Identifying Prevention Methods to Reduce CTS Incidents: Based on Analysis of Employee Perception and by Utilizing the Strain Index

Gabriel C. Smith, Mandara D. Savage
Southern Illinois University Carbondale
smithgabrielc@johndeere.com

Abstract

Carpal tunnel syndrome (CTS) incidents occur predominantly among manufacturing assembly operations in the United States. The purpose of this study was to establish a methodology to reduce CTS incidents by utilizing the strain index (SI) to assess hazardous operations that contribute to CTS; identify methods to reduce CTS incidents at the hazardous operations with the help of upper management; and seek employee feedback on how successful the identified methods to reduce CTS will be over time. Forty-three employees exposed to hazardous operations were surveyed to determine if the proposed prevention methods would be successful over time. The survey results were analyzed by the chi-square goodness-of-fit test, and the employees significantly agreed that all of the proposed prevention methods would lead to fewer CTS incidents over time, which was verified by the level of significance shown by the chi-square goodness-of-fit test.

Introduction

Work-related carpal tunnel syndrome (CTS) incidents occur predominantly among manufacturing assembly operators in the United States [1]. Occupational risk factors associated with CTS are repetition, force, awkward posture, and vibration [2, 3, 4, 5, 6]. Researchers recently developed the strain index (SI) to identify hazardous operations that contribute to work-related CTS [7]. The SI has been validated in numerous studies as a state-of-the-art risk assessment tool for analyzing CTS risk [7, 8, 9, 10, 11]. However, few studies have focused on using a risk assessment similar to the SI as a mechanism to establish and monitor the effects of CTS prevention methods over time. Therefore, the purpose of this study was to establish a methodology to reduce CTS incidents by using the SI to identify operations that have high CTS risk, to identify prevention methods to reduce CTS risk at the hazardous operations, and to seek employee feedback on how successful the identified CTS prevention methods will be over time.

Methods

The methods for this study consisted of the following:

1. Analyze assembly operations for CTS risk with the SI.
2. Obtain SI rating values for each observed operation.
3. Define operations that have high risk for CTS.

4. Inform upper management about the identified hazardous CTS operations and ways to prevent CTS.
5. Identify prevention methods to reduce CTS at the hazardous operations.
6. Seek employee feedback on the proposed prevention methods.

Manufacturing assembly operations were analyzed in a compact disk manufacturing facility. The operations analyzed were from the manual packaging line, manual bulk packaging line, and hand boxing station. A video recorder was used to record employees' hand and wrist movements while conducting an operation. Each task was videotaped for approximately 10 cycles to allow SI evaluation.

The SI rating values for intensity of exertion (IEM), duration of task per day (DDM), efforts per minute (EMM), duration of exertion (DEM), speed of work (SWM), and hand/wrist posture (HWM) were obtained using the SI procedures established by the authors [7]. After each SI rating value was obtained for each parameter, the next step consisted of obtaining the SI score. The SI score was found by taking the product of all the SI rating values.

Once the manufacturing assembly operations were assessed with the SI, the next step consisted of classifying operations for the level of risk for developing CTS. For this step, an operation was considered hazardous for CTS risk if it had a SI score of five or greater. If an operation had an SI score of less than five, the operation was considered safe. This rule for differentiating between hazardous and safe operations for CTS risk was consistent with previous research studies on the SI [7, 8, 9].

After the SI was used to classify safe and hazardous operations for CTS risk, the next step consisted of meeting with upper management to discuss hazardous CTS risk operations and ways to prevent CTS. This step involved informing upper management about how the SI works, operations identified with high CTS risk by the SI, and administrative and engineering controls commonly used to prevent CTS.

After upper management was informed of operations with high CTS risk and common CTS prevention methods, the next step consisted of proposing prevention methods to reduce CTS incidents at the hazardous operations. The prevention methods to reduce CTS were determined by upper management reviewing the hazardous CTS operations and discussing feasible prevention methods.

Since CTS is a cumulative trauma disorder that may take months or years to develop in the hand, it is difficult to determine how successful CTS prevention measures will be over time. However, it was possible to ask employees exposed to hazardous CTS operations if the proposed prevention methods identified by upper management would lead to less CTS incidents in the future. This step surveyed the employees' affected by the hazardous operations and asked their opinion on whether the proposed methods to reduce CTS would lead to fewer cases of CTS in the future. The chi-square goodness-of-fit test was used to determine if employees significantly agreed that a proposed prevention method would lead to fewer CTS incidents in the future.

Results

Twenty-four employees from two different shifts voluntarily participated in the videotaping to analyze 27 operations for CTS risk. Twelve operations were analyzed from the manual packaging line, 11 operations from the manual bulk packaging line, and four operations were from the hand boxing area. Tables 1–3 contain SI results obtained from each area where the 27 operations were investigated. By using the SI criteria, a total of 19 operations were identified as hazardous for developing CTS, while eight operations were considered safe.

Table 1. SI Results from the Manual Packaging Line

Operation #	Task Name	IEM	DDM	EMM	DEM	SWM	HWM	SI Score
1	Case disassembly	3	1	3	3	1	1.5	40.5
2	Inlay folding	3	1	1	2	1	1.5	9.00
3	Insert inlay	1	1	3	2	1	1.5	9.00
4	Sleeving	3	1	2	1	1.5	1	9.00
5	Traying	3	1	1.5	1.5	1	1.5	10.13
6	Disking	1	1	3	3	1	1.5	13.50
7	Booking	3	1	1.5	2	1	1	9.00
8	CD placing	3	1	3	2	1	1	18.00
9	CD packaging	3	1	1	1	1	1.5	4.50
10	Box assembly	3	1	0.5	1.5	1	2	4.50
11	Close CD case and align	3	1	3	2	1	1.5	27.00
12	Case alignment	3	1	3	2	1	1.5	27.00

Table 2. SI Results from the Manual Bulk Packaging Line

Task #	Task Name	IEM	DDM	EMM	DEM	SWM	HWM	SI Score
13	Place plastic lid on spindle	1	1.5	1.5	1	1	1	2.25
14	Transport empty spindles	9	1.5	1	1	1	1	13.50
15	Pick up bulk CDs from spindle and place in box	13	1.5	1.5	1	1	2	58.50
16	Fold down box lid	3	1.5	1	1	1	2	9.00
17	Push full box of CDs onto rollers	6	1.5	1	1	1	3	27.00
18	Stack full box of CDs onto pallet	3	1.5	1	1	1	1.5	6.75

19	Transport CDs on spindle from shelf to counter	3	1.5	1	0.5	1	1	2.25
20	Transport CDs from spindle to counter	3	1.5	1	1	1	1.5	6.75
21	Transport CDs from counter to larger spindle	3	1.5	1	1	1	1.5	6.75
22	Transport CDs on larger spindle to conveyor	3	1.5	1	0.5	1	1.5	3.38
23	Bulk CD sleeving	1	1.5	0.5	1	1	1	0.75

Table 3. SI Results from the Hand Boxing Area

Task #	Task Name	IEM	DDM	EMM	DEM	SWM	HWM	SI Score
24	Assemble box on table	3	1.5	1	1	1	1.5	6.75
25	Place 20 cased CDs in box	3	1.5	1	1	1	2	9.00
26	Fold down box	3	1.5	0.5	0.5	1	1.5	1.69
27	Push box forward	3	1.5	0.5	0.5	1	1.5	1.69

After discussing the CTS hazardous operations and methods to prevent CTS within their company, members of upper management proposed the following ideas to reduce CTS incidents at the hazardous operations:

1. Have workers conduct frequent exercises of the hand and wrist.
2. Allow workers to conduct more tasks that would allow variation in hand and wrist movements.
3. Rotate workers between jobs every one to two hours.
4. Redesign the workstation to prohibit hazardous operations.
5. Allow workers to alternate hands when conducting a task.
6. Train employees about proper ergonomic procedures.
7. Provide assisted lifting devices to employees.

Once the proposed prevention methods to reduce CTS were established, a survey instrument was developed to seek employee input on how successful upper management's CTS prevention methods will be over time. The following questions were developed from upper management's feedback to survey employee perception:

1. Which area(s) do you work within the plant (for example, manual packaging line, bulk packaging line, hand boxing area, other)?
2. Do you believe frequent exercising of the hand and wrist will lead to less incidents of carpal tunnel syndrome? (Yes/No)
3. Do you believe that splitting tasks among workers will lead to less carpal tunnel syndrome incidents (for example, one worker will do three tasks instead of one task)? (Yes/No)
4. If workers are rotated between jobs every one to two hours, with each rotation requiring different muscular contractions, will carpal tunnel syndrome incidents decrease? (Yes/No)
5. Do you think that a better designed workstation would result in less carpal tunnel syndrome incidents? (Yes/No)
6. Would alternating hands (for example, switching from the left to the right hand) while performing a task reduce carpal tunnel syndrome incidents? (Yes/No)
7. Would training employees about using ergonomics lead to less incidents of carpal tunnel syndrome? (Yes/No)
8. Do you believe that assisted lifting devices could be used to reduce carpal tunnel syndrome cases? (Yes/No)

Approximately 43 out of a possible 85 employees voluntarily filled out the survey. A chi-square goodness-of-fit test was used to determine if employees significantly agreed/disagreed that a proposed prevention method would lead to fewer CTS incidents. Each survey question had one degree of freedom and was analyzed at a 95 percent significance level (alpha = 0.05). Employees who participated in the survey served in some capacity at the hazardous operations that were classified by the SI (as identified in question 1 of the survey).

Table 4 contains a descriptive analysis of the number of “yes/no” responses obtained from collecting data on each question of the 43 respondents and illustrates the results for each question from the chi-square goodness-of-fit test. For question two, 42 out of 43 subjects responded. The results showed that employees significantly agree that frequent exercises of the hand and wrist would reduce the frequency of CTS incidents over time (chi-square = 13.714). Question three had 42 out of 43 subjects respond, with the results showing that employees significantly agreed that task variety could help reduce the frequency of CTS cases (chi-square = 7.714). For question four, all 43 respondents answered the question, and employees significantly agreed that rotating jobs every one to two hours could reduce CTS incidents (chi-square = 22.349). Question five had 38 out of 43 subjects respond, which may have indicated that the question was unclear. However, employees significantly agreed that a better designed workstation could lead to less CTS cases in the future (chi-square = 10.526). All 43 subjects replied to question six, and employees significantly agreed that alternating hands while conducting a task could reduce future cases of CTS (chi-square = 3.930). Question seven had 42 out of 43 subjects respond, with the results showing that employees believed that ergonomics training could lead to fewer incidents of CTS over time (chi-square = 21.429). Question eight had 42 out of 43 subjects respond, and employees significantly agreed that assisted lifting devices could reduce future CTS cases at their workstations (chi-square = 16.095).

Table 4. Chi-square Goodness-of-fit Test Result for Each Survey Question

Q	N	Expected Frequency	Observed "Yes" Responses	Observed "No" Responses	Chi-square	P-value
2	42	21	33	9	13.714	0.000
3	42	21	30	12	7.714	0.005
4	43	21.5	37	6	22.349	0.000
5	38	19	29	8	10.526	0.001
6	43	21.5	28	15	3.930	0.047
7	42	21	36	6	21.429	0.000
8	42	21	34	8	16.095	0.000

Where:
Q = Question number
N = Number of respondents

Conclusion

A prevention methodology was developed to reduce CTS incidents at hazardous manufacturing assembly operations. This method was conducted by using the SI to assess manufacturing assembly operations, proposing CTS prevention methods with the help of upper management, and analyzing employee perception on how successful the proposed CTS prevention methods will be over time. The results of the survey showed that according to employee perception, all of the proposed CTS prevention methods identified by upper management will lead to fewer CTS cases over time.

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Biography

Gabriel Smith is currently a Quality Engineer at John Deere. He graduated with a Masters of Science in Manufacturing Systems from Southern Illinois University Carbondale in 2007. He is certified by the National Association of Industrial Technology as a Certified Industrial Technologist and by the American Society for Quality as a Certified Quality Process Analyst.

Mandara Savage is currently a Professor and Chair of the Department of Technology at Southern Illinois University Carbondale. His research interests include machine tool dynamics, manufacturing systems and processes, and Lean manufacturing systems design. His additional research interests include occupational safety and health, as well as musculoskeletal disorders. He serves as the National Safety Division President for the National Association of Industrial Technology.