Analysis of a US Department of Energy Emergent Technologies Cohort

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Introduction

As with any new technology, the earliest and most extensive exposure to hazards is most likely to occur in the workplace. Workers within nanotechnology-related industries have the potential to be exposed to uniquely engineered materials with novel sizes, shapes, and physical and chemical properties. Recent literature suggests that exposure to engineered nanomaterials may result in adverse health effects in many organ systems plus genotoxic effects, although the long-term human health effects are still unknown. As a major user of engineered nanoparticles, the U.S. Department of Energy (DOE) uses various methods to monitor the health of emergent technologies workers (ETW) who handle or could potentially be exposed to unbound engineered nanoparticles (UNP).

Methods

Using data from DOE's Illness and Injury Surveillance Program (IISP) (Figure 1), Oak Ridge Associated Universities (ORAU) created a registry of ETWs. IISP currently tracks 125,000 workers at 14 DOE facilities. Workers in IISP, who were classified as ETWs, were placed in a separate database using Microsoft Access. Using SAS (Version 9.2; Cary, NC), the health status of this cohort was analyzed by a variety of different variables such as age, gender, occupation, years of employment, number of years classified as an ETW, and site.

Results

We identified 920 individuals who were classified as ETWs. Of these, 212 individuals recorded 569 absences and 754 diagnoses (during their careers). The largest percentage of ETWs we identified worked at the Hanford Site (Table 1), and Crafts Workers recorded the most absences (Table 2). Respiratory diagnoses were the number one reported condition, and most of these diagnoses were reported by Technical Workers (Figure 2). The distribution of diagnoses in this subgroup was similar to the rest of the IISP population. The majority of all health events in this group (73%) were reported before employees were classified as ETWs. This cohort reported 16,725 career days lost. Overall, the median of the total days absent was significantly different ($p<0.0001$) between men and women (Table 3), and the median days lost before being classified as an ETW was 13 days, while median days lost afterwards was 17; this difference is also statistically significant ($p=0.05$) and may be attenuated after age-adjustment, but our current sample size is too small to adequately address this question.

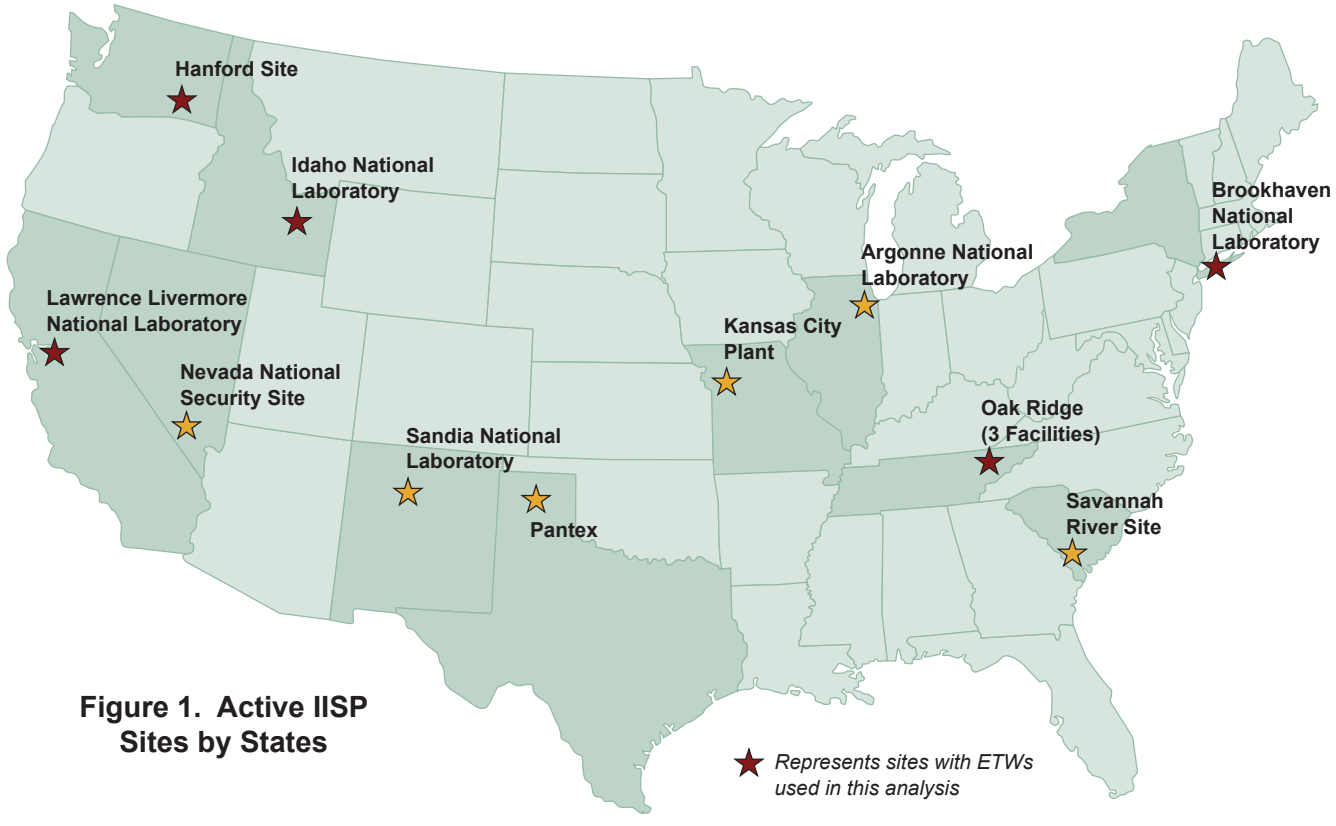


Figure 1. Active IISP Sites by States

Table 1. Absences by Site

Site	Absence Before ETW Tag			Absence After ETW Tag		
	Workers	Absences	Days Lost	Workers	Absences	Days Lost
Brookhaven National Laboratory	19	99	1,358	13	23	472
Hanford Site	58	190	6,987	41	92	2,754
Idaho National Laboratory	14	34	1,577	4	9	654
Lawrence Livermore National Laboratory	19	25	1,147	8	7	274
Oak Ridge National Laboratory	26	69	972	10	21	530
Total	**136**	**417**	**12,041**	**76**	**152**	**4,684**

Table 2. Absences by Occupation

Occupation	Absence Before ETW Tag			Absence After ETW Tag		
	Workers	Absences	Days Lost	Workers	Absences	Days Lost
Crafts	34	142	5,277	12	51	1,448
Technical Support	34	129	2,280	13	28	623
Operator	7	51	2,264	10	32	1,313
In-House Professionals	31	41	823	20	18	545
Field Professionals	27	47	1,182	17	18	486
Other	3	7	215	4	5	269
Total	**136**	**417**	**12,041**	**76**	**152**	**4,684**

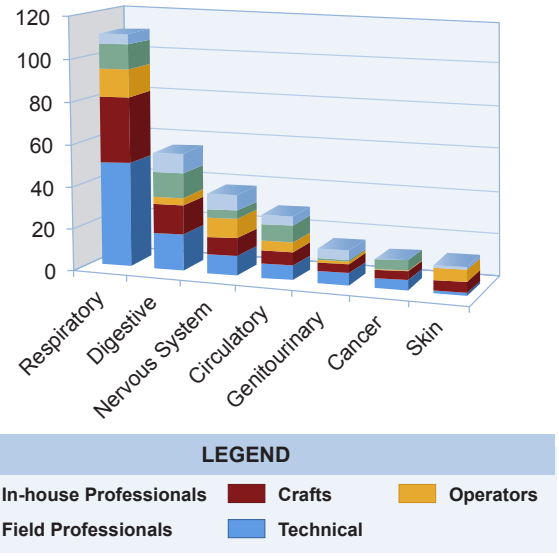
Table 3. Absences by Gender

Gender	Age	Number of Workers	Number of Absences	Number of Days Absent	
				Total	Median
Women	16-29	7	19	139	5
	30-39	29	38	1,338	30
	40-49	13	40	1,510	19.5
	50-59	11	35	986	17
	60+	0	-	-	-
	Total	**60**	**132**	**4,023**	**17.5**
Men	16-29	6	9	77	10
	30-39	28	75	1,562	11
	40-49	55	184	4,861	11
	50-59	56	147	5,686	19
	60+	7	22	516	16.5
	Total	**152**	**437**	**12,702**	**14**

Discussion

Engineered nanomaterials are used in over 1,000 commercial products in a variety of industries; however, limited information exists on likely exposure pathways, safe working levels, material toxicity, and adverse health outcomes that may be related to exposure. Understanding some of the potential health effects associated with exposure to UNP, we looked for significant increases in the diagnostic categories thought likely to be associated with exposure to engineered nanomaterials. A useful tool in the surveillance of a new or perceived hazard, especially when the risks to workers are not well defined, is an exposure registry that provides documentation of who is working with which materials, when, and where in a facility (Trout and Schulte, 2010). As a result of evaluating these data, we wanted to see if any statistically significant differences existed among workers before and after they were classified as ETWs.

Figure 2. Number of Diagnoses by Occupation



Limitations

- *Unspecified exposure data* – The exact type of engineered nanomaterials being used was unknown. The amount and length of time these materials were used was also unknown.
- *Short time period of observation* – The IISP program only began tracking ETWs in 2008, so that we only have four years of post-exposure observation (2008-2011), which prohibits our ability to estimate latency period.
- *Small sample size* – Only 212 out of 920 ETWs actually reported to their medical clinics, which currently limits analyses between groups.
- *Secondary data collection* – As with any registry, we had to rely on data that were reported directly from the sites.

Conclusion and Next Steps

Despite some challenges, our data provided an insightful baseline measurement for this particular cohort. Based on our analysis, we conclude that an exposure registry for UNP can be a practical tool for monitoring the health of ETWs. If some of the limitations mentioned can be overcome, future data will become an even greater asset to predicting the overall health of ETWs. Much research is still needed to understand the impact of nanotechnology on health and how to determine appropriate monitoring and control strategies; registries and surveillance programs such as IISP are an invaluable tool for determining risk and crafting policy. We recommend that this cohort continue to be monitored and that data are reported and analyzed periodically, perhaps on an annual basis. Additionally, we suggest that future analyses should include modeling and a case-crossover study.

References

1. Trout, DB and Schulte, PA. 2010. Medical surveillance, exposure registries, and epidemiologic research for workers exposed to nanomaterials. Toxicology. 269, 128-135.