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Safety management intervention among small metal fabrication businesses: The National Machine Guarding Program

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Background: Injuries in Metal Fabrication

	Rate per 10,000 workers	
	Metal fabrication	Private industry
Lost-time injuries	116.3	93.9
Amputations	3.7	0.6
Eye	7.0	2.1
Upper extremities	53.8	30.6

2015 rate data for NAICS 332 and all private industry from: U.S. Dept. of Labor, Bureau of Labor Statistics. *Occupational Injuries/Illnesses and Fatal Injuries Profiles.* http://data.bls.gov/gqt; Accessed 08/29/2017.

Background

- Small manufacturing businesses often lack access to occupational safety and health (OSH) expertise.
- Development of effective OSH interventions widely applicable to smaller firms remains a persistent challenge.

National Machine Guarding Program

- Safety intervention among small (3 -150 employees) metal fabrication businesses.
- Scale-up of methods applied in a regional study: Minnesota Machine Guarding Study.
- Workers' compensation insurers were study partners.
- Insurance safety consultants are trained as study field staff.

Criteria for Participation

- 3-150 employees
- Workers' compensation coverage with one of our two partners
- In business for at least one year
- Engaged in metal fabrication for 75% or more of business
- Only one site per business entitity

Business safety evaluation

- Checklist evaluation of 12 randomly selected machines.
- Completion of a shop evaluation checklist.
  - Business Report, safety scores, and Business Action Plan.
- Business safety evaluation conducted at baseline and again at follow-up.

Key outcomes assessed

- Machine safeguarding practices
- Lockout/tagout
- Safety management programs

Partial checklist

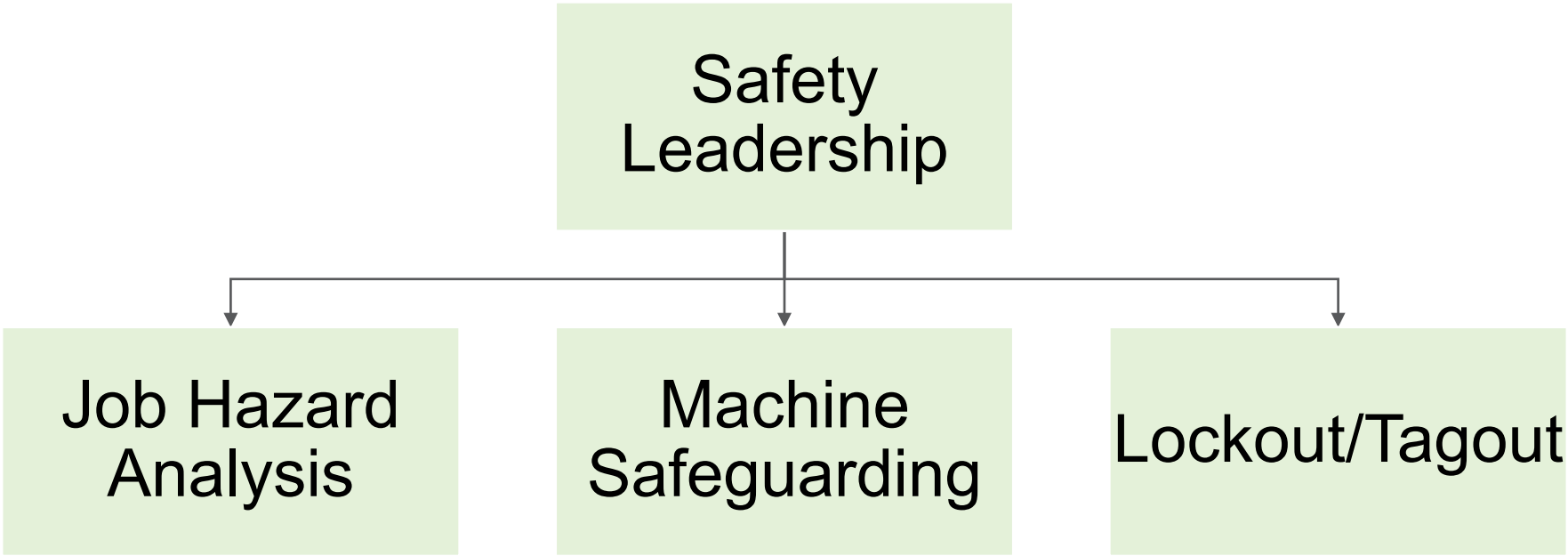
CNC Lathe
Safety Evaluation Checklist

Business Name: _____ Today's Date: _____

Machine Tag #: _____ Manufacturer: _____ Year of Manufacture: _____

Yes	No	N/A	
			Point of operation -- Completely enclosed
			Is the point of operation completely enclosed?
			If "Yes" -- Is each door and access portal equipped with an interlock? (Ask operator)
			Point of operation – Not completely enclosed
			Is a chip and coolant shield in place?
			Is shield free from cracks and in good condition?
			Is a work-holding device (chuck) shield in place?
			Is shield free from cracks and in good condition?
			Is the chuck guarded?
			Bar feed
			Are safeguards in place to enclose location where bar stock is fed in to the machine?
			Is entire length of rotating bar stock enclosed?
			Chip removal system
			Is chip removal system enclosed?
			If there is a chip conveyor, is there a separate set of controls for the conveyor?
			Guards, general
			Are guards free from cracks and in good condition?
			Power transmission guard
			Are all moving parts below 7 ft. guarded?
			Is guard free from cracks and in good condition?
			Operational controls
			Are all controls legibly marked?
			Are controls accessible without reaching over rotating/dangerous parts?
			Are safeguards in place to prevent unintended activation of controls?

Intervention programs



Intervention timeline

- Four on-site visits at each site:
  - Baseline evaluation
  - First intervention at 3 months
  - Second intervention at 6 months
  - Follow-up evaluation at 12 months

Business characteristics for 160 shops completing the intervention

Number of states	31
Number of employees	
3-10	44
11-29	65
30-49	22
50–150	29
Mean number of employees	29
Number and percent with a safety committee	55 (34%)

Business-level machine audit scores: Baseline and 12-month follow-up

	Baseline	12-nonth follow-up	Change	
Evaluation measure	Mean %	Mean %	Percentage point change	p-value
Business-level machine score	73	79	6	<0.0001
Equipment safeguards	81	83	2	<0.0001
Lockable disconnects	88	92	4	<0.0001
LOTO procedures	8	33	25	<0.0001
Electrical	92	95	3	<0.0001

Pre/post intervention safety management audit scores

Number of employees		Intervention status	Safety leadership	Machine maintenance	LOTO**	Overall safety management score
	N		Mean %	Mean %	Mean %	Mean %
All shops		Pre	58	43	55	43
	160	Post	73	58	76	59
Percentage point increase			15	15	21	16
p-value			<0.0001	<0.0001	<0.0001	<0.0001

Pre/post intervention safety management scores for shops that maintained (n = 51), established (n =42), or did not establish a safety committee (n = 63)*

Safety committee status pre/post	Pre-intervention		Post-intervention		P-value for change in mean pre/post scores	Pre/post change in percentage points (SD)	p-value ***
	Mean %	SD	Mean %	SD			
	Overall safety management audit**						
Yes to yes	55	19	74	15	<0.0001		
No to yes	44	19	68	19	<0.0001	24 (21)	0.000
No to no	33	18	42	20	<0.0001	9 (14)	2

* Excludes 4 shops that went from having to not having a safety committee
** Excludes checklist item concerning presence of safety committee.
*** Comparison of groups "no to yes" versus "no to no".

Pre/post intervention LOTO scores for shops that maintained (n = 51), established (n =42), or did not establish a safety committee (n = 63)*

Safety committee status pre/post	Pre-intervention		Post-intervention		P-value for change in mean pre/post scores	Pre/post change in percentage points (SD)	p-value **
	Mean %	SD	Mean %	SD			
	LOTO						
Yes to yes	72	28	89	18	<0.0001		
No to yes	54	39	87	26	<0.0001	33 (39)	0.06
No to no	41	38	59	39	0.0006	18 (41)	

* Excludes 4 shops that went from having to not having a safety committee
** Comparison of groups "no to yes" versus "no to no".

Regression

- S*afety leadership*, *LOTO*, and *machine maintenance* scores were combined into a summary measure and entered into a stepwise regression model with *business-level machine score* as the dependent variable.
- The *business-level machine score* increased by 0.14% for each percent increase in the summary measure.

Discussion

- Businesses in all size ranges made large improvements in LOTO procedures and LOTO program scores, and improved significantly for lockable disconnects.
- Adding a safety committee was correlated with larger improvements regardless of shop size.
- When controlling for safety committee status, magnitude of change was not significantly related to shop size.
- Our partners were great but the intervention was not sustainable!

Some of our publications

- Findings From the National Machine Guarding Program: Safety Climate, Hazard Assessment, and Safety Leadership in Small Metal Fabrication Businesses. J Occup Environ Med. 2017 Sep 1
- Self-audit of lockout/tagout in manufacturing workplaces: A pilot study. Am J Ind Med. 2017 May;60(5):504-509.
- Findings From the National Machine Guarding Program-A Small Business Intervention: Machine Safety. J Occup Environ Med. 2016 Sep;58(9):885-91.
- Analysis of workers' compensation claims data for machine-related injuries in metal fabrication businesses. Am J Ind Med. 2016 Aug;59(8):656-64.
- Findings From the National Machine Guarding Program: A Small Business Intervention: Lockout/Tagout. J Occup Environ Med. 2016 Jan;58(1):61-8.
- National Machine Guarding Program: Part 2. Safety management in small metal fabrication enterprises. Am J Ind Med. 2015 Nov;58(11):1184-93.
- National Machine Guarding Program: Part 1. Machine safeguarding practices in small metal fabrication businesses. Am J Ind Med. 2015 Nov;58(11):1174-83.