fusion in the "as treated" analysis.<sup>395</sup> One comparative trial of spinal fusion with spinal fusion plus decompressive surgery for treatment of adult spondylolisthesis found no additive benefits of the decompressive surgery.<sup>396</sup> Another trial of unilateral compared with bilateral fusion found no significant differences.<sup>398</sup> Thus, the highest quality evidence suggests there may be a beneficial effect of fusion surgery for treatment of isthmic spondylolisthesis and it is also believed to be true for degenerative spondylolisthesis and thus it is recommended (see indications above).

There are three moderate-quality comparative trials of fusion versus rehabilitation programs for treatment of chronic LBP and two suggest fusion is inferior to rehabilitation.<sup>383–385,387–390,392,490,504,505</sup>

The third study reported surgical fusion improved upon standard conservative care<sup>385,389</sup>; however, the wait-listed control group's treatment consisted of "more of the same" that previously failed,<sup>506</sup> while anticipating surgery and thus using a biased design. In addition, Fritzell's patients were highly selected (each surgeon did on average two fusions for chronic back pain each year). They had a lower incidence of depressive symptoms than is seen in typical chronic LBP populations. Benefits from fusion were on average small (on average 30% improvement), and about one in six

patients became pain free. The study was not blinded and improvement in outcomes from fusion over nonoperative treatment decreased over time.<sup>488</sup> These studies demonstrate that if there is a benefit from fusion, it is not much.<sup>383,390,392</sup> A meta-analysis of RCTs found that at an average 11 years after surgery/randomization, there is no demonstrable benefit for fusion surgery among these patients and there was more adjacent segment disease among those undergoing fusion surgery although it was not clinically significant.<sup>505,507–511</sup> In a pooled study, the surgical group incurred reoperations (23%), worse disability (53% vs 32% disability pensions) and greater fear avoidant beliefs.<sup>391</sup> There are no published RCTs of lumbar fusion in a US workers' compensation population. There are four retrospective cohort studies in workers' compensation systems, and these show the results of fusion are significantly worse than in a non-workers' compensation population.<sup>456,512–514</sup> In summary, there is not quality evidence to support fusion for chronic non-specific LBP in any population, while there is evidence of considerably worse outcomes among workers. Thus, lumbar fusion is Moderately Not Recommended (B), Moderate Confidence as a treatment for chronic non-specific LBP.<sup>383,384,390,392,504,505</sup>

There are no quality trials of fusion in patients with radiculopathy from disc herniation. Without other indications for more extensive surgery, far less invasive surgical options (eg, nonoperative management, discectomy, etc) are available. Thus, lumbar fusion is Not Recommended (I), Moderate Confidence to treat radiculopathy from disc herniation or for most patients with chronic LBP after lumbar discectomy. Exceptions are rare but include large foraminal herniations with need to remove the facet joint to access the disc.

There are no quality trials of patients treated with spinal fusion while undergoing a third discectomy on the same disc. If there is a second herniation of the same disc, repeat discectomy results in comparable outcomes and is recommended.<sup>515–518</sup> However, among those having undergone two prior discectomies, it is believed to be a reasonable option to attempt fusion to avoid the theoretical need for a fourth discectomy and thus, spinal fusion is Recommended (I), Low Confidence as an option at the time of discectomy if a patient is having the third lumbar discectomy on the same disc.

Decompressive surgery (see above), is a less extensive surgical approach that resolves spinal stenosis without concomitant instability or deformity. One moderate-quality trial reported no advantage of fusion over decompression for foraminal stenosis.<sup>399</sup> In the absence of proven instability

or deformity, lumbar fusion is Not Recommended (C), Moderate Confidence for treatment of spinal stenosis.<sup>343,346</sup>

## DISC REPLACEMENT

There are zero high-quality and 16 moderate-quality studies included in this analysis.<sup>128,290,301,302,434,438–440,519–524</sup>

Artificial disc replacement was devised as an alternative to fusion for the patient with chronic non-specific LBP thought to be disc-related<sup>480,525–528</sup> as well as for focal lumbar stenosis.<sup>529</sup> Its theoretical advantage is that it preserves motion in the involved vertebral segment thus purportedly decreasing the chances of degenerative changes developing at the adjacent motion segments. The term “adjacent segment disease” is used to describe patients with degenerative changes (that are presumed to be painful) at the spinal level above or below a spinal motion segment that has been treated, for example, by spinal fusion. Currently, two manufacturers have FDA approval to sell disc replacement prostheses, CHARITÉ<sup>®</sup> and ProDisc.<sup>530</sup>

There is one moderate-quality trial comparing disc replacement with only ~2 weeks of a rehabilitation program, showing some evidence of superiority over 2 years based on Oswestry Disability Index (ODI) scores. However, the study reported worse adjacent segment disease and facet degeneration in the surgical arm<sup>519–521</sup> and no significant advantage in range of motion.<sup>302</sup> The rehabilitation was so short that it may likely be susceptible to both undertreatment and attention biases. A few comparative RCTs suggest potential superiority of disc replacement to fusion over short to intermediate terms.<sup>128,438–440,522–524</sup> Results from trials are not generalizable to those with multi-level degenerative disc disease. One trial has now been reported to 5 years of follow up, suggesting superiority over fusion,<sup>128</sup> but no longer-term quality studies have been reported.

Available RCTs compare disc replacement to fusion<sup>128,524,531</sup> and as noted in the fusion section of this Guideline, fusion has not been shown to improve the outcomes over modern nonoperative care. The follow-up in the published RCTs is now up to 5 years. Some may consider this too short to be considered standard treatment for a permanent appliance. There is evidence that higher volume surgical centers have shorter hospital stays and lower complication rates.<sup>532</sup> Complication rates are not inconsiderable and include 2.8 adverse events per patient, 5% device failures, 5% neurological deteriorations at 24 months compared with baseline, and 33.3% failure to have at least a 25% decrease in the ODI at 24 months compared

with baseline. Additional research including demonstrated long-term safety and efficacy is needed prior to a recommendation in support. Thus, artificial disc replacement is Not Recommended, Insufficient Evidence (I) for treatment of chronic non-specific LBP and any other spinal pain syndrome. There is also No Recommendation (I), Low Confidence regarding artificial disc replacement as a treatment for subacute or chronic radiculopathy or myelopathy.

## VERTEBROPLASTY

There are four high-quality and 13 moderate-quality studies incorporated into this analysis.<sup>533–548</sup> Vertebroplasty involves an injection of polymethylmethacrylate within the vertebral body, in order to stabilize vertebral fractures caused by osteoporosis,<sup>549–556</sup> vertebral osteonecrosis, or malignancies of the spinal column.<sup>557–565</sup> This procedure is most common among elderly osteoporotic patients who have delayed healing of compression fractures of the vertebral body(ies),<sup>566</sup> but it is sometimes performed on younger patients with acute vertebral fractures due to osteoporosis.

There are multiple high-quality, sham-controlled RCTs that evaluated the efficacy of vertebroplasty and failed to find significant improvements in the patients who underwent vertebroplasty compared with a sham procedure.<sup>492,533,534,536</sup> These results are in contrast with two moderate-quality RCTs,<sup>537,539</sup> and other low-quality studies that had reported pain relief and other functional improvements that had appeared promising.<sup>562,567–575</sup> There is one other quality trial which reported pain relief and increased mobility. However, that trial is of lower quality, was short term (2 weeks), and had a substantially lower sample size than both of the high-quality RCTs, and appears biased against pain treatment.<sup>538</sup> In addition, substantial complications occur with this procedure including deaths,<sup>536,562,576,577</sup> and subsequent fractures.<sup>578,579</sup> Thus, vertebroplasty is Strongly Not Recommended (A) [Subacute, Chronic], High Confidence; Not Recommended (C) [Acute], Moderate Confidence as a routine treatment for patients with low back or thoracic pain due to vertebral compression fractures.<sup>533,536</sup>

It remains unclear whether there are highly selected unusual patients—such as severely affected patients, patients with three or more simultaneous compression fractures, or patients with pathologic fractures due to neoplasms<sup>580</sup>—who were outside the scope of these two quality trials, who might still derive benefit from this procedure. Thus, there is No Recommendation (I), Low Confidence for or against

the use of vertebroplasty for treatment of highly select patients with low back or thoracic pain due to unusual vertebral compression fractures, that is, for highly select patients with severe pain lasting over 2 months who have failed other interventions (including quality medical management) and for whom there are no other options available, whose significant pain is not resolving, pathological fractures due to neoplasias, multiple simultaneous compression fractures (three or more), and especially for those having failed bisphosphonate therapy.

### KYPHOPLASTY

There are one high-quality and 14 moderate-quality studies incorporated into this analysis.<sup>219,581–594</sup> Kyphoplasty has been used similarly to vertebroplasty to restore vertebral body height and improve sagittal alignment of the spine.<sup>560,576,595–605</sup> It involves injection of polymethylmethacrylate within a cavity in the vertebral body that has been created by the percutaneous insertion of a balloon through the involved pedicle(s).<sup>582</sup> It has been suggested that kyphoplasty may be appropriate as a prophylactic procedure.<sup>606</sup>

There are no quality studies comparing kyphoplasty with a sham procedure. There is one moderate-quality study comparing kyphoplasty with an unstructured, unblinded, non-interventional control that included cancer patients.<sup>584</sup> This study also differentially utilized passive treatments between the two groups, such as bed rest and braces that may have confounded the results. There are comparative clinical trials and other low-quality studies suggesting benefit.<sup>597,607,608</sup> These have been compiled into meta-analyses with a conclusion of efficacy (as well as efficacy of vertebroplasty).<sup>609–611</sup> Yet, as kyphoplasty is similar to vertebroplasty, and two high-quality, sham-controlled trials for vertebroplasty show a lack of benefit,<sup>533,536</sup> and despite the Wardlaw study which included patients with neoplasia, it appears reasonable to assume the same lack of benefit will eventually be shown for kyphoplasty for treatment of non-cancer patients. It remains unclear whether there are highly selected, unusual patients such as those severely affected, patients with three or more simultaneous compression fractures, or patients with pathologic fractures due to neoplasms,<sup>580</sup> who may derive benefit from this procedure. Kyphoplasty has also been found to be associated with subsequent, adjacent vertebral compression fractures.<sup>578,579,591,612–617</sup> Thus, there is No Recommendation (I), Low Confidence for or against the use of kyphoplasty for the treatment of low back or thoracic pain due

to vertebral compression fractures. Potential indications for unusual clinical scenarios are the same as those for vertebroplasty above.

### SACROILIAC SURGERY

There are zero high-quality and nine moderate-quality studies incorporated into this analysis.<sup>143,144,148,618–621</sup> Two trials with several reports compare SI joint fusion surgery with nonoperative management.<sup>143,144,618,620</sup> Both trials excluded patients with workers' compensation.<sup>144</sup> Patients included in the larger US-based study had either SI joint disruption or degenerative SI joints,<sup>618</sup> but only had degenerative disease in the European study.<sup>620</sup> Neither of the two trials included a control arm consisting of a functional restoration program with progressive aerobic and strengthening exercises combined with cognitive behavioral therapy (CBT) or sham-control.<sup>383,390,391</sup> Yet, in treatment of LBP, the analogous procedure of lumbar fusion has been shown to be ineffective compared with a quality rehabilitation program (see Lumbar Fusion section above). There also are SI joint fusion case series.<sup>619</sup> Prior studies of SI joint fusion reported relatively poor results (one study found that 18% of patients operated on were "satisfied" and 65% required additional surgery)<sup>622</sup> but used different techniques than the more recent studies. Other surgical series have reported better results with unpublished results as high as 90% good or excellent.<sup>623–625</sup> Thus, as there are no quality trials comparing SI joint fusion with a quality rehabilitative program, sacroiliac joint fusion surgery and other sacroiliac joint surgical procedures are Not Recommended (I), Low Confidence for treatment of any LBP disorder. SI fusion is a reasonable option for treatment of severe pelvic fractures with or without instability.<sup>626</sup> There may be limited uses for posttraumatic, unstable SI joints that requires further definition in quality studies.

### IMPLANTABLE SPINAL CORD STIMULATORS

There are zero high-quality and seven moderate-quality studies incorporated into this analysis.<sup>627–633</sup> Spinal cord stimulators (SCSs) deliver electrical impulses to the spinal cord area through electrodes that are implanted by laminotomy or percutaneously.<sup>634–637</sup> Proponents believe that this device is successful via the gate-control theory in which stimulating nerve fibers closes other paths of pain conduction<sup>638</sup>; however, this mechanism is poorly understood.<sup>639</sup>

There are few quality studies evaluating SCS for the treatment of LBP, none of

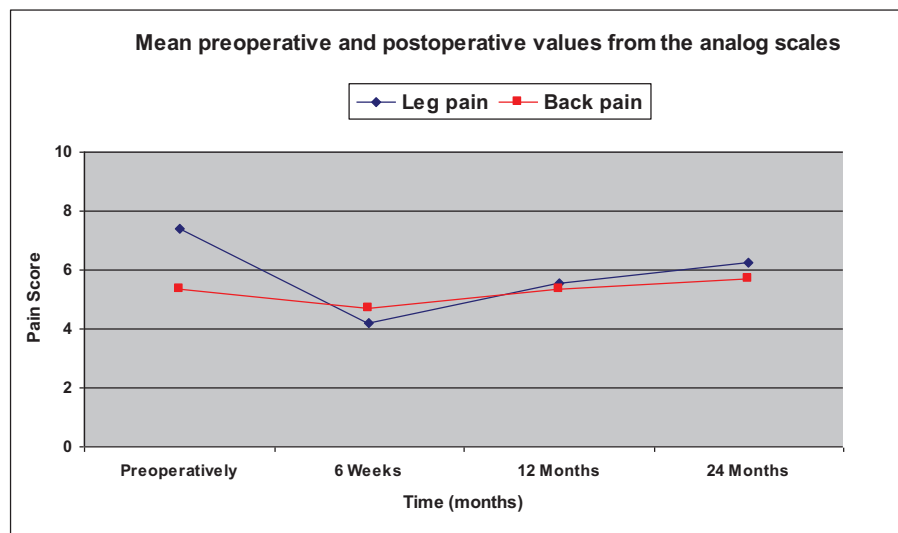
which compared SCS with a non-surgical treatment such as a quality multi-disciplinary rehabilitation program or a sham procedure.<sup>628,631</sup> Problems with study design have been noted for many years,<sup>640,641</sup> but to date have not been addressed in quality studies.

One moderate-quality study showed reduced pain ratings by 6 and 12 months after implantation, but improvements diminished over time.<sup>628</sup> A more recent RCT found better efficacy with high-frequency stimulation than with traditional SCS, but had no sham- or functional restoration-controlled arm, similar to the weaknesses of prior studies.<sup>197</sup> A non-RCT of 40 patients with chronic LBP with intractable leg pain attempted to determine whether operating when the patient was awake and able to provide feedback would improve outcomes<sup>642</sup>; however, there appeared to be a lack of lasting benefit (Fig. 1).

Reports with workers' compensation patients include a controlled, 2-year cohort study of workers' compensation patients in Washington State which found a low success rate, lack of long-term benefits, and increased opioid use among those receiving stimulators.<sup>640</sup> Cost effectiveness was also not shown in Washington State,<sup>643</sup> resulting in a decision to not cover the procedure for workers' compensation patients.<sup>640</sup>

Spinal cord stimulators are costly,<sup>629\*</sup> invasive, have reported serious complications (including surgical procedures for loose leads, repairs, and surgical removal of the devices), and have a significant revision rate.<sup>644,645</sup> Without quality evidence of enduring efficacy compared with either sham-control or a quality functional restoration program, they are Not Recommended (I), Low Confidence for treatment of acute, subacute, chronic low back pain, radicular pain syndromes or failed back surgery syndrome. Potential indications are provided in Table 1 in the event that there is a patient with predominant radicular pain, unamenable to surgery, with

\*A cost-effectiveness analysis from Canada has been used to support cost-effectiveness of SCS. The cost analyses for conservative care included annual, 3-day hospitalizations for breakthrough pain [\$9405 total], 24 annual visits with a family physician, and physician therapy charges over 5 years [estimated at \$8680]. Five-year costs were estimated at \$28,123 SCS vs \$38,029 for conservative care. Hospitalization for breakthrough pain [\$9405] is highly unusual in the United States, and without that expense [without consideration of the other unusual numbers of visits], the fiscal advantage of SCS completely disappeared. As the study contains unusual assumptions and elimination of hospitalization causes the purported fiscal advantage of the SCS to disappear, the conclusions of this study do not appear applicable to typical US patients. A second cost-effectiveness estimate in the United Kingdom reported approximately 4.8-fold higher costs in those receiving SCS.



**FIGURE 1.** Spinal cord stimulator mean preoperative and postoperative analog pain scale ratings. Adapted from Ohnmeiss et al.<sup>642</sup>

**TABLE 2.** Selection Criteria for Implantable Spinal Cord Stimulator in a Chronic Radiculopathy Patient\*

1. Clear diagnosis of chronic radiculopathy including supportive evidence on electrodiagnostic study. Leg pain should predominate over axial back pain.<sup>646</sup>
2. Poor or inadequate response to surgical treatment such as discectomy.
3. Poor or inadequate response to functional restoration program with treatment generally for at least 6 months.\*\* Program should have been in an experienced interdisciplinary clinic with proven good outcomes that included core, emphasized elements of progressive aerobic exercise, strengthening, and cognitive behavioral therapy, and for which the patient demonstrated good compliance.
4. Remedial surgery inadvisable or not feasible.
5. Major psychiatric disorders have been treated with expected responses. Somatization disorder not amenable to treatment disqualifies the patient for use of invasive procedures, as the risk of the procedure is higher than the expected success rate. The candidate should have a successful independent, psychological evaluation and a structured interview performed by a psychologist specialized in chronic pain management including appropriate psychometric testing (see Chronic Pain guideline,<sup>3</sup> Appendix 1). The psychological evaluation should be performed by a practitioner who is not employed by the requesting or treating physicians.<sup>\*\*\*</sup>
6. Willingness to stop inappropriate drug use before implantation.
7. No indication that secondary gain is directly influencing pain or disability complaints.
8. Ability to give informed consent for the procedure.
9. Successful results of at least 50% pain reduction from a trial of a temporary external stimulator of approximately 2 to 3 days and reduction of use of opioid medication or other medication with significant adverse effects or functional improvement such as return to work that may be evaluated by an occupational or physical therapist prior to and before discontinuation of the trial.

\*Adapted from Kumar et al,<sup>647</sup> Lee et al,<sup>648</sup> Segal et al.<sup>649,650</sup>

\*\*Some authors advocate earlier intervention<sup>651,652</sup>; however, quality evidence is lacking.

\*\*\*Presence of depression is common in patients with chronic pain, requires evaluation and may require treatment. Depression that is particularly severe may require treatment prior to assessing appropriateness of SCS, however, the presence of depression does not preclude SCS.

inadequate function after complying with functional restoration program components for at least 6 months who wishes to seek potential approval from a workers' compensation insurer (Table 2).

## CONCLUSION

Evidence-based recommendations have been developed for invasive treatments to manage low back disorders. We have included psychological screening in this guideline as, while necessary for all low back disorder cases, that is especially needed prior to invasive treatments. Most common invasive treatments have quality RCTs to address either efficacy and/or

comparable efficacy. A total of 47 high-quality and 321 moderate-quality trials were identified for invasive management of low back disorders. This guideline includes 49 specific recommendations. Quality evidence should guide the treatment of all phases of managing low back disorders, including invasive treatments.

## ACKNOWLEDGMENTS

The authors acknowledge the assistance of the Research Team at the University of Utah's Rocky Mountain Center for Occupational and Environmental Health without which this work would not have been possible. Team members include:

Jeremy J. Biggs, MD, MSPH, Matthew A. Hughes, MD, MPH, Matthew S. Thiese, PhD, MSPH, Ulrike Ott, PhD, MSPH, Atim Effiong, MPH, Kristine Hegmann, MSPH, CIC, Alzina Koric, MPP, Brenden Ronna, BS, Austen J. Knudsen, Pranjali A. Muthe, Leslie MC Echeverria, BS, Jeremiah L. Dortch, BS, Ninoska De Jesus, BS, Zackary C. Arnold, BS, Kylee F. Tokita, BS, Katherine A. Schwei, MPH, Deborah G. Passey, MS, Holly Uphold, PhD, Jenna L. Praggastis, BS, Weijun Yu, BS, Emilee Eden, MPH, Chapman B. Cox, Jenny Dang, BS, Melissa Gonzalez, Amrinder Kaur Thind, Helena Tremblay, Uchenna Ogbonnaya, MS, Elise Chan, and Madison Tallman.

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