

HANFORD

Chronic Beryllium Disease Prevention Program Epidemiological Study at the Department of Energy Hanford Site

National Jewish Health Epidemiologic Study Findings

September 2015

Study Team

Presenting today:

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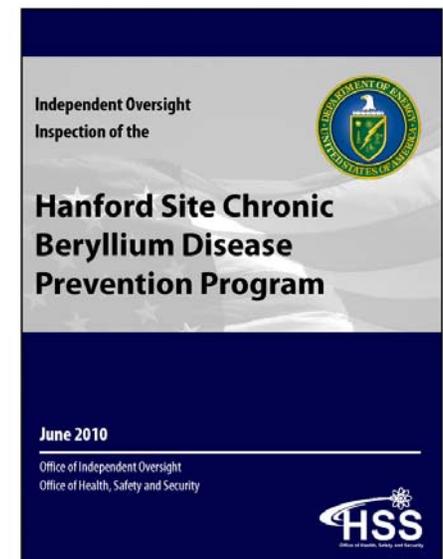
Many others throughout the project:

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INTRODUCTION

Study Background

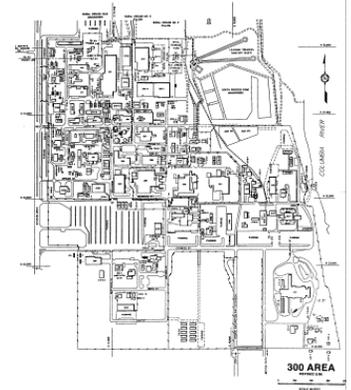
- The Department of Energy's corrective action plan, following concerns over the Hanford beryllium program, proposed that a study be conducted at Hanford that:
 - was a separate, independent epidemiologic study
 - described beryllium sensitization (BeS) risk in the workforce
 - described chronic beryllium disease (CBD) risk in the workforce
 - identified opportunities for prevention





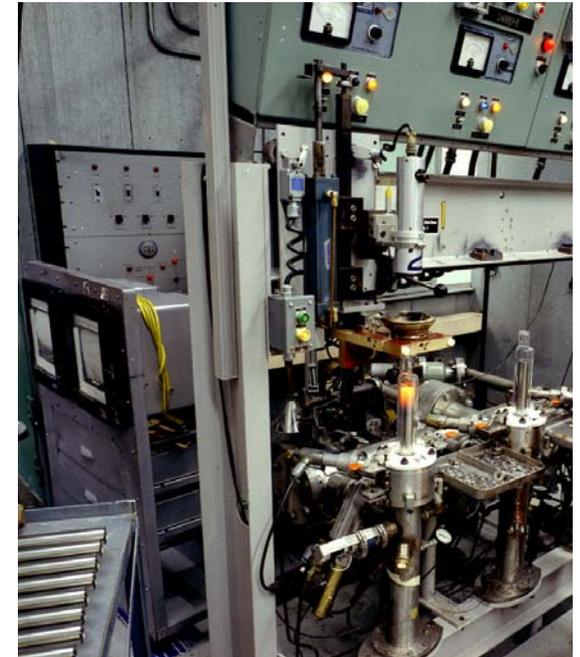
History of Beryllium at Hanford

- Be was first used experimentally in fuel rods in the 1950s
- Integrated into production of fuel rods in the 1960s
 - Some end cap rings for the fuel element cladding on fuel rods ~5% beryllium-zircalloy
 - Be alloy rings underwent heat-treatment, acid cleaning, machining, brazing, welding, and etching during production
- Be use in fuel rods was discontinued when production at Hanford ceased in 1986
- **Post-1986** potential for Be exposure remained in:
 - R&D labs
 - non-sparking tools
 - routine metal alloy applications
 - legacy Be in waste throughout Hanford site



Areas of Potential Be Exposure

- Fuel rod fabrication and metallurgical production
 - 300 area
- Buildings where Be-containing fuel rods were consumed
 - 100N area (use in N Reactor)
- Buildings where spent fuel and fuel rods were processed or stored
 - PFP
 - K Basins
- Be tool modification in shops
- D&D of buildings in which Be was used



Study Objectives



Primary Objective:

- Perform an epidemiology study to identify past and present jobs, work areas, or processes with increased probability of BeS and CBD.

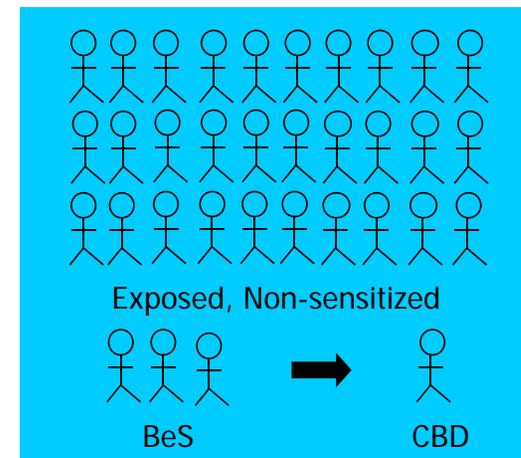
Secondary Objectives:

- 1) Characterize the prognosis of BeS among Hanford workers.
- 2) Characterize the prognosis of CBD among Hanford workers.
- 3) Characterize the prevalence of other potentially beryllium-related health symptoms and medical diagnoses among BeS and CBD cases.
- 4) Repeat the analyses from the primary study objective to determine risk factors for sarcoidosis.

METHODS

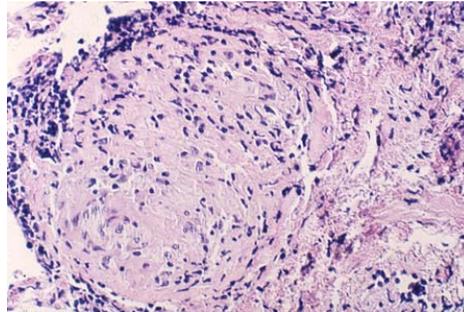
Study Design

- Case-control study
 - Current and former workers
 - “Case” diagnosed with **BeS, CBD, or sarcoidosis**
 - “Control” subjects **DID NOT** have BeS, CBD, or sarcoidosis
- Medical symptom/diagnosis questionnaire and quality of life (QOL)
- Medical records and data were collected for cases
- Work history and exposure interview conducted by an industrial hygienist (IH)
 - IH did not know case status



Case Definitions

- BeS - any of the following:
 - ≥ 2 abnormal BeLPT
 - 1 abnormal and 1 borderline BeLPT
 - 1 abnormal bronchoalveolar lavage (BAL) BeLPT
 - Patch test
- CBD - BeS diagnosis and one of the following:
 - Granulomas on biopsy
 - An abnormal BAL BeLPT and $> 15\%$ lymphocytes in BAL fluid
- Sarcoidosis - physician diagnosis of sarcoidosis, and:
 - At least 2 normal and NO abnormal BeLPTs, including having one BeLPT performed in the last 5 years



Health and Well-Being Questionnaires

Hanford Study Questionnaire		
ALL QUESTIONS CONTAINED IN THIS QUESTIONNAIRE ARE OPTIONAL AND WILL BE KEPT STRICTLY CONFIDENTIAL		
Name <i>(Last, First, M.I.)</i>	Gender: <input type="checkbox"/> M <input type="checkbox"/> F	Birth Date: ____/____/____
Street Address:		
City:	State:	ZIP:
Home Phone Number: ()- -	Cell Phone Number: ()- -	
Country of Birth:		
Marital status: <input type="checkbox"/> Single <input type="checkbox"/> Partnered <input type="checkbox"/> Married <input type="checkbox"/> Separated <input type="checkbox"/> Divorced <input type="checkbox"/> Widowed		
PERSONAL DATA		
Highest grade completed in school: <small>(ex: High School = 12, Bachelor's = 16, Master's = 18)</small>		
Work Status	<input type="checkbox"/> Current Hanford Worker <input type="checkbox"/> Former Hanford Worker	
What race do you most identify with? (Choose one)		
White:	<input type="checkbox"/>	
Black or African American:	<input type="checkbox"/>	
American Indian or Native Alaskan:	<input type="checkbox"/>	
Asian / Pacific Islander:	<input type="checkbox"/>	
Mixed Race:	<input type="checkbox"/>	
Do you consider yourself Hispanic or Latino? <input type="checkbox"/> Yes <input type="checkbox"/> No		
HEALTH HABITS		

Your Health and Well-Being SF-36				
This survey asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. <i>Thank you for completing this survey!</i>				
For each of the following questions, please mark an <input checked="" type="checkbox"/> in the one box that best describes your answer.				
1. In general, would you say your health is:				
Excellent	Very good	Good	Fair	Poor
▼	▼	▼	▼	▼
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
2. <u>Compared to one year ago</u> , how would you rate your health in general <u>now</u> ?				
Much better now than one year ago	Somewhat better now than one year ago	About the same as one year ago	Somewhat worse now than one year ago	Much worse now than one year ago
▼	▼	▼	▼	▼
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Exposure Interview: Surrogate for Exposure Data

Work History (Hanford and other possible Be Exposure Jobs)														
#	Start Date	Stop Date	Facility*	Job Title	Salaried/Non	Task Type*	Task	Exposure Type*	% Time Task	% Time Be	Type of Be*	Controls*	PPE*	Buildings*

Hanford or other facilities with Be work

- Production
- Laboratory
- Maintenance
- Construction
- R&D
- Waste/D&D
- Production support
- Administrative

Coded Job Title:

- Directly altering Be part
- Work within 5 feet of Be operation
- Work in same room as Be operation
- Work in same bldg as Be operation
- Contact with Be waste materials
- Contact with finished Be part
- Work in potential Be legacy area
- No known Be exposure

Job titles

- 159 job titles

M076	Research Program Mgr	E022	Independent Assessments	E053	Software QA
M077	Production Control Manager	E023	Industrial Hygienist	E054	Special Assignment
M078	Program Manager	E024	Law Enforcement Innovation Center	E055	Special Projects
M079	Engineering Manager	E025	Lead Assessor	E056	Specialist
M080	Quality Manager	E026	Lead Evaluator	E057	Staff Consultant
M081	Project Manager	E027	Lead Scheduler	E058	Staff Member
M082	First Line Supervisors	E028	Leader	E059	Staff Physician
M083	General Managers Executives	E029	Lessons Learned	E060	Statistician
M084	Other Managers	E030	Liaison	E061	Storage Expansion
Engineering, Scientific, & Health Care		E031	Manager	E062	Subcontract Technical Representative
E001	Advisor	E032	Mentor	E063	Supervisor
E002	Analyst	E033	Mfg Planner	E064	Surveillance & Quality Evaluation
E003	Buyer	E034	Nuclear Spectroscopist	E065	Computer System Administration
E004	Chemist	E035	Occ Med Nurse	E066	Systems Support
E005	Clinical Psychologist	E036	Occurrence Reporting	E067	Team Leader
E006	Computer & Information Security	E037	Physician Assistant	E068	Technical Fellowship Program
E007	Computer Staff	E038	Program Support Planning	E069	Technical Information Office Support
E008	Coordinator	E039	Computer Programmer/Staff	E070	Technical Leader
E009	Criticality Safety Officer	E040	Project Leader	E071	Technical Liaison
E010	Designer	E041	Project Planning & Integration	E072	Technical Support/Liaison/Rep
E011	Development Staff	E042	Project Support	E073	Technician
E012	Dimensional Metrologist	E043	Quality Assessment/Corrective Action	E074	Technologist
E013	Engineer	E044	Radcon Computer/Instr Support	E075	Tn Oversight Agreement Engineer
E014	Environmental Compliance Officer	E045	Radcon Source Control	E076	Unclassified Comp Sec
E015	Estimator/Cost Engineer	E046	Radiochemistry Technical Support	E077	Weapons Evaluation Leader
E016	Field Support	E047	Radiography/Ultrasonic Physicist	E078	Weapons Procurement Auditor
E017	Fire Compliance Evaluator	E048	Regulatory Compliance	E079	Weapons Product Auditor
E018	Fire Protection Engineer	E049	Research Specialist/Staff	E080	NC Programmer
E019	FOIA/Privacy Act Coordinator	E050	Reservation Services	E081	Engineering Manager
E020	Group Leader	E051	Safeguards Expert	E082	Research Specialist
E021	Hydrogeologist	E052	Section Head		

Tasks

- 154 tasks

Task Coding Key (For Supervision of any of these tasks enter S before code)		
Code	Task	
M	Machining	
	M001	Lathe
	M002	Mill
	M003	Lap
	M004	Grind (Machining)
	M005	Drill/Bore
	M006	Machine Polishing
	M007	Deburr
	M008	Tool Grinding
	M009	NC Mill
	M010	NC Lathe
	M011	EDM
	M012	Bench Lap
	M013	Misc Machining
	M014	Jig Bore
	M015	Shop Manager
	M016	Handed out tools
	M017	Process Engineer
	M018	Tool Making
	M019	Machining Observation
	M020	Pu Machining
C	Cutting	
	C001	Band Saw/Hack Saw
	C002	Shear
	C003	Torch Cutting
W	Welding	
	W001	Brazing
	W002	MIG/TIG
	W003	PIGMA
	W004	Electron Beam Welding
	W005	Forge/Furnace Welding
	W006	Chamber Welding
	W007	Furnace Welding
	W008	TIG/MIG Chamber
F	Forming/Treating	
	F001	Hot Pressing
	F002	Pressing: Powder Handling
	F003	Casting
	F004	Casting: Mold/Furnace Cleaning
	F005	Electroplating (Plating)
	F006	Plating: Tank Cleaning
	F007	Forging/Stamping
	F008	Extrusion
	F009	Rolling
	F010	Annealing/Heat Treating
	F011	Heat Treating
	F012	Etching
	F013	Chemical Milling
	F014	Vapor Deposition
	F015	Chem Finishing (Axsys Plating/Anodizing)
	F016	Cleaning Parts (Cleaning Tank)
	F017	Grit/Sand Blasting
	F018	Metal Spray
	F019	Powder Spraying
	F020	Power Operations
	F021	Spray Treatment
	F022	Arc Melt
	F023	Mold Breakout
	F024	Stamping
	F025	Breaking Be Bricks

Buildings

- 134 buildings

Building Coding Key		
Code	Building	Name
H001	120	
H002	103-B	Fresh Metal Storage
H003	105-B	Reactor Building
H004	106-B	Contaminated Equipment Storage
H005	107-B	Effluent Water Retention Basin
H006	108-B	Laboratory Building
H007	111-B	Decontamination Station
H008	115-B	Gas Recirculation
H009	117-B	Exhaust Air Filter Building
H010	181-B	River Pump House
H011	182-B	Reservoir and Pump House
H012	183-B	Filter Plant
H013	184-B	Power House
H014	185-B	Water Treatment Plant
H015	190-B	Main Pump House and Annex
H016	1154	
H017	1701-B	Gate House
H018	1702-B	105 Area Badge House
H019	1704-B	Office Building
H020	1707-B	Change House
H021	1707A-B	Maintenance Changehouse
H022	1709-B	Fire Headquarters
H023	1713-B	Store Room and Warehouse
H024	1715-B	Oil and Paint Storage (Oil and Paint Storage Building)
H025	1716-B	Automotive Repair
H026	1717-B	Area Maintenance Shops (Combined Shops)
H027	1719-B	First Aid
H028	1720-B	Patrol Headquarters
H029	1722-B	Paint Shop and Riggers Loft
H030	1736-B	Storage Building
H031	105-C	Reactor Building
H032	107-C	Effluent Water Retention Basin
H033	117-C	Exhaust Air Filter Building
H034	183-C	Filter Plant
H035	190-C	Main Pump House
H036	1702-C	105 Area Badge House
H037	1736-C	Storage Building
H038	103-D	Fresh Metal Storage
H039	105-D	Reactor Building
H040	107-D	Effluent Water Retention Basin
H041	108-D	Mechanical Development Laboratory
H042	115-D	Gas Recirculation
H043	117-D	Filter Building
H044	181-D	River Pump House
H045	182-D	Reservoir and Pump House
H046	183-D	Filter Plant (head house and chemical building, flocculation and subsidence basins, filter building, clearwells)
H047	184-D	Power House
H048	185-D	Thermal Hydraulic Laboratory
H049	186-D	Water Treatment Building
H050	189-D	Experimental Laboratory
H051	190-D	Main Pump House and Annex
H052	195-D	Vertical Safety Rod Tower
H053	1605-D	Guard Tower
H054	1608-D	Waste Water Pump House

Exposure Assessment Challenges

- Limited IH sampling data
 - Exposure estimates not calculated for any study participants
 - Results or comments on “exposure” reflect ONLY the potential for exposure
- Work histories spanned 8 decades: 1947-2013
- Workers changed job titles often
- Very large site with diverse operations throughout
- Hundreds of buildings



Beryllium Building Rating (BBR)

- Surrogate for industrial hygiene data
- Based on historical documents
- Rated the 134 buildings worked in
- Scale from 1 to 5:
 - 1: No Be exposure potential documented
 - 2: Little to no potential for Be exposure
 - 3: Minimal potential for Be exposure
 - 4: Be detected via IH survey or historical documentation, some potential for exposure
 - 5: Be detected via IH survey or historical documentation, high potential for exposure



Dust Generating Rating (DGR)

- Potential for generating dust and exposure to beryllium
- Rated the 154 tasks reported for potential dust generation
- Scale from 0 to 2
 - 0: Little to no potential for generating dust
 - 1: Some potential for generating dust
 - 2: High potential for generating dust



Exposure Score Calculation

- Calculated exposure score using exposure interview data:
 - Time spent in each building
 - Beryllium building rating
 - Task performed
 - Dust generating rating for each task
 - Time spent performing each task
- Cumulative score = unit-less number reflecting the potential magnitude of exposure
- Average score = Cumulative score/ tenure

RESULTS

Study Population



238 current and former workers

- 16 unable to be classified
- 1 withdrew

221 subjects



17 CBD

47 BeS

146 Controls

12 Sarc



Study Population Demographics

Entire study population

- 80.6% male, 95.5% non-Hispanic
- Average age: 55 (range: 29-85)
- 79.7% were active employees
- Median hire year was 1984 (range: 1966-2012)

	CBD N= 17	BeS N =47	Sarcoidosis N = 12	Control N = 146
Gender				
Male	94.1%	75.6%	100%	79.3%
Female	5.9%	25.5%	0%	21.2%
Race				
White	94.1%	93.6%	100%	91.1%
Other	5.9%	6.4%	0%	8.9%
Smoking status				
Current	0%	8.5%	0%	4.8%
Former	29.4%	31.9%	8.3%	31.5%
Never	70.6%	59.6%	91.7%	63.7%
Work Status				
Current worker	47.1%	70.2%	66.7%	87.7%
Former worker	52.9% *	29.8%	33.3%	12.3%
Median age	60 **	58 **	58	55
Median year of hire	1978 **	1982	1981	1985
Tenure mean years	29.0	26.9	26.6	25.2
Facility				
Hanford	88.2%	78.7%	91.7%	82.2%
PNNL	11.8%	17.0%	8.3%	10.3%
Both	0%	4.3%	0%	7.5%

*Statistically different than BeS, CBD and controls

** Statistically different than controls

Primary Objective

Identify past and present jobs, work areas, or processes with increased probability of BeS and CBD.



Large Number of Analyses to Evaluate Potential Exposure

- Job class/type
- Area worked in
- Type of work (building)
- Exposure type
- Task type
- Task class
- Years of exposure
- Pre- and post-production work
- Highest exposure type
- Building-specific analysis for buildings where Be production took place
- Job type combined with task class
- Beryllium building rating score
- Dust generating potential
- Exposure rating score
- Exposure to Be other than at Hanford
- Working with Be tools
- Machine learning

Work in Be Buildings

Variable	CBD N=17	BeS N=47	Sarc N=12	Control N=146
Ave total time in Be building (years)*	16.8 **	13.6	10.5	12.2
Hired Post-1986	23.5% **	40.4%	41.7%	47.6%
Pre-1986 Be time	52.9%	40%	41.7%	35.6%
Post 1986 Be time	100%	95.6%	91.7%	96.6%
Ave Pre-1986 Be time (years)	3.6	5.4	3.1	3.2
Ave Post-1986 Be time (years)	14.9	11.9	10.0	11.1
Worked as Machinist	11.8%	13.3%	16.7%	17.1%
Exposure other than at Hanford	11.8%	25.5%	8.3%	15.9%
Direct Exposure	23.5%	20.0%	33.3%	36.6%
Indirect Exposure	52.9%	44.7%	41.7%	40.0%
Work with Be Tools	52.9%	29.8%	50.0%	41.4%
Modify Be tools	17.7%	2.2%	8.3%	11.7%
300 Area	82.4%	83.0%	66.7%	77.2%
PFP	58.9%	34.0%	41.7%	51.0%
100N	64.7%	46.8%	41.7%	52.4%
K Basins	17.6%	17.0%	16.7%	31.0%

*All BeS, CBD, and sarc cases worked in a Be building

****Significant difference between CBD & controls**

Work by Type of Job Title

Job Types	CBD N=17 %	BeS N=47 %	CBD & BES N = 64 %	Control N=146 %
Administration	23.5	19.1	20.3	21.9
Construction Worker	0.0	2.1	1.6	0.7
Custodial/Maintenance	23.5	10.6	14.1	16.4
D&D	0.0	6.4	4.7	6.2
Engineer/R&D	11.8	8.5	9.4	13.7
In Plant Trades Person	35.3	31.9	32.8	23.3
Industrial Hygiene/Safety	11.8	10.6	10.9	21.9
Industrial Production	17.6	14.9	15.6	13.0
Inspector/Quality Control	0.0	4.3	3.1	1.4
Laboratory	0.0	6.4	4.7	3.4
Machinist	0.0	0.0	0.0	1.4
Management	5.9	8.5	7.8	9.6
Non-Production	29.4	36.2	34.4	34.3
Security	0.0	2.1	1.6	4.8
Waste	5.9	2.1	3.1	4.8

Work by Task

Task Class	CBD N=17 %	BeS N=47 %	CBD & BES N = 64 %	Control N=146 %
Administrative	23.5	25.5	25.0	28.1
Assembly	5.9	2.1	3.1	3.4
Cleaning	23.5	8.5	12.5	9.6
Cutting	0.0	0.0	0.0	2.1
D&D	11.8	8.5	9.4	17.8
Forming	11.8	0.0	3.1	6.2
Hand Work	0.0	0.0	0.0	4.8
Inspection/Testing	11.8	4.3	6.3	8.2
Laboratory	17.6	8.5	10.9	6.9
Machining	5.9	6.4	6.3	8.2
Material Handling & Control	11.8	0.0	3.1	6.9
Mfg Support & Oversight	41.2	53.2	50.0	64.4
Plating/Finishing	0.0	0.0	0.0	0.7
Production	5.9	10.6	9.4	10.3
Trades & Maintenance	52.9	48.9	50.0	35.6
Unknown	0.0	2.1	1.6	2.8
Waste	23.5	31.9	29.7	28.8
Welding	11.8	6.4	7.8	8.9

BBR and DGR by Case Status

	n	CBD (n=17)	n	BeS (n=47)	n	Control (n=146)
Beryllium Building Rating		Avg. Years		Avg. Years		Avg. Years
1	16	10.4	46	10.5	140	11.0
2	8	4.5	37	3.4	96	3.1
3	12	3.6	41	3.6	119	3.0
4	15	8.4	38	5.5	117	4.9
5	5	5.4	34	1.9	110	3.0
Building rating = 1, 2, 3	14	14.5	47	16.2	144	15.2
Building rating = 4, 5	16	12.0	40	6.9	135	6.7
Dust Generating Rating						
0	6	8.1	18	16.0	53	12.3
1	12	15.8*	30	14.0	106	11.4
2	12	16.5	31	13.7	93	15.0
DGR = 2 + BBR = 4 5	12	7.2	23	5.8	77	5.0

*Significant compared to controls

Exposure Score by Case Status

	CBD (n=17)	BeS (n=47)	Control (n=146)
Cumulative exposure score	97.9 *	60.1	64.5
Average exposure score	3.3 **	2.2	2.5

* CBD significantly different than controls and BeS

** CBD significantly different than BeS



Post 1986 risk factors

- 19 cases of BeS (40.4%) and 4 cases of CBD (23.5%) hired after 1986
- 6 (26.1% -2 CBD and 4 BeS) had Be exposure before Hanford
- 10/23 (41.7%) in manufacturing support and oversight
- 9/23 (39.1%) in 105N
- 6/23 (26.1%) work with Be tools
- 6/23 (26.1%) trades workers
- 5/23 (21.7%) waste recycling
- 22/23 (95.7%) were involved in dust generating tasks
- Cumulative exposure score was higher for CBD cases hired after 1986 (56.1) vs. controls (36.7) and BeS (32.4)



Limitations

- Limited IH data
 - No subject-specific exposure data, only surrogates reflecting potential for exposure
- Minimal information on historic uses of beryllium
 - production changed over time
 - classified use
- Participation rate lower than expected
- Physically large site and numerous contractors, changing over time



Conclusions

- CBD had higher cumulative beryllium exposure score than BeS or controls
 - More time spent in buildings and tasks with potential beryllium exposure
- CBD had more work years in beryllium buildings than controls
- CBD more likely to be hired during active production - pre 1986
- CBD and BeS hired after 1986 were involved in jobs and tasks with potential for encountering legacy beryllium

SECONDARY OBJECTIVES - RESULTS

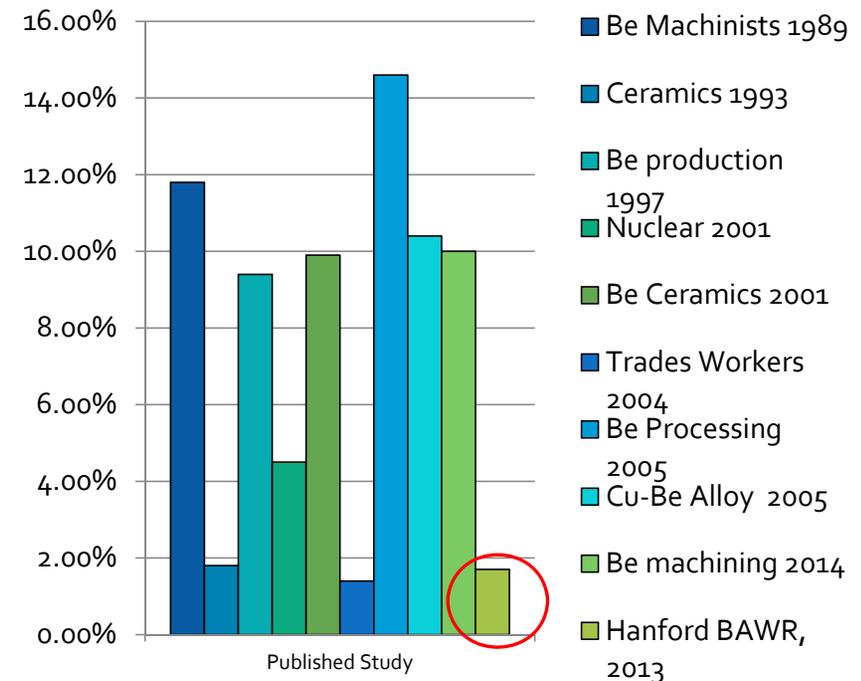
Background: BeS and CBD at Hanford

Beryllium-Associated Worker Registry 2013

- 7,480 current workers tested (since 2002)
- 91 with BeS (1.2%) and 34 with CBD (0.5%)
- **Overall Prevalence of BeS = 1.7%**
- % of BeS with CBD = 27%

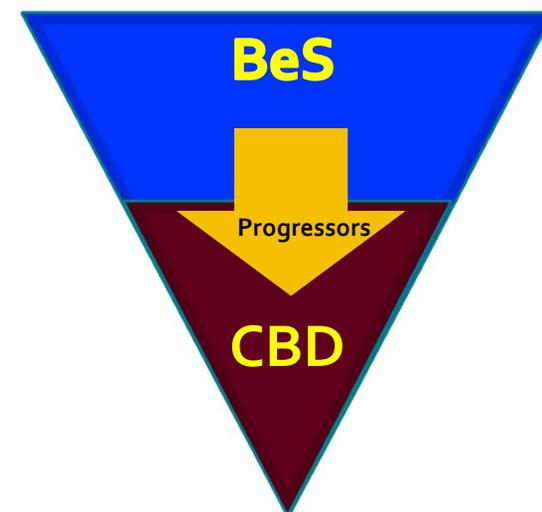
Former Worker Medical Screening Program 2014

- Production workers – 4,175 initial screening
 - 49 with abnormal BeLPTs
 - **Overall prevalence of BeS = 1.2%**
- Construction workers – 3,004 screened
 - 40 with abnormal BeLPTs
 - **Overall Prevalence of BeS – 1.3%**



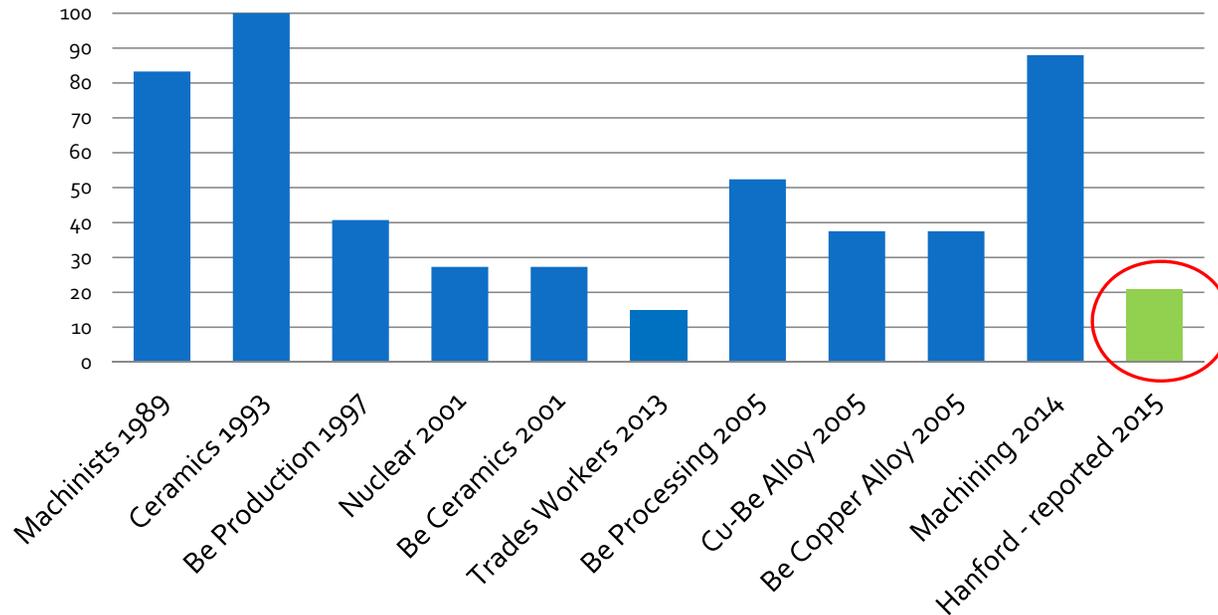
1) Characterize the prognosis of BeS among Hanford workers

- 47 BeS+ 4 progressed to CBD =51 ever BeS
- Overall progression rate for study group: **7.8%** (4/51).
- Time from initial BeS to CBD was 2.6 years (range 1.6 – 4.0 years)
- Rate of BeS to CBD: **3.0%** per year.
- **Lower annual progression** rate vs **8.1%** per year found in a clinical follow-up study (Newman et al, 2005)



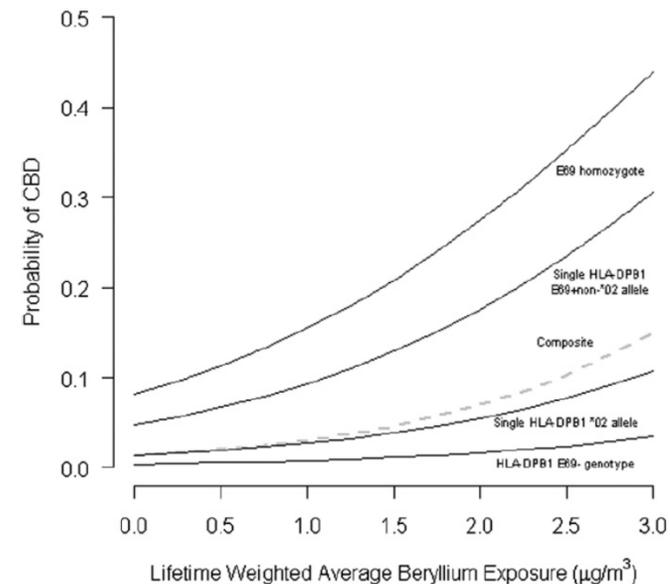
Percent of CBD among those with BeS

- % BeS with CBD is **21%** (33/158)
 - Based on the reports from the Hanford/PNNL medical contractors



Conclusions

- Lower % of BeS with CBD at Hanford, compared to other studies, suggests overall lower exposures at Hanford
- The lower exposures at Hanford may be associated with lower progression
- Estimates of BeS and CBD from medical screening programs shows BeS prevalence of 1.2 – 1.7% ↓ than other workforces



Van Dyke et al AJRCCM 2011

2) Characterize the prognosis of CBD among Hanford workers

- No differences between BeS and CBD cases in any pulmonary function (PFT) variables at initial clinical evaluation
- Average PFTs for BeS and CBD above normal based on expected for age, race, gender
- 1 CBD and 2 BeS < normal PFTs; all had other lung problems, including asthma
- CBD cases had a \uparrow decline in TLC compared to BeS
 - Weight gain in 7/8 : can cause restriction
- CBD patients had \uparrow yearly decline in work load with exercise vs. BeS



Conclusions

- Initial BeS and CBD clinical evaluation
 - Normal PFTs on initial clinical evaluation- no difference
 - No difference in exercise physiology testing or gas exchange
- Changes in PFTs over time similar for CBD and BeS, most improving
- 2/15 CBD cases (13.3%) prominent annualized decline in PFT
 - one was being treated
- Most cases of CBD at Hanford are in the very early stages of disease, although some progression in a few individuals



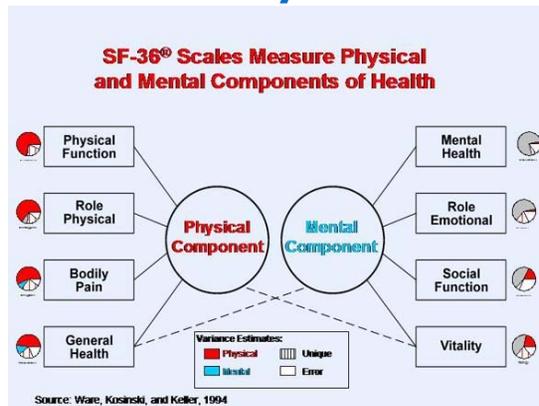
3) Characterize the prevalence of other potentially beryllium-related health symptoms and medical diagnoses among BeS and CBD cases

- No differences respiratory symptoms between CBD, BeS and controls
- CBD patients were NOT more likely to have heart problems, diabetes, connective tissue or autoimmune disorders
- BeS and CBD more likely to report other lung problems vs. controls
- Osteoporosis ↑ BeS and CBD vs controls
 - 2 CBD cases treated with prednisone
- BeS and CBD more likely to have other symptoms vs. controls

	CBD(n=17)	BeS(n=47)	Control(n=146)
Comorbidities			
Other Lung Problems*	52.9% Ω	44.7% β	24.0%
Skin Problems due to Be	11.8%	2.1%	0.0%
Sleep Apnea	64.7% β	23.4%	27.4%
Osteoporosis	11.8% Ω	14.9 β	3.4%
Pneumonia	35.3%	27.7%	30.8%
Other Symptoms			
Unexplained muscle twitches	52.9%	46.8%	40.4%
Night Sweats	76.5% β	57.5% Ω	37.0%
Fatigue/Tired	70.6%	80.8% Ω	57.5%
Day Sweats	23.5%	36.2% β	11.7%
Loss of Appetite	11.8%	13.0%	11.0%
Depression	41.2% Ω	25.5% Ω	11.0%
Unexplained Weight Gain	29.4% β	12.8%	8.2%
Memory Loss	47.1% Ω	38.3%	24.7%

* Includes chronic bronchitis, COPD or emphysema, pulmonary fibrosis, asthma
 Ω p<0.05 compared to controls
 β p<0.01 compared to controls

Quality of Life (SF36) Questionnaire



- 67% above the population norm for physical score
- 87% above the population norm for mental score
- CBD/BeS scores higher than another DOE population

SF 36 Average	CBD(n=17)	BeS(n=47)	Control(n=146)
Components and domains			
Physical Component Score	45.1 *	45.1 *	50.7
Physical Function	46.8 *	47.2 *	51.6
Bodily Pain	46.1	45.5 *	50.3
Role-physical	45.9 *	47.2 *	52.6
General health	45.9	47.4 *	52.8
Mental Component Score	49.8	52.7	54.8
Vitality	47.9	49.6 *	53.4
Social function	46.4 *	49.7 *	52.9
Role-emotional	48.0	50.5 *	53.8
Mental health	51.0	52.3	54.8

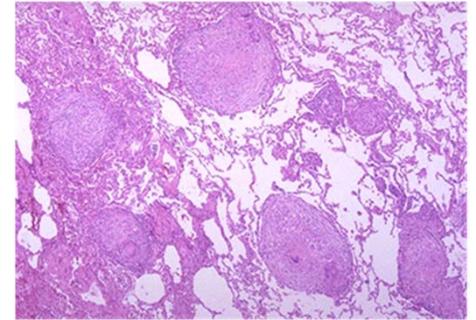
*Statistically different than controls

Conclusions

- Respiratory symptoms did not differ CBD, BeS and control subjects
- CBD patients were NOT more likely to have heart problems, diabetes, connective tissue or autoimmune disorders
- Reports of depression in CBD patients and fatigue/tiredness, depression and malaise in BeS may be related to uncertainties that go along with a diagnosis
- Quality of Life measures were above the general population and reported for DOE workers (BeS, CBD) in another study.
- CBD and BeS subjects ↓ physical score vs control, BUT significantly older
- CBD and BeS cases ↓ social-function vs controls
 - Could be related to the anxiety associated with diagnosis, having to change jobs and having regular medical follow-up and other factors

4) Evaluate risk factors for sarcoidosis

- Sarcoidosis worked many different jobs
- All cases worked in beryllium buildings
- Sarcoidosis cases were more likely to work
 - **In trades and maintenance** vs controls (66.7% vs. 35.6%)
 - **In management** vs controls (41.7% vs. 9.6%), BeS (8.5%) and CBD (5.9%)
 - **Outdoor job** (58%) vs CBD (18%)
- Cumulative beryllium exposure score lower for sarcoidosis (67.4) vs CBD (97.9)
- Sarcoidosis and CBD similar health/medical outcomes
- Sarcoidosis report extra-pulmonary involvement



Conclusions

- No specific jobs, buildings or tasks associated with sarcoidosis
- Sarcoidosis cases were significantly more likely:
 - Have an outdoor job compared to CBD cases
 - Involved in trades and maintenance compared to controls
 - Work in management compared to controls
- Sarcoidosis more extra-pulmonary involvement
- Sarcoidosis is a distinct disease from CBD at Hanford
- Evaluate these differences to determine cause of sarcoidosis



CONCLUSIONS

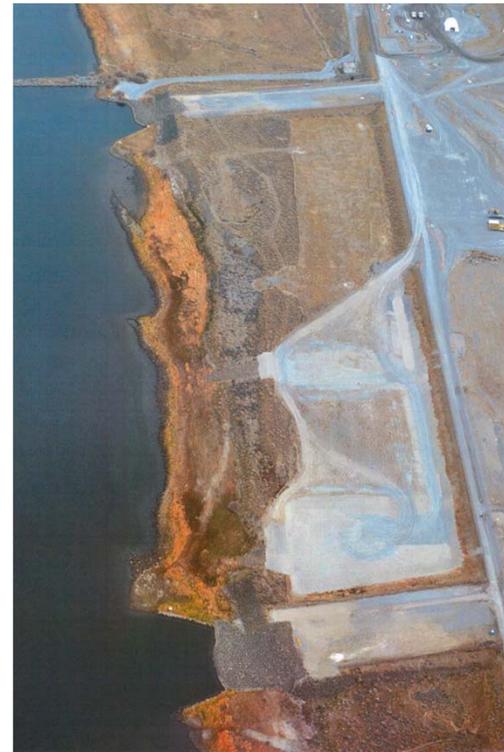
Overall Conclusions

- CBD cases were:
 - Hired before 1986
 - Worked more years in a beryllium building
 - ↑ Cumulative and average exposure score than BeS cases and controls
- CBD cases occurred among employees hired after 1986
 - Suggests legacy exposure
- CBD and BeS cases at Hanford are healthy based on:
 - Medical evaluation, other conditions and QOL
- % of BeS with CBD at Hanford is low vs. other workforces
- CBD cases reported disease-related symptoms
 - Progression of disease over time was minimal
- Sarcoidosis is distinct from CBD:
 - Different work risks
 - Extrapulmonary involvement



Future Direction and Recommendations

- Continue to characterize potential exposures
 - Wipe and air sampling
- Vigilant controls measures, such as PPE, to prevent exposure
- CBD and BeS should be removed from further exposure or exposure should be minimized as much as possible
- Medical surveillance and evaluate CBD/ BeS risk (job title, task, etc.) per CFR 850 to provide larger group
- Further characterization of jobs, buildings and work areas to examine other exposures related to sarcoidosis (e.g., zirconium and aluminum)



Future Direction and Recommendations

- Cases should continue regular medical follow-up to detect disease related progression
- Hanford and PNNL should work closely with BeS/CBD cases to reduce stress related to job placement, medical follow-up and compensation
- Continue to promote worker wellness to keep workers healthy
 - Smoking Cessation – if you smoke – Quit!
 - Healthy diet and exercise
 - Medical surveillance for other hazards
 - Stress management
- Conduct genetic studies to further examine gene-environment interaction; genetic predisposition is likely increased in BeS vs. CBD

THANK YOU!

Study Participants



Titan Consulting Group, LLC

QUESTIONS?
