Use and Effectiveness of Ethyl Chloride for Hand Injections

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Purpose Limited literature supports using ethyl chloride topical spray as an anesthetic for hand injections whereas documented risks include frostbite, skin irritation, and inhalation toxicity. We hypothesize that ethyl chloride spray imparts no benefit to patients' perception of pain or anxiety for routine hand injections.

Methods We first surveyed all members of the American Society for Surgery of the Hand to discern the prevalence of ethyl chloride use during routine injections. We then performed a prospective, randomized, study at 2 institutions evaluating the efficacy of ethyl chloride spray compared with "routine injection" (no topical spray) in patients indicated for a hand injection. All patients completed a pre- and postinjection 11-point questionnaire that inquired about various components of pain and anxiety.

Results A total of 2,083 (73% response rate) American Society for Surgery of the Hand members responded to the survey and revealed that 59% of hand surgeons always or often use ethyl chloride, and 24% never use it. There were no differences for region or practice setting, but experienced surgeons were less likely to routinely use ethyl chloride (35%) compared with younger surgeons (66%). Among 151 patients participating in the clinical study (75 with ethyl chloride), there were no differences for any outcome measure assessed. Injection pain in the spray and no-spray groups, pain after 1 minute, and overall anxiety were equivalent. Subgroup analysis demonstrated no effect of sex, anticipated anxiety, or pain threshold.

Conclusions Ethyl chloride is widely used among hand surgeons but imparts no benefit for routine hand injections in the clinical setting. The potential risks and costs of ethyl chloride use may outweigh its benefits. *(J Hand Surg Am. 2017;42(3):175–181. Copyright © 2017 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Therapeutic II.

Key words Ethyl chloride, vapocoolant, injections, trigger finger, carpal tunnel.

Additional Material at jhandsurg.org

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Received for publication June 9, 2016; accepted in revised form December 31, 2016.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

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0363-5023/17/4203-0004$36.00/0
http://dx.doi.org/10.1016/j.jhsa.2016.12.013

THE USE OF TOPICAL, VAPOCOOLANT analgesia prior to routine hand injections is a common practice owing to a perceived reduction in pain and anxiety in the patient. However, limited evidence exists to support the use of a common vapocoolant spray for intravenous catheter placement[1–4] and intradermal injections,[5,6] and no studies have evaluated its efficacy for use in routine musculoskeletal injections. Nevertheless, we have recognized the

widespread use and perception that vapocoolant spray is preferred by patients and providers alike when administering corticosteroid injections in the hand. Based on our personal experience both using and not using this spray prior to injections, we questioned its efficacy.

Despite ubiquitous use, vapocoolant spray has limited literature support that has never been specifically examined for routine hand injections. In addition, its use may have associated risks. One study found that ethyl chloride is not superior to ice prior to intradermal injections,[5] whereas other studies have reported a moderate effect, greater than controls but less than lidocaine.[1] Importantly, most prior studies have focused on pediatric patients prior to intravenous cannulation, but none have addressed musculoskeletal injections in adults. In addition, although rare, side effects of its use and misuse include frostbite, contact dermatitis, inhalation intoxication, and death.[7–9] Some authors have also identified potential skin sterility concerns when using a spray solution prior to injection.[10]

Based on our personal observations and conflicting findings in the literature, we conducted a 2-part study to address the following question: What is the current use and effectiveness of ethyl chloride spray for routine hand injections? To address this question, our study included a national e-mail–based survey of hand surgeons in the United States regarding ethyl chloride use and a prospective, randomized, study examining patient perception of pain and anxiety before and after routine hand injections with and without the use of ethyl chloride spray.

METHODOLOGY

This study was performed after obtaining institutional review board approval. The study was divided into 2 parts: a national e-mail–based survey and a prospective clinical study.

E-Mail survey

An e-mail–based survey was performed to evaluate the use of ethyl chloride spray prior to routine hand injections among hand surgeons in the United States. Contact information for hand surgeons was obtained through membership records of the American Society for Surgery of the Hand (ASSH). All members were then sent an identical e-mail asking a single question with 5 answer choices. The question and answers were as follows: "In your hand practice, how often do you use Ethyl Chloride spray for analgesic effects immediately before a steroid injection (trigger finger, DeQuervain, carpal tunnel, joint injections)?" with responses as follows: Always (> 90%), Often (67%–90%), Sometimes (33%–66%), Rarely (10%–32%), Never (< 10%).

Responses were collected over a 2-week period with interval reminder e-mails sent to non-respondents. Once all survey responses were collected, we analyzed the distribution of responses as it related to years of ASSH membership (by decade), region of practice in the United States (U.S. Census defined: West, Midwest, South, Northeast), type of practice (academic or private with or without university affiliation), and specialty (orthopedic, plastic, or general surgery) as denoted in their ASSH membership records.

Clinical study

A prospective, randomized, study was performed to evaluate pain perception and anxiety experienced by patients before and after routine hand injections either with or without the use of ethyl chloride. Patients were invited to participate in the study only after meeting the indications for 1 of the following hand injections during a routine clinical evaluation: trigger finger, first dorsal compartment (DeQuervain tenosynovitis), carpal tunnel syndrome, and first carpometacarpal joint osteoarthritis. Exclusion criteria included patients who specifically requested ethyl chloride prior to an injection or could not complete an English survey. Informed consent was performed in all cases, and patients were then randomized to either receive or not receive ethyl chloride spray prior to their planned injection based on the calendar month (eg, no-spray in January, spray in February).

Procedure: The procedure was performed similarly for all patients at the 2 separate health care institutions participating in the study. Patients were positioned for comfort as per the attending surgeon's usual routine. The skin was aseptically prepared with alcohol swabs prior to injection. For patients randomized to receive a vapocoolant spray, the injection area was then bathed in ethyl chloride spray (Gebauer's Company, Cleveland, OH) for approximately 7 to 10 seconds, followed immediately by the injection. All injections were performed with a 27-gauge needle and the injection technique between the spray and the no-spray groups was consistent based on the surgeon's practice. In all cases, the injected substance was a 1:1 combination of 1% plain lidocaine and 4 mg/mL dexamethasone. Injection volumes were as follows: 1 mL for trigger finger, 2 mL for DeQuervain tenosynovitis, 2 mL for carpal

TABLE 1. E-Mail Survey Responses Among Hand Society Members

Characteristics (n)	Frequency of Ethyl Chloride Use				
	Never (< 10%)	Rarely (10%–32%)	Sometimes (33%–66%)	Often (67%–90%)	Always (> 90%)
All respondents (2,083)	501	230	133	198	1,021
Decade of practice					
1 (1,126)	201	112	67	115	631
2 (460)	128	52	30	35	215
3 (352)	121	50	21	27	133
4 (123)	43	12	12	18	38
5 (22)	8	4	3	3	4
Region					
Midwest (660)	176	76	32	60	316
Northeast (314)	89	34	24	35	132
South (439)	88	50	28	39	234
West (651)	138	69	48	62	334
Practice type					
Academic, full time (322)	93	30	14	33	152
Other (292)	77	37	14	32	132
Private, nonuniversity (589)	127	74	38	46	304
Private, university (241)	61	28	11	20	121
Specialty					
General surgery (91)	27	10	5	8	41
Orthopedic surgery (1678)	355	188	110	154	871
Plastic surgery (264)	110	24	16	30	84

tunnel injections, and 1 mL for thumb basilar joint injections.

Outcomes: Prior to the injection, and after consenting to enrolling in the study, patients completed a 4-item questionnaire asking the following questions utilizing an 11-point Likert scale from "none" to "extreme" for the first 3 questions: (1) How painful do you think it will be?, (2) How painful will it be 1 minute after the injection?, (3) How nervous are you about the injection?, (4) Have you had a hand injection before? …and if so, was ethyl chloride (freeze spray) used? (Appendix A; available on the *Journal*'s Web site at www.jhandsurg.org).

One minute following the injection, patients were then asked to complete a similar 4-item questionnaire asking to report from 1 to 10 on: (1) actual pain of the needle, (2) actual pain of the medication, (3) actual pain 1 minute after the injection, (4) overall anxiety related to the procedure (Appendix A; available on the *Journal*'s Web site at www.jhandsurg.org).

Statistics: The e-mail survey responses are reported as descriptive statistics with Goodman and Kruskal's test used as a nonparametric measure of strength and direction of association that exists between variables on an ordinal square. All analyses were performed on raw numbers. Prior to initiating the clinical study, a sample size estimate was performed to determine the number of patients required for enrollment. Based on means and SD derived from a pilot study at our institution, we calculated that 150 participants (75 in each group) would need to be enrolled to have adequate power to make comparisons between spray and no-spray groups. This was based on a clinical relevance constituted by a 2-point difference on the response scale for postinjection pain. There is no established minimal clinically important difference for this Likert scale; however, the minimal clinically important difference has been defined by Jaeschke et al as "The smallest difference in score in the domain of interest which *patients* perceive as beneficial and which would mandate, in the absence of troublesome side effects and excessive cost, a change in the patient's *management*."[11] We asked this question to our hand practice of 9 surgeons and determined that 2 points would meet this criterion by

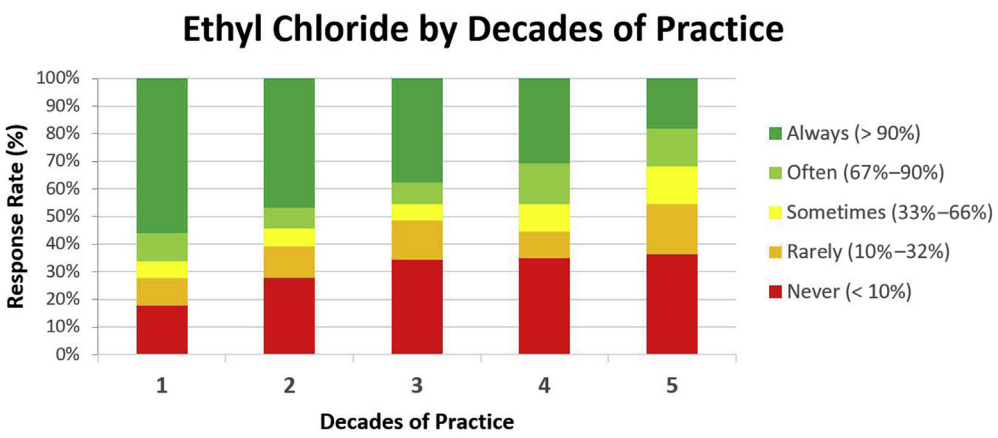

FIGURE 1: Ethyl chloride use among hand surgeons based on years in practice (separated by decade).

consensus. At the conclusion of the study, a power analysis was performed to compute minimum sample size. Minimum sample size required in order to detect a mean difference between 2 independent groups with 90% power and a medium effect size is 140 (70 per group). Minimum sample size for a paired *t* test is 47. The Spearman rank-order correlation coefficient was calculated to measure an association between preinjection pain and postinjection needle pain. The Mann-Whitney U test was used to determine differences between the 2 groups based on preinjection pain, postinjection pain, postinjection pain after 1 minute, and preinjection nervousness. Further analysis was performed to evaluate differences by sex, high-anxiety, or high-pain anticipation groups based on preinjection responses (Appendix A, Questions 1 and 2; available on the *Journal*'s Web site at www.jhandsurg.org) after calculating a sample size for ordinal logistic regression was computed at 150 subjects. Based on the 16 comparisons made, a Bonferroni correction resulted in an alpha level of 0.003.

RESULTS

E-Mail Survey

The e-mail survey was sent to 2,868 members of the ASSH, and 2,083 responses were received (73% response rate). The cumulative results for all respondents revealed that 49% "Always" use ethyl chloride and 24% "Never" use ethyl chloride (Table 1). The nonparametric test (Goodman and Kruskal's test) for association failed to identify any correlation with region or practice type (Table 1). However, we found a significant relationship between decreasing use of ethyl chloride and increasing decades of practice ($P < .05$; Fig. 1). In addition, there was a decreasing frequency of ethyl chloride use among orthopedic, general, and plastic surgeons, respectively ($P < .05$; Fig. 2).

Clinical study

The clinical study enrolled 151 patients, 75 in the "spray" group. The demographic information for participants and injections is shown in Table 2. The Pearson test demonstrated that postinjection pain of the needle and pain of the medication were highly correlated ($R = 0.73$) and thus a mean of the values were used to represent injection pain. Likert responses for the no-spray and spray groups were similar for injection (3.08 vs 3.10), pain 1 minute after injection (1.22 vs 1.52), and anxiety (2.46 vs 2.70).

Our analysis of change in anticipated versus actual pain and anxiety revealed no differences within the whole sample (Table 3). We further tested the hypothesis (using ordinal logistic regression) that pretreatment anticipated pain could predict an effect of ethyl chloride or that ethyl chloride would have a different effect based on sex or baseline anxiety. We identified a significant difference in postinjection pain among females and a significant reduction in postinjection pain in the preinjection high-pain anticipation group (Table 3). No other comparisons for pre- and postinjection variables, nor subgroup analyses for sex, anxiety, and pain, demonstrated significant differences between no-spray and spray groups. We could not identify any subgroup in which ethyl chloride was associated with a statistically significant improvement in anxiety or pain perception.

DISCUSSION

This study demonstrates that, despite limited clinical evidence supporting its use throughout the body and no evidence specifically supporting its use for hand

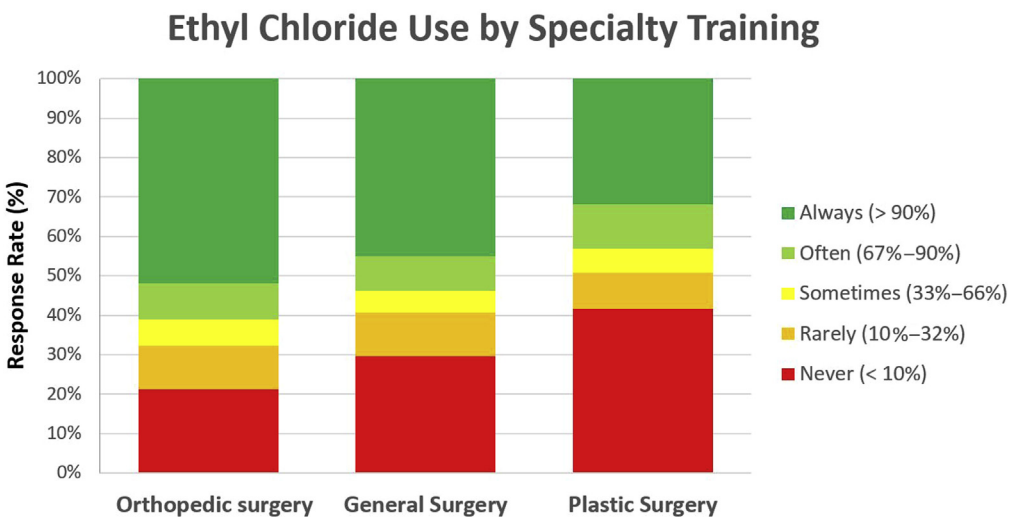

FIGURE 2: Ethyl chloride use among hand surgeons based on training specialty.

TABLE 2. Demographics of Participants

Ethyl chloride?	No	Yes
Total participants	76	75
Age (mean, y)	60.1	60.3
Sex		
Female	53	48
Male	21	25
Hand dominance		
Right	57	63
Left	12	5
Injection side		
Right	39	46
Left	26	28
Injection site		
Trigger finger	24	33
Thumb carpometacarpal	28	16
Carpal tunnel	14	10
DeQuervain	7	12
Other	3	4
Prior injection		
No	39	42
Yes	37	32
Prior ethyl chloride	19	23

injections, nearly 50% of U.S. hand surgeons always use ethyl chloride spray prior to routine injections, and over 75% use it some of the time. There were no identifiable variations in use based on practice type or region; however, there appeared to be a decreased use with greater surgeon experience and a difference among orthopedic, general, and plastic surgeons. The results of our clinical study suggest that the use of ethyl chloride imparts no benefit to the patient's perception of pain or anxiety and has the equivalent effect of no spray. The only significant finding was that ethyl chloride spray potentially increases pain perception in high-pain anticipators compared with no spray, implying a detrimental overall effect of its use. Based on these results, we believe that the widespread use of ethyl chloride for routine hand injections should be reconsidered.

Ethyl chloride was first shown to be effective for cutaneous anesthesia in 1955.[12] Since then, other studies have evaluated and validated its use for pre-injection anesthesia and minor procedures, sports injuries, or myofascial pain.[13,14] The strongest evidence supporting its use was published by Armstrong et al in 1990.[1] This study was designed to compare the effect of ethyl chloride and intradermal lidocaine prior to intravenous cannulation with a 20-gauge cannula. The study was performed with 120 female patients undergoing minor gynecological outpatient surgery and patients were randomized to receive no treatment, 0.2 mL of plain lidocaine, or ethyl chloride prior to cannulation. The authors demonstrated that cannulation pain was 3.8, 1.8, and 0.7, respectively, on a 10-point scale. These results suggested that ethyl chloride was less potent than lidocaine but still more effective than no treatment. This study was limited by a lack of blinding, and the authors acknowledged that some of the results may have been influenced by patient and observer bias. The results of our study contrast those described previously for intravenous cannulation. One explanation for these differences could be that injections that penetrate beyond subcutaneous tissue, such as those in our study, are less

TABLE 3. Mean Likert Scale Responses for All Patients and Subgroup Analysis*

Outcome Measure	Pain			Δ Pain			Anxiety			Δ Anxiety		
Ethyl chloride use	No	Yes	*P*	No	Yes	*P*	No	Yes	*P*	No	Yes	*P*
Tested condition (n)												
All patients (151)	3.08	3.10	.96	2.34	2.55	.61	2.46	2.71	.62	1.54	1.04	.21
Sex												
Female (101)	3.51	3.18	.53	1.45	0.94	.30	2.81	3.19	.57	1.98	2.99	.06
Male (46)	2.05	2.82	.17	1.57	1.28	.70	1.43	1.52	.87	2.90	1.74	.09
Anticipated pain												
High (≥ 6) (77)	4.32	3.81	.40	2.29	0.97	.03	3.74	4.13	.61	3.29	4.01	.22
Low (< 6) (74)	1.84	2.33	.22	0.79	1.11	.53	1.18	1.17	.97	1.39	0.97	.31
Procedure anxiety												
High (≥ 3) (81)	4.05	3.88	.76	2.83	1.93	.16	4.25	4.41	.82	2.53	3.05	.38
Low (< 3) (70)	2.00	2.16	.73	0.11	0.03	.45	0.47	0.65	.36	2.14	1.96	.75

Δ Anxiety, preinjection anxiety score minus postinjection anxiety score.
P = .003 after Bonferroni correction.
*Δ Pain, anticipated preinjection pain score minus postinjection pain score (average of needle and medication pain).

likely to be affected by a superficial application of cold spray.

In contrast to evidence supporting its use, many articles refute the therapeutic value of ethyl chloride. In a prospective, blinded study by Ramsook et al,[3] pediatric patients (ages 3−18 years) were randomized to receive a 5-second application of either ethyl chloride or a placebo, isopropyl alcohol, prior to placement of an intravenous cannula with pain assessments performed by a "child life specialist.". The authors demonstrated no significant difference in pain scores between the groups even when stratified by age; furthermore, ethyl chloride spray resulted in more difficulty performing the procedure as ranked on a 4-point scale from "extremely easy" to "impossible."[3] In another study, Costello et al[2] performed a randomized, double-blind, placebo-controlled trial comparing ethyl chloride spray, isopropyl alcohol spray, and no treatment prior to intravenous cannulation in a pediatric emergency department. Mean pain scores were 34, 33, and 31, respectively, with no significant differences between groups; corroborating the findings of other authors that ethyl chloride has no therapeutic effects. A more recent study from 2007 compared ethyl chloride spray versus simple ice cube application to skin prior to placement of an antibiotic skin test.[5] Using a prospective, crossover, randomized design in adult volunteers, the results demonstrated ice cubes to be significantly more effective with 90% of subjects preferring the ice cube to ethyl chloride.[5]

The results of our study are consistent with prior reports that have not found any statistically significant difference between using and not using ethyl chloride prior to an injection. Furthermore, our study was adequately powered to determine equivalence between the 2 conditions, thereby increasing the strength of our primary results. Importantly, many advocates of ethyl chloride emphasize the importance of a "placebo" effect and the reduction of patient anxiety prior to an injection. However, this belief is not supported by any existing literature and has likely been perpetuated among clinicians based on personal communication. This potential effect was specifically addressed in our study by stratifying patients by anticipated preinjection pain and anxiety. However, our results remained unchanged and did not identify any measurable clinical effects on either pain or anxiety with the exception of a possible dampening of pain reduction in high-pain anticipation patients.

The use of ethyl chloride is associated with some risks. Routine use has been associated with a rare incidence of frostbite.[7,8] Its vapor is toxic, resulting in feelings similar to alcohol intoxication, and in extreme cases has resulted in death.[9] Certainly, the cost of ethyl chloride may be relevant in the current U.S. health care climate that emphasizes cost-effective, evidence-based care. Ethyl chloride is typically sold at a retail cost of $30 to $100 per bottle. Although seemingly insignificant among much higher expenses in health care, a recent study reported over 250,000 steroid injections to the hand among a 55-million-patient sample over a 4-year

period.[15] Based on these numbers, we estimate that there are nearly 300,000 steroid injections in the hand annually in the United States with over 50% of patients potentially receiving ethyl chloride spray based on our data.

The limitations of this study include using only patients who received injections in the hand. Thus, we caution readers against extrapolating these results to other body parts, such as the knee or shoulder, where ethyl chloride may have a different effect, or while using different size needles (we used only a 27-gauge needle), which may similarly influence the effects. Another limitation is that a majority of injections were performed by a single, board-certified and experienced hand surgeon (J.P.S.). It is possible that personal experience and technique may influence the potential benefits of using ethyl chloride spray among other physicians. Lastly, we excluded patients who specifically requested ethyl chloride spray based on the assumption that their prior experience would bias the results. Although this accounted for a very small percent of patients relative to our enrollment number, theoretically this could bias our conclusions.

This study has a number of strengths. It is a prospective, randomized trial thereby reducing the risk of selection bias in a patient sample. In addition, by assessing preinjection anxiety and anticipated pain, we could further investigate the effect in patients who were at higher risk of perceiving discomfort during a minor procedure. Our results confirmed a suspicion that patients with higher anticipated pain experience higher injection pain levels; however, the effect of ethyl chloride on pain perception remained nonsignificant. Finally, by performing a prestudy sample size estimate and post hoc power analysis, we were able to demonstrate clinical equivalence (with and without ethyl chloride spray), further strengthening our conclusions.

We conclude that ethyl chloride spray for hand injections is ineffective based on our data that demonstrate no appreciable clinical effect prior to injections. However, our survey suggests that approximately 50% of hand surgeons always use such spray prior to injections. The literature supports a potential risk to the use of ethyl chloride based on its small, but relevant, risk profile. Thus, we recommend that the routine use of ethyl chloride for injections of the hand be discontinued in adult patients.

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APPENDIX A. Injection Questionnaire

For office use only (to be completed by provider)			Provider: Dr. _____
Date: _____ Ethyl Chloride? Yes No	Gender: Male Female Age: _____ Dominance: Right Left	Injection: Trigger Carpal Tunnel 1st Dorsal Comp. CMC	Thumb Right Index Long Left Ring Small

Fold Here

Before the Injection

Circle the best answer.

How painful do you think it will be?

0 1 2 3 4 5 6 7 8 9 10

No Pain — Extremely Painful

How painful will it be 1-minute after the injection?

0 1 2 3 4 5 6 7 8 9 10

No Pain — Extremely Painful

How nervous are you about the injection?

0 1 2 3 4 5 6 7 8 9 10

Not nervous — Extremely Nervous

Have you had a hand injection before? Yes / No

Was Ethyl Chloride (freeze spray) used? Yes / No / I don't know

Fold Here

After the Injection (complete 1 minute after)

Circle the best answer.

Actual pain of the needle

0 1 2 3 4 5 6 7 8 9 10

No Pain — Extremely Painful

Actual pain of the medication

0 1 2 3 4 5 6 7 8 9 10

No Pain — Extremely Painful

Actual pain 1-minute after the injection

0 1 2 3 4 5 6 7 8 9 10

No Pain — Extremely Painful

Overall anxiety related to the procedure

0 1 2 3 4 5 6 7 8 9 10

Not nervous — Extremely Nervous