MEL & ENID ZUCKERMAN COLLEGE OF PUBLIC HEALTH
Western Mining Safety and Health Training Resource Center

IDENTIFYING LEADING INDICATORS OF INJURY

Association Rules for Assessing Operators' Risk Management Plans and Controls Hierarchies

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Identifying Leading Indicators of Injury

As a step toward identifying leading indicators of injury, Association Rule Mining (ARM) was used to explore the relationship between keywords in the text our partners' Significant Potential Injury (SPI) reports and seven classes of injuries, including ankle, back, eye, finger, knee, shoulder, and wrist. ARM is a powerful unsupervised learning technique that generates rules in a human-readable format which can be shared with industry stakeholders to assess their usefulness. Useful rules may then be used to revise operators' controls hierarchies or augment their training practices. To derive these rules, we executed three major tasks: 1) Extract keywords from reports using Topic Modeling techniques; 2) Discover candidate association rules using ARM; and 3) Evaluate the association rules with mining industry experts to determine their usefulness. An article on these results is currently in preparation (Dinesh, Brown, Burgess, & Cui, 2023).

Keyword Extraction. Before association rules may be generated, keywords must be extracted from for each class of injury. We chose to use our partners' SPI reports, as opposed to the publicly available MSHA "Accident Injuries" database, to extract keywords for three reasons: 1) Operators' internal reporting corpus has not been used extensively in the body of research surveyed (see Aim 1); 2) Internal reports often capture data that is not readily available in the public dataset; and 3) The prose and phrasing of company reports more closely matches the vernacular of the workforce and thus may yield keyword associations that better resonate with our target audience (i.e. mine operators).

As company SPI data reports were not intrinsically labelled by injury class, we used the FastText algorithm (see Aim 2) to label each incident description with injury classes automatically. Keywords were then extracted from the SPI reports by combining two different methods: (1) Using Structural Topic Modeling (STM) with an 8-topic model; (2) Using Topic Modeling with term frequency—inverse document frequency (tf*idf) to generate a document-term matrix from which keywords were extracted. Note that eight classes of injuries were used in this analysis, which included the six classes identified previously, plus "Wrist" and "Other". Both the STM and TM with tf*idf methods produced good results for approximately half of the injury classes and confusing results for the other half. We also noted considerable amounts of overlap between classes. For example, we found that, even after removing stopwords, the narratives of any pair of injury classes had > 30% keyword overlap with each other using the 8-topic STM. This finding may suggest that different injury classes occur under similar circumstances or context; it also informs the types of goodness of fit measures that may be more suitable to ARM (see below) – in particular, the Confidence and Lift may be better measures of goodness than the Kulczyinski Method or Imbalance Ratio.

Discovery of Association Rules. After labelling and Topic Modeling, the class labels and keywords of each record were merged to create "transactions" for the ARM method *a priori*. The ARM process then discovers human-readable rules in the following format:

[left hand indicators] $\rightarrow$ *[right-hand indicators] (support, confidence)*

To understand this syntax, consider the rule "smoking $\rightarrow$ lung cancer (0.05, 0.30)". This rule states that within the dataset mined 5% of the people smoke, and within those people, 30% of them get lung cancer.

Details on the ARM technique may be found in Han, Kamber, & Pei (2012). The rules generation process yields an arbitrarily large number of candidate rules which may be ranked by a "measure of goodness" criterion. For reasons outlined above, Confidence was used as the measure of goodness for this study, with a Confidence threshold of 80% (0.80) as the inclusion criterion. In total, 149 rules satisfied this criterion across seven named classes of injury (i.e. excluding catch-all category "Other"). Figure 1 provides a summary visualization of these association rules and their supports; please refer to Appendix D for a full listing of the 149 rules and their performance on various measures of goodness.

Evaluation of Association Rules. Although association may be discovered with high Confidence by the ARM technique, this does not mean that the rules are themselves meaningful for improving H&S. Expert feedback is necessary to evaluate the rules in terms of their intuitiveness of the rules – that is, the rules reveal interesting associations between classes of injury and potential correlating factors – and their applicability to safety management processes, such as for improving controls hierarchies or training.

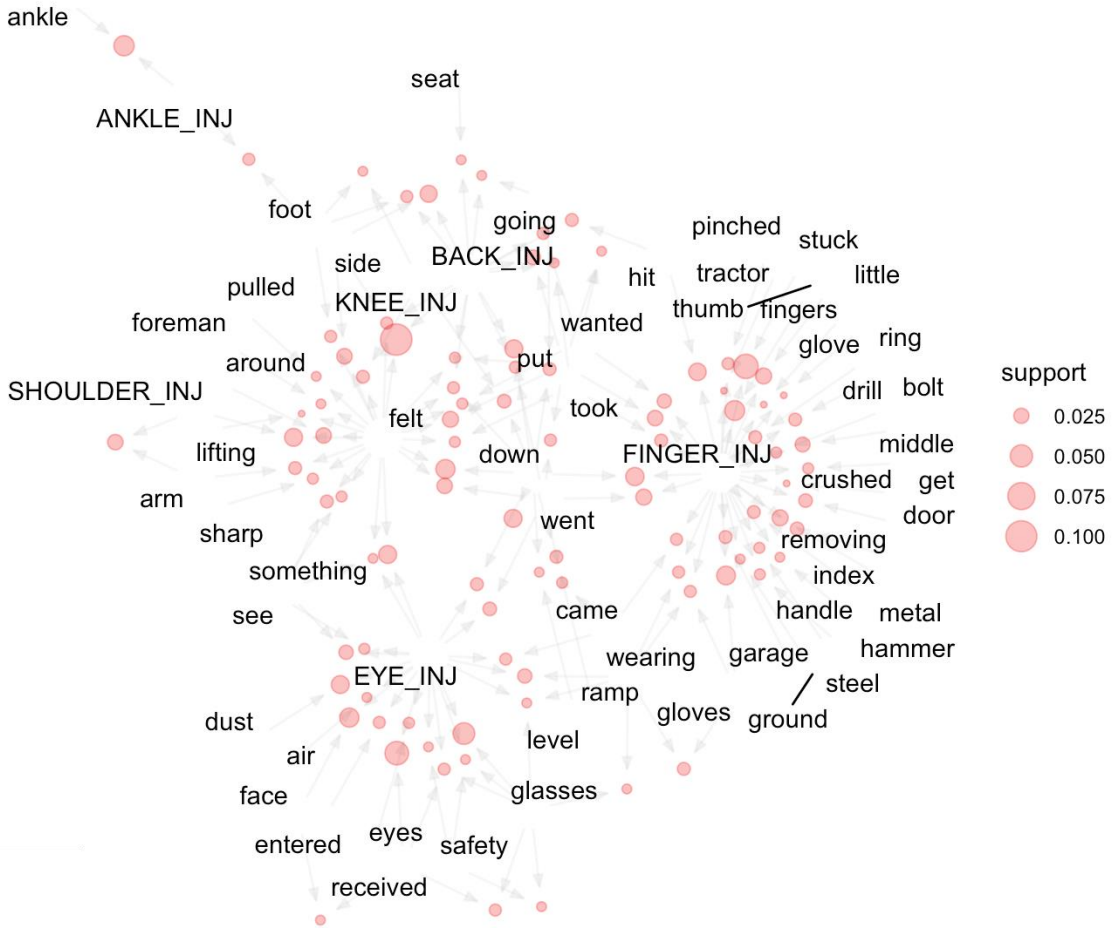

Figure 1. A visualization of association rules and supports for six classes of injuries.

For this evaluation, we invited four experts to survey the rules and evaluate them as being either "useful" (i.e., interesting and/or applicable) or "not useful" (i.e. too vague or nonsensical). Experts 1 and 2, EXP1 and EXP2 respectively, participated in the Aim 2 assessments. A third expert (EXP3) was a veteran of the

mining workforce with 30 years of hands-on mining experience and a certified MSHA trainer (blue card) with CMSP certification. A fourth expert (EXP4) had over 25 years of mining management experience and held a senior leadership position as head of a major operator's Department of Health, Safety, and Environment. Each expert provided ratings independently.

Table 1. Number of association rules labelled as "Useful" by experts for each injury class.

	Cumulative Usefulness Score (*n* = number of experts judging useful)					
Injury Class	***n* = 0**	***n* = 1**	***n* = 2**	***n* = 3**	***n* = 4**	**Total Rules**
Ankle	0	4	0	**1**	**2**	7
Back	13	5	4	**5**	**3**	30
Eye	30	3	11	**12**	**5**	61
Finger	24	5	6	**7**	**4**	46
Hand	1	0	0	**0**	**0**	1
Shoulder	0	0	1	**0**	**0**	1
Wrist	1	0	2	**0**	**0**	3

A survey of the experts' Usefulness ratings is given in Table 1, above. We used a binary classification to label each rule as either Useful=1 or Not Useful=0 for each of the four experts. The cumulative usefulness score indicates the number of rules satisfying each level of expert consensus. For instance, for the "Eye" class of injury, 5 rules (out of 61 candidates) were unanimously voted as useful by all four experts, while 17 rules were voted as useful by three or four experts. Notably, fully half of the association rules were rated as Useful by at least one expert (Cumulative Usefulness > 0) and 39 rules had a high level of consensus as being Useful (Cumulative Usefulness = 3 or 4). Furthermore, a correlation analysis was performed to identify the relationships between experts' Usefulness scores and the various measures of goodness. As shown in Table 2 below, Confidence, Lift, and Certainty all positively correlated with the experts' ratings, while an inverse relationship was noted for Support, Coverage, and Count. Individual expert ratings for each rule may be found in Appendix A.

Table 2. Correlation of association rule measures with experts' "useful" rating.

Measure	Correlation
Support	-0.242163
Confidence	0.289462
Coverage	-0.255107
Lift	0.114873
Count	-0.242163
Cosine	-0.082435
Certainty	0.288759
Leverage	-0.216698

The validated Association Rules represent a significant contribution of this project, as they provide operators with insights – from their own reporting processes – on the controls and trainings that work and that may warrant improvement. We have shared these findings with our industry partners, who are now surveying the rules to revise their risk assessment and management plans. We are also developing

new training tools for annual refreshers that will target many of the contextual situations of injury that are suggested by these rules. For example, a word cloud has been generated using the SPI dataset (Figure 2, below). In future work, we expect to provide expert interpretations and mitigation strategies for each of the 39 validated rules; the work will be submitted to a journal focusing on occupational safety.

Figure 2. A word cloud illustrating the common circumstances of injuries, as constructed from the MSHA "Accident Injuries" dataset.

References

1. Brown, L.D., A. Dinesh, J.L. Burgess, & H. Cui. "Using Multi-class Classifiers to Predict Injuries and Identify Leading Indicators in Mine Industry Safety Report Corpus," *iSchools Conference* (iConference), *Springer LNCS Series*, 2023. (In Preparation)

2. Han, J., Kamber, M., & Pei, J. (2012). Data Mining: Concepts and Techniques. New York: Morgan Kaufmann.

Appendix A: Association Rules

lhs		rhs	sup.	conf.	cov.	lift	count	cos.	cert.	lev.	EXP1	EXP2	EXP3	EXP4	Useful
Ankle															
{ankle, mud}	=>	{ANKLE_INJ}	0.0057	1	0.0057	19.5	4	0.333	1	0.0054	1	1	1	1	4
{ankle, rolled}	=>	{ANKLE_INJ}	0.0114	1	0.0114	19.5	8	0.471	1	0.0108	1		1	1	3
{ankle, walking}	=>	{ANKLE_INJ}	0.0085	1	0.0085	19.5	6	0.408	1	0.0081				1	1
{ankle, hole}	=>	{ANKLE_INJ}	0.0057	1	0.0057	19.5	4	0.333	1	0.0054	1	1	1	1	4
{ankle, foot}	=>	{ANKLE_INJ}	0.0142	1	0.0142	19.5	10	0.527	1	0.0135				1	1
{ankle, down}	=>	{ANKLE_INJ}	0.0057	1	0.0057	19.5	4	0.333	1	0.0054				1	1
{ankle, felt}	=>	{ANKLE_INJ}	0.0057	1	0.0057	19.5	4	0.333	1	0.0054				1	1
Back															0
{nerve}	=>	{BACK_INJ}	0.0057	1	0.0057	5.24	4	0.173	1	0.0046					0
{twinge}	=>	{BACK_INJ}	0.0071	1	0.0071	5.24	5	0.193	1	0.0058					0
{buttock}	=>	{BACK_INJ}	0.0071	1	0.0071	5.24	5	0.193	1	0.0058					0
{felt, twinge}	=>	{BACK_INJ}	0.0071	1	0.0071	5.24	5	0.193	1	0.0058	1		1	1	3
{felt, muck}	=>	{BACK_INJ}	0.0057	1	0.0057	5.24	4	0.173	1	0.0046	1	1	1	1	4
{felt, picked}	=>	{BACK_INJ}	0.0057	1	0.0057	5.24	4	0.173	1	0.0046	1	1		1	3
{felt, said}	=>	{BACK_INJ}	0.0057	1	0.0057	5.24	4	0.173	1	0.0046					0
{felt, heat}	=>	{BACK_INJ}	0.0057	1	0.0057	5.24	4	0.173	1	0.0046	1	1		1	3
{bent, felt}	=>	{BACK_INJ}	0.0071	1	0.0071	5.24	5	0.193	1	0.0058	1	1	1	1	4
{box, shovel}	=>	{BACK_INJ}	0.0057	1	0.0057	5.24	4	0.173	1	0.0046	1	1			2
{seat, side}	=>	{BACK_INJ}	0.0057	1	0.0057	5.24	4	0.173	1	0.0046		1			1
{down, seat}	=>	{BACK_INJ}	0.0071	1	0.0071	5.24	5	0.193	1	0.0058	1	1		1	3
{felt, seat}	=>	{BACK_INJ}	0.01	1	0.01	5.24	7	0.229	1	0.0081	1	1		1	3
{big, felt}	=>	{BACK_INJ}	0.0085	1	0.0085	5.24	6	0.212	1	0.0069					0
{box, put}	=>	{BACK_INJ}	0.0057	1	0.0057	5.24	4	0.173	1	0.0046	1			1	2
{bottom, side}	=>	{BACK_INJ}	0.0057	1	0.0057	5.24	4	0.173	1	0.0046					0
{foreman, wanted}	=>	{BACK_INJ}	0.0057	1	0.0057	5.24	4	0.173	1	0.0046			1		1
{down, felt, seat}	=>	{BACK_INJ}	0.0057	1	0.0057	5.24	4	0.173	1	0.0046	1	1			2
{felt, going, side}	=>	{BACK_INJ}	0.0057	1	0.0057	5.24	4	0.173	1	0.0046	1				1
{felt, morning}	=>	{BACK_INJ}	0.01	0.875	0.0114	4.58	7	0.214	0.846	0.0078	1		1		2

{seat}	=>	{BACK_INJ}	0.0157	0.846	0.0185	4.43	11	0.159	0.799	0.0056					0
{blades}	=>	{BACK_INJ}	0.0071	0.833	0.0085	4.37	5	0.264	0.81	0.0121					0
{felt, like}	=>	{BACK_INJ}	0.0071	0.833	0.0085	4.37	5	0.202	0.765	0.0093				1	1
{bump}	=>	{BACK_INJ}	0.0057	0.8	0.0071	4.19	4	0.125	0.718	0.0036					0
{intense}	=>	{BACK_INJ}	0.0057	0.8	0.0071	4.19	4	0.155	0.753	0.0043					0
{feel}	=>	{BACK_INJ}	0.0057	0.8	0.0071	4.19	4	0.155	0.753	0.0043					0
{continue}	=>	{BACK_INJ}	0.0057	0.8	0.0071	4.19	4	0.155	0.753	0.0043					0
{blades, felt}	=>	{BACK_INJ}	0.0057	0.8	0.0071	4.19	4	0.177	0.718	0.0073			1		1
{felt, moving}	=>	{BACK_INJ}	0.0057	0.8	0.0071	4.19	4	0.155	0.753	0.0043					0
{down, ice}	=>	{BACK_INJ}	0.0057	0.8	0.0071	4.19	4	0.155	0.753	0.0043	1	1	1	1	4
Eye															0
{splash}	=>	{EYE_INJ}	0.0085	1	0.0085	5.16	6	0.21	1	0.0069					0
{projection}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046					0
{rinsed}	=>	{EYE_INJ}	0.0085	1	0.0085	5.16	6	0.21	1	0.0069					0
{ended}	=>	{EYE_INJ}	0.0071	1	0.0071	5.16	5	0.192	1	0.0057					0
{debris}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046					0
{sprayed}	=>	{EYE_INJ}	0.01	1	0.01	5.16	7	0.227	1	0.008					0
{eyewash}	=>	{EYE_INJ}	0.0085	1	0.0085	5.16	6	0.21	1	0.0069					0
{eyes}	=>	{EYE_INJ}	0.0171	1	0.0171	5.16	12	0.297	1	0.0138					0
{received, rinsed}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046		1	1	1	3
{face, sprayed}	=>	{EYE_INJ}	0.0071	1	0.0071	5.16	5	0.192	1	0.0057	1	1	1	1	4
{eyewash, received}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046		1	1	1	3
{body, foreign}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046	1		1		2
{body, received}	=>	{EYE_INJ}	0.0071	1	0.0071	5.16	5	0.192	1	0.0057					0
{burn, corner}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046		1	1		2
{cement, received}	=>	{EYE_INJ}	0.0071	1	0.0071	5.16	5	0.192	1	0.0057	1	1	1	1	4
{foreign, glasses}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046			1		1
{foreign, received}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046					0
{face, valve}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046	1	1	1		3
{eyes, glasses}	=>	{EYE_INJ}	0.0071	1	0.0071	5.16	5	0.192	1	0.0057			1	1	2
{eyes, face}	=>	{EYE_INJ}	0.0085	1	0.0085	5.16	6	0.21	1	0.0069					0

{entered, hole}	=>	{EYE_INJ}	0.0071	1	0.0071	5.16	5	0.192	1	0.0057	1	1	1		3
{entered, felt}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046					0
{glasses, safety}	=>	{EYE_INJ}	0.0157	1	0.0157	5.16	11	0.284	1	0.0126			1	1	2
{received, safety}	=>	{EYE_INJ}	0.0085	1	0.0085	5.16	6	0.21	1	0.0069					0
{face, safety}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046					0
{face, pressure}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046	1	1	1	1	4
{face, top}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046					0
{dust, glasses}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046	1	1	1	1	4
{dust, received}	=>	{EYE_INJ}	0.01	1	0.01	5.16	7	0.227	1	0.008	1	1		1	3
{dust, felt}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046	1	1	1		3
{foreman, something}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046					0
{air, received}	=>	{EYE_INJ}	0.0071	1	0.0071	5.16	5	0.192	1	0.0057		1		1	2
{air, face}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046		1	1	1	3
{see, something}	=>	{EYE_INJ}	0.0071	1	0.0071	5.16	5	0.192	1	0.0057					0
{glasses, something}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046					0
{hose, received}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046	1	1	1	1	4
{glasses, wearing}	=>	{EYE_INJ}	0.0157	1	0.0157	5.16	11	0.284	1	0.0126		1	1	1	3
{received, wearing}	=>	{EYE_INJ}	0.0114	1	0.0114	5.16	8	0.243	1	0.0092					0
{received, water}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046		1		1	2
{glasses, received}	=>	{EYE_INJ}	0.0185	1	0.0185	5.16	13	0.309	1	0.0149					0
{face, glasses}	=>	{EYE_INJ}	0.0142	1	0.0142	5.16	10	0.271	1	0.0115					0
{came, glasses}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046					0
{glasses, wanted}	=>	{EYE_INJ}	0.0085	1	0.0085	5.16	6	0.21	1	0.0069					0
{felt, glasses}	=>	{EYE_INJ}	0.0071	1	0.0071	5.16	5	0.192	1	0.0057			1		1
{body, foreign, received}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046			1	1	2
{entered, felt, hole}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046	1	1			2
{glasses, safety, wearing}	=>	{EYE_INJ}	0.0085	1	0.0085	5.16	6	0.21	1	0.0069		1	1	1	3
{received, safety, wearing}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046		1	1	1	3

{glasses, received, safety }	=>	{EYE_INJ}	0.0085	1	0.0085	5.16	6	0.21	1	0.0069			1	1	2
{face, glasses, safety}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046			1	1	2
{felt, foreman, something }	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046					0
{glasses, received, wearing}	=>	{EYE_INJ}	0.0085	1	0.0085	5.16	6	0.21	1	0.0069		1	1	1	3
{face, glasses, received}	=>	{EYE_INJ}	0.0071	1	0.0071	5.16	5	0.192	1	0.0057			1	1	2
{glasses, received, safety , wearing}	=>	{EYE_INJ}	0.0057	1	0.0057	5.16	4	0.171	1	0.0046		1	1	1	3
{glasses}	=>	{EYE_INJ}	0.047	0.943	0.0499	4.87	33	0.478	0.929	0.0373					0
{dust}	=>	{EYE_INJ}	0.0328	0.92	0.0356	4.75	23	0.394	0.901	0.0259					0
{face, received}	=>	{EYE_INJ}	0.0142	0.909	0.0157	4.69	10	0.259	0.887	0.0112					0
{foreign}	=>	{EYE_INJ}	0.0114	0.889	0.0128	4.59	8	0.229	0.862	0.0089					0
{particle}	=>	{EYE_INJ}	0.01	0.875	0.0114	4.52	7	0.212	0.845	0.0078					0
{safety, wearing}	=>	{EYE_INJ}	0.0085	0.857	0.01	4.42	6	0.159	0.799	0.0056		1			1
{received}	=>	{EYE_INJ}	0.0556	0.813	0.0684	4.19	39	0.228	0.736	0.0119					0
Finger															0
{punch}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004					0
{strap}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004					0
{guardrail}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004					0
{smashed}	=>	{FINGER_INJ}	0.0128	1	0.0128	3.44	9	0.21	1	0.0091					0
{index}	=>	{FINGER_INJ}	0.0271	1	0.0271	3.44	19	0.305	1	0.0192					0
{hit, punch}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004	1		1	1	3
{guardrail, stuck}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004	1	1		1	3
{scissor, stuck}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004	1	1		1	3
{frame, tractor}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004	1	1		1	3
{jack, stuck}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004	1	1	1	1	4
{bit, gloves}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004		1	1		2
{gloves, index}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004		1	1	1	3
{index, stuck}	=>	{FINGER_INJ}	0.0071	1	0.0071	3.44	5	0.157	1	0.0051	1		1	1	3

{platform, stuck}	=>	{FINGER_INJ}	0.0071	1	0.0071	3.44	5	0.157	1	0.0051		1		1	2
{hold, stuck}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004					0
{head, stuck}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004			1	1	2
{gloves, pipe}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004	1	1	1	1	4
{drill, stuck}	=>	{FINGER_INJ}	0.0071	1	0.0071	3.44	5	0.157	1	0.0051	1	1	1	1	4
{metal, took}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004					0
{get, thumb}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004					0
{came, thumb}	=>	{FINGER_INJ}	0.0071	1	0.0071	3.44	5	0.157	1	0.0051					0
{thumb, wanted}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004					0
{stuck, thumb}	=>	{FINGER_INJ}	0.0085	1	0.0085	3.44	6	0.171	1	0.0061			1	1	2
{hit, thumb}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004			1	1	2
{put, thumb}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004			1		1
{thumb, went}	=>	{FINGER_INJ}	0.01	1	0.01	3.44	7	0.185	1	0.0071					0
{stuck, wanted}	=>	{FINGER_INJ}	0.0071	1	0.0071	3.44	5	0.157	1	0.0051					0
{down, stuck, went}	=>	{FINGER_INJ}	0.0057	1	0.0057	3.44	4	0.14	1	0.004			1		1
{thumb}	=>	{FINGER_INJ}	0.0399	0.966	0.0413	3.32	28	0.364	0.951	0.0279					0
{gloves, wearing}	=>	{FINGER_INJ}	0.0185	0.929	0.0199	3.2	13	0.243	0.899	0.0127	1	1	1		3
{ring}	=>	{FINGER_INJ}	0.0142	0.909	0.0157	3.13	10	0.211	0.872	0.0097					0
{little, stuck}	=>	{FINGER_INJ}	0.01	0.875	0.0114	3.01	7	0.173	0.824	0.0067			1		1
{gloves, stuck}	=>	{FINGER_INJ}	0.01	0.875	0.0114	3.01	7	0.173	0.824	0.0067		1	1		2
{placing}	=>	{FINGER_INJ}	0.0085	0.857	0.01	2.95	6	0.159	0.799	0.0056					0
{stuck, took}	=>	{FINGER_INJ}	0.0085	0.857	0.01	2.95	6	0.194	0.823	0.0066				1	1
{stopper}	=>	{FINGER_INJ}	0.0071	0.833	0.0085	2.87	5	0.176	0.794	0.0055					0
{push}	=>	{FINGER_INJ}	0.0071	0.833	0.0085	2.87	5	0.143	0.765	0.0046					0
{fingers}	=>	{FINGER_INJ}	0.0142	0.833	0.0171	2.87	10	0.143	0.765	0.0046					0
{chisel, stuck}	=>	{FINGER_INJ}	0.0071	0.833	0.0085	2.87	5	0.176	0.794	0.0055	1	1	1	1	4
{gloves, went}	=>	{FINGER_INJ}	0.0071	0.833	0.0085	2.87	5	0.143	0.765	0.0046		1			1
{down, stuck}	=>	{FINGER_INJ}	0.0071	0.833	0.0085	2.87	5	0.143	0.765	0.0046					0
{pinched}	=>	{FINGER_INJ}	0.0185	0.813	0.0228	2.8	13	0.143	0.765	0.0046					0
{handling}	=>	{FINGER_INJ}	0.0057	0.8	0.0071	2.75	4	0.483	0.767	0.0423					0
{chute}	=>	{FINGER_INJ}	0.0057	0.8	0.0071	2.75	4	0.125	0.718	0.0036					0
{frame}	=>	{FINGER_INJ}	0.0114	0.8	0.0142	2.75	8	0.155	0.753	0.0043					0

{wire}	=>	{FINGER_INJ}	0.0114	0.8	0.0142	2.75	8	0.177	0.718	0.0073				0
Hand														0
{palm}	=>	{HAND_INJ}	0.01	1	0.01	14.3	7	0.378	1	0.0093				0
Shoulder														0
{arm, around}	=>	{SHOULDER_	0.0057	1	0.0057	11.7	4	0.258	1	0.0052	1	1		2
Wrist														0
{hit, wrist}	=>	{WRIST_INJ}	0.0071	1	0.0071	27	5	0.439	1	0.0069			1	1	2
{felt, wrist}	=>	{WRIST_INJ}	0.0085	1	0.0085	27	6	0.48	1	0.0082			1	1	2
{wrist}	=>	{WRIST_INJ}	0.0328	0.885	0.037	23.9	23	0.885	0.88	0.0314					0