The Role of Elbow Tender Point Examination in the Diagnosis of Lateral Epicondylitis

Sarang K. Yoon, DO, MOH, Matthew S. Thiese, PhD, MSPH, Ulrike Ott, PhD, MSPH, Jay Kapellusch, PhD, Andrew Merryweather, PhD, Eric M. Wood, MD, MPH, Brenden B. Ronna, BS, James Foster, MD, MPH, David L. Drury, MD, MPH, and Kurt T. Hegmann, MD, MPH

Objective: To quantify sensitivity and specificity of the tender points and demonstrate how variability in case definition impacts prevalence of lateral epicondylitis (LE). **Methods:** Baseline data analyzed from 1216 workers from the WISTAH study, a multicenter prospective cohort study of upper extremity musculoskeletal disorders. All workers completed computerized questionnaires, structured interviews, and two independent physical examinations in accordance with an established protocol. **Results:** The prevalence of LE differed based on case definition ranging from 4.7% to 12.1%. Sensitivity was low for tender points 1 to 4 ranging from 6.8% to 34.6%. Specificity was high for tender points 1 to 4 ranging from 95.2% to 97.9%. **Conclusions:** The prevalence of lateral epicondylitis differs markedly based on case definition used, ranging more than two-fold. Standardization of a case definition is essential to allow for comparisons across studies.

Keywords: case definitions, interobserver variability, lateral epicondylagia, lateral epicondylitis, prevalence, sensitivity, specificity, tender points, tennis elbow

Lateral epicondylitis is one of the common upper extremity musculoskeletal disorders[1,2] with population-based estimates from Washington State of an average incidence rate for nontraumatic (lateral and medial) of 1.6 claims per 10,000 full-time equivalent (FTE), median claim cost of $19,484, average direct cost per claim of $55,121, and 769.5 lost workdays per 10,000 FTE workers per year.[3] Lost workdays and high costs pose burdens on both employers and employees.[3,4]

Currently, there is no gold standard for diagnosing lateral epicondylitis. Prior prevalence estimates vary more than 5-fold, from 0.7% to 4.0% for the general population and 0.3% to 14.5% in working populations.[5–19] Yet, these studies lack consistent nomenclature and case definitions, validity and repeatability of study protocols, identification of specific sites for palpation, and/or consistency in the pressure applied during palpation thus making it difficult to compare studies (see Table, Supplemental Digital Content 1, http://links.lww.com/JOM/A492, which shows various case definitions used for lateral epicondylitis).[5,6,10–13,15–18,20,22–31]

The studies by Shiri et al,[6] Chiang et al,[10] and Hegmann et al[13] exemplify the wide variance in case definitions used in epidemiological studies. Shiri et al[6] studied Finnish workers, defined lateral epicondylitis as ''pain at the elbow during the preceding 30 days and pain at the lateral humeral epicondyle region on resisted extension of the wrist with the elbow extended'' and reported prevalence of 1.3%. Chiang et al[10] studied workers in the fish processing industry, did not differentiate lateral from medial epicondylitis, used a case definition of ''pain in the last 30 days, local tenderness, pain during resisted extension or flexion of the wrist and fingers, and decreased handgrip compared with that of the opposite hand,'' and reported a prevalence rate of 14.5%. Hegmann et al,[13] studied workers in multiple employment settings, reported a case definition of ''pain in the lateral elbow and pain on palpation of at least one of the six standardized tender points,'' reported a secondary case definition of including lateral elbow pain on at least one of two resisted maneuvers (wrist and/or middle finger extension),'' and reported prevalences 9.9% and 3.5%, respectively.

While many epidemiological studies used questionnaires, in those using physical examinations, the examinations are not well described and vary in palpation technique.[5,6,10–12,15–35] To our knowledge, no study has yet identified specific elbow tender points when diagnosing lateral epicondylitis and thus the purpose of this study is to examine this issue. This issue may have further impacts. For example, the American College of Occupational and Environmental Medicine Guidelines include a systematic review of randomized control trials (RCT) for treatment of lateral epicondylitis with injections.[36] They found the site of injections was not standardized. For example, one RCT placed steroid injections into ''deepest aspect of common tendon origin'' while another RCT injected ''the greatest tender point.''[37,38] This brings into question whether lateral epicondylitis is being accurately diagnosed or if there is a need to identify and standardize the tender point(s) for treatments using injections or other invasive treatments.

In this study, we analyzed six tender points at the elbow in an attempt to determine anatomical sites that may be best associated with the diagnosis of lateral epicondylitis.[39] The goal of this study is to quantify sensitivity and specificity of the tender points and demonstrates how variability in case definition impacts prevalence of lateral epicondylitis in a large working population.

METHODS

For this study, we analyzed baseline data from the WISTAH study, a multicenter prospective cohort study of distal upper extremity musculoskeletal disorders (DUE MSDs). The WISTAH study was approved by the institutional review boards. Complete study methods are previously published,[39] and thus brief methods follow.

Workers were recruited as a convenience sample from 15 different employers that represented 17 diverse production facilities located in Wisconsin, Utah, and Illinois. Approximately, one-third of workers were targeted to be enrolled in low, medium and high physical demand jobs to quantify disorder–exposure relationships.

From the Rocky Mountain Center for Occupational and Environmental Health (RMCOEH) (Dr Yoon, Dr Thiese, Dr Ott, Dr Wood, Mr Ronna, Dr Hegmann); Center for Ergonomics, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin (Dr Kapellusch, Dr Foster); Department of Mechanical Engineering (Dr Merryweather), University of Utah, Salt Lake City, Utah; Allina Health Clinics, Minneapolis, Minnesota (Dr Drury).

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Address correspondence to: Kurt T. Hegmann, MD, MPH, Rocky Mountain Center for Occupational and Environmental Health, Department of Family and Preventive Medicine, School of Medicine, University of Utah, 391 Chipeta Way, Suite C Salt Lake City, UT 84108 (kurt.hegmann@hsc.utah.ed).

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Study participants were: (1) at least 18 years of age, (2) able to give informed consent, (3) had no plans to retire or leave their employer within 4 years, (4) able to speak either English or Spanish, and (5) free of major limb deformities and/or substantial amputations. Participating workers were paid regular wages by their employers and no incentives were paid.

DATA COLLECTION

The Health Outcomes Assessment Team administered computerized questionnaires, structured interviews, obtained anthropomorphic measures, and performed physical examinations. The questionnaire ($n = 266$) was computerized and included medical health items (eg, age, sex, medical history), psychosocial factors (eg, depression, job satisfaction), and other lifestyle questions (eg, smoking, alcohol). The structured interview was also computerized, was administered by trained therapists and occupational medicine residents, included a survey of symptoms required for case definitions ($n = 483$), and utilized a body diagram for localization of symptoms. Symptoms included were pain, ache, burning, and/or stiffness currently or in the past month, duration of pain, and prior history of specific disorders including lateral epicondylalgia (''epicondylitis''). Pain of any type or quality (eg, burning, stabbing) was considered as one symptom. For this report, only pain localized in the right lateral elbow was included.

PHYSICAL EXAMINATION MANEUVERS

All workers underwent two independent standardized physical examinations. Health team members were trained on the examinations through review of the videotaped examples of the examination techniques and practice in small group sessions until accuracy and consistency were demonstrated. The standardized examination included reproducibly palpating manually with 4 kg of force, which used a force gauge for purposes of force matching. Therapists or occupational medicine residents performed the first examination, and all maneuvers were performed by the first examiner regardless of the presence or absence of symptoms. Board-certified occupational medicine physicians performed the second physical examinations. Second examiners viewed a computerized symptoms summary page from the structured interview and the results of the first examiner's physical examination tests. The purpose of this second examination was to confirm positive findings and to assess pertinent negatives.

Examinations included (1) observation of the distal upper extremity (DUE), (2) inspection of the DUE, (3) palpation of elbow tender points, (4) range of motion, and (5) specific examination maneuvers (resisted wrist extension, resisted middle finger extension). To assess tender points, the elbow was positioned at 90 degrees flexion and 90 degrees pronation. In this position, the bulk of the extensor mass is rotated away from the tender points allowing for a better examination and identification of the palpation locations. Approximately, 4 kg of force was manually applied to each of the six tender points: (1) retro lateral epicondyle, (2) lateral epicondyle, (3) between lateral epicondyle and radial head, (4) radial head, (5) 1 to 2 cm distal to the radial head, (6) radial tunnel (refer to Fig. 1). The resisted wrist extension and resisted middle finger extension maneuvers were considered positive only if there was pain that included localization in the lateral epicondylar region.

CASE DEFINITION

The primary case definition of lateral epicondylitis was lateral elbow pain plus pain at any tender point. This was decided based on the clinical impression that if a worker had those symptoms and signs but a negative resisted maneuver, he or she would likely still be diagnosed and treated for lateral epicondylitis. The secondary case

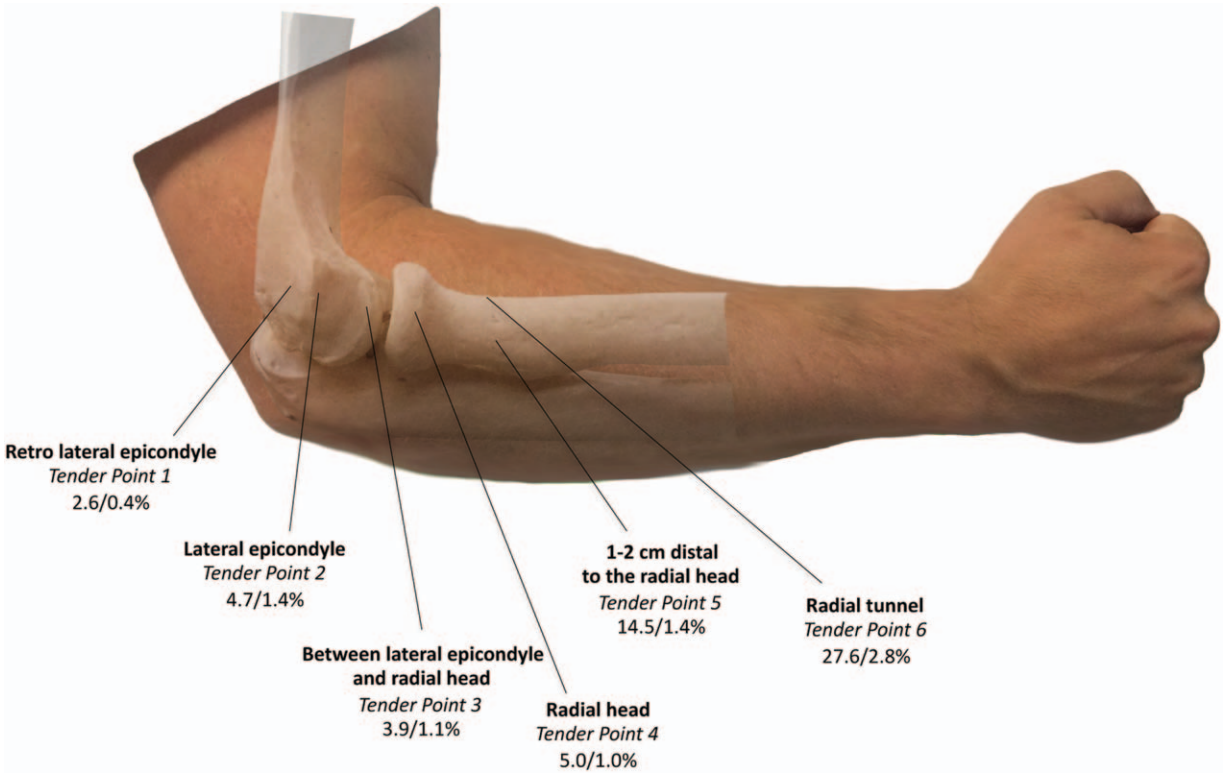

FIGURE 1. Six elbow tender points with proportion acknowledging ''pain'' on palpation with 4 kg/prevalence of epicondylitis based on case definition of lateral right elbow pain + tender point + any resisted maneuver. The figure is not to scale.

definition was lateral elbow pain plus at least one positive tender point plus at least one positive resisted maneuver. In addition, we analyzed a variety of case definitions to demonstrate how differences in definitions may affect the prevalence, sensitivity, and specificity:

(1) Lateral elbow pain only
(2) Any positive tender point
(3) Lateral elbow pain + tender point
(4) Lateral elbow pain + tender point + positive resisted middle finger extension
(5) Lateral elbow pain + tender point + positive resisted wrist extension
(6) Lateral elbow pain + tender point + positive resisted middle finger OR wrist extension

JOB PHYSICAL EXPOSURES

The Job Exposure Assessment Team collected each worker's baseline job physical exposure data. The analysts were blinded to symptoms and health data. They collected data on individual jobs (ie, job title, duration of shift, pace, job rotation, etc.), observed and videotaped the worker performing the task. Videotapes were analyzed and physical exposure variables (force, repetition, duration of exertion, exposure/day, hand/wrist posture, etc.) were recorded. Threshold limit value for hand activity level (TLV for HAL) and Strain Index (SI) for each worker and for each task were calculated.

STATISTICAL ANALYSIS

Analyses were performed for the symptoms and signs in the right elbow. Prevalence was calculated for lateral elbow pain only, any positive tender point, primary case definition, and secondary case definition. Sensitivity and specificity were calculated for tender point plus lateral elbow pain. Another set of sensitivities and specificities were calculated for tender point plus lateral elbow pain plus positive resisted maneuver(s). A tender point was considered to be positive and included in the data analyses if at least one examiner obtained a positive response. Calculation of the Kappa statistic (κ) for interobserver reliability was analyzed for each tender point and resisted maneuvers. The comparison was between the first examiner (therapist or occupational medicine resident) and second examiner (board-certified occupational medicine physicians). The median TLV for HAL and median for SI were also calculated. Data were analyzed in SAS 9.4 (SAS Institute, Cary, NC).

RESULTS DEMOGRAPHICS

A total of 1,216 workers were included in these analyses (see Table 1). A majority were right-handed (86.8%), women (66.1%), with a mean age of 41.2 years, and mean BMI of 29.5 kg/m^2. Mean systolic blood pressure was 128 mmHg and mean diastolic blood pressure was 80 mmHg, while 16.6% had a diagnosis of high blood pressure and 17.8% had a history of high cholesterol. A plurality (47.4%) had never smoked tobacco. Relatively few had been diagnosed with rheumatoid arthritis (0.9%), osteoarthritis (9.1%), fibromyalgia (0.8%), diabetes mellitus (5.3%), thyroid disorders (6.8%), or kidney failure (0.4%). Most reported that they ''seldom'' or ''never'' felt depressed (80.2%), they were ''satisfied'' or ''very satisfied'' with their job (75.2%), and they ''seldom'' or ''never'' felt mentally exhausted (77.3%).

The strain index (SI) and threshold limit value for hand activity level (TLV for HAL) are ergonomic risk analysis tools used to identify job tasks associated with distal upper extremity disorders.[40,41] The median SI score was 6.0, signifying moderate risk.[40] The median TLV for HAL was 0.5.

TABLE 1. Demographics

Variable	Mean ± SD (%)
Age, yr	41.9 ± 11.4
Female	804 (66.1%)
Right-handed	1056 (86.8%)
Left-handed	95 (7.8%)
Uses both hands equally	65 (5.3%)
Body mass index, kg/m^2	29.5 ± 6.8
Systolic blood pressure, mmHg[*]	127.6 ± 17.1
Diastolic blood pressure, mmHg[*]	79.7 ± 10.7
Tobacco, current use[†]	334 (27.8%)
Tobacco, past[†]	298 (24.8%)
Tobacco, never[†]	569 (47.4%)
Diabetes mellitus	64 (5.3%)
High blood pressure	202 (16.6%)
High cholesterol	216 (17.8%)
Thyroid disorder	83 (6.8%)
Rheumatoid arthritis[‡]	11 (0.9%)
Osteoarthritis	111 (9.1%)
Fibromyalgia[§]	8 (0.8%)
Kidney failure[‖]	5 (0.4%)
Felt depressed:	
Always	23 (1.9%)
Often	210 (17.4%)
Seldom	670 (55.5%)
Never	305 (25.3%)
Job satisfaction:	
Very satisfied	284 (23.4%)
Satisfied	631 (51.9%)
Neither satisfied nor dissatisfied	218 (17.9%)
Dissatisfied	72 (5.9%)
Very dissatisfied	11 (0.9%)
Mentally exhausted:	
Always	45 (3.7%)
Often	231 (19.0%)
Seldom	606 (49.8%)
Never	334 (27.5%)
SI (median ± SD)	6.0 ± 10.3
TLV for HAL (median ± SD)	0.5 ± 0.57
Job physical demand[¶]:	
Low	389 (36.2%)
Medium	285 (26.5%)
High	402 (37.4%)
Prevalence of right lateral elbow pain	12.1%
Prevalence of tender point[#¥¥] (right hand only):	
Tender point 1	2.6%
Tender point 2	4.7%
Tender point 3	3.9%
Tender point 4	5.0%
Tender point 5	14.5%
Tender point 6	27.6%
Prevalence of lateral right elbow pain + tender point + any resisted maneuver[#] (right hand only):	
Tender point 1	0.4%
Tender point 2	1.4%
Tender point 3	1.1%
Tender point 4	1.0%
Tender point 5	1.4%
Tender point 6	2.8%

[*] $N = 1211$ denominator.
[†] $N = 1201$.
[‡] $N = 1208$.
[§] $N = 1014$.
[‖] $N = 1206$.
[¶] $N = 1076$.
[#] Some subjects may have had more than one tender point.

Prevalence of Tender Points

The prevalence of lateral epicondylitis differed markedly depending on which case definition was used (see Table 2). In this study, we evaluated workers who reported right lateral elbow pain currently or within the past month (12.1%). Of those who reported current pain symptoms, most had pain present in the past 2 weeks

TABLE 2. 1-Month Period Prevalence of Right Lateral Epicondylitis Based on Varying Case Definitions

Prevalence of Lateral Epicondylitis	
Lateral elbow pain	12.1%
Any positive tender point	37.6%
Lateral elbow pain + any positive tender point	10.0%
Lateral elbow pain + any positive tender point + a positive resisted maneuver*	4.7%

*Includes resisted middle finger extension or resisted wrist extension.

(94%). Prevalence decreased by approximately 50% when using case definitions that included the resisted maneuvers. Tender point 1 and 6 had the lowest and highest prevalence, respectively. However, tender point 6 was also painful in 21.2% of those without lateral elbow pain.

Sensitivity and Specificity of Tender Points

The sensitivity and specificity of each tender point was compared with lateral elbow pain and positive resisted maneuvers (see Table 3). Overall, sensitivity was low for all the tender points and specificity was higher for tender points 1 through 4.

Interobserver Reliability

Interobserver reliability for tender points and resisted maneuvers (wrist extension and middle finger extension) were calculated. Tender point 2 and 6, resisted middle finger extension, and resisted wrist extension showed moderate agreement between the two examiners (correlation $\kappa = 0.5$, 0.5, 0.5, and 0.4, respectively). Tender points 1, 3, and 5 showed fair agreement (correlation $\kappa = 0.3$, 0.4, and 0.3, respectively). Tender point 4 showed slight agreement (correlation $\kappa = 0.2$).

DISCUSSION

The prevalence of lateral epicondylitis differs markedly based on the locations of tender points and the case definition used. The prevalence of pain on palpation of tender points varied 10-fold. When using a simpler case definition such as lateral elbow pain or lateral elbow pain plus any positive tender point, the prevalence was 12.1% and 10.0%, respectively. When at least one positive resisted maneuver was added to the criteria, the prevalence nearly halved to 4.7%. The impacts of the tender points has not been previously described, although a sharp reduction in prevalence with inclusion of resisted maneuvers has been reported from this study.[13] Similarly, Shiri et al[6] demonstrated a similar change in prevalence when using a less restrictive case definition (''definite or possible'' lateral epicondylitis, prevalence 2.8%) versus a stricter one (''definite'' lateral epicondylitis, prevalence 1.3%). These studies demonstrate significant impacts of varying case definitions on prevalence rates and suggest the need for consistency in definitions for epidemiological and clinical studies of lateral epicondylitis.

This study also reports unique data on the overall sensitivity of the examinations and interobserver reliability of the tender point examination in the diagnosis of lateral epicondylitis. Despite standardization and careful observations during enrollments, reproducibility of maneuvers was relatively low which raises questions regarding the value of physical examination maneuvers. This was confirmed by the field observations of workers repeatedly commenting that a maneuver hurt the first time but not the second, or vice versa.

We evaluated interobserver reliability of the tender point and resisted maneuver examinations between the two examiners to determine the repeatability of the clinical examination. In our study, although all examiners received the same standardized instruction and rigorous practice prior to the study and applied 4-kg force to each tender point, our interobserver reliability ranged from 0.2 to 0.5 (slight to moderate agreement). These results suggest that the worker's history should be preferentially emphasized over physical examination findings in diagnosing lateral epicondylitis. Other studies that incorporated a physical examination had similar or higher interobserver reliability, however, we are unable to directly compare the data because these other studies used different methods.[16,19,31]

To our knowledge this is the only study of lateral epicondylitis that examined both sensitivity and specificity of tender points compared with lateral elbow pain and resisted maneuvers. The overall sensitivities were low and the specificities were high (Table 3). The tender point at the radial tunnel had the highest sensitivity, whereas the lateral epicondyle, a commonly used tender point, had comparatively lower sensitivity but higher specificity. This study found that the tender point over the radial tunnel (No. 6) was quite tender in many workers, including those asymptomatic, and thus tenderness at this point appears most likely to mislead in diagnosing pathologic conditions.

Currently there is no gold standard for the diagnosis of lateral epicondylitis. Multiple studies have used various case definitions (see supplemental electronic materials, http://links.lww.com/JOM/

TABLE 3. Sensitivity and Specificity of Each Right Elbow Tender Point Using Five Different Case Definitions

	Tender Point					
	Sensitivity					
	Specificity (%)					
Case Definition	**1**	**2**	**3**	**4**	**5**	**6**
Lateral elbow pain	6.8	16.3	14.3	14.3	21.2	53.1
	97.9	96.9	97.6	96.3	87.3	75.9
Lateral elbow pain + positive resisted middle finger extension	6.7	33.3	30.0	13.3	20.0	46.7
	97.9	96.0	96.8	95.2	85.7	72.8
Lateral elbow pain + positive resisted wrist extension	8.9	28.6	23.2	21.4	26.8	57.1
	97.7	96.5	97.1	95.8	86.1	73.8
Lateral elbow pain + positive resisted middle finger extension + positive resisted wrist extension	7.7	34.6	34.6	15.4	15.4	46.2
	97.5	96.0	96.8	95.2	85.56	72.8
Lateral elbow pain + positive resisted middle finger extension or positive resisted wrist extension	8.3	28.3	21.7	20.0	28.3	56.7
	97.7	96.5	97.1	95.8	86.3	73.9

A492), and therefore it is difficult to compare the results between studies.[9] Due to the use of multiple case definitions, there is a wide range in the prevalence of lateral epicondylitis reported in epidemiological studies.[5,6,10–13,15–18,20,22–31] One literature review found that there are over 27 classification systems for upper extremity disorders for the working population and 14 classification systems for lateral epicondylitis alone.[42] Uniformity of case definitions may seem to also be important to allow for robust comparisons across clinical trials, which is currently not possible.

This study's strengths include the large sample size from 17 diverse employment settings in three different states, computerized structured interviews, and standardized physical examinations to help assure consistency in capturing data.

This study enrolled workers, which likely resulted in a higher prevalence than the general population. However, changing populations should not alter the sensitivities and specificities calculated. Since this is a population-based study, the cases of lateral epicondylitis likely included milder cases than in a clinic-based study, although a spectrum of different case severity is also not believed to materially affect sensitivity and specificity estimates.[43,44] The examination maneuvers did not use a tool to apply 4 kg of force (eg, a dolorimeter) which presumably would have at least somewhat improved reproducibility; however, such devices are not commonly used in clinical practices, and thus would have limited generalizability beyond a research study unlike this study's design which more closely mirrors clinical practice.

The study findings provide value to both the clinical and research fields. For the clinician, knowing the prevalence and predictive value of tender points and resisted manuevers may aid with the clinical diagnosis of lateral epicondylitis. In this study, the prevalence of lateral epicondylitis differs markedly based on the case definition used, ranging more than 2-fold. Pain at the lateral epicondylar tender points varies up to 10-fold. Thus, this demonstrates a need for the standardization of a case definition for lateral epicondylitis to allow for comparisons across epidemiological studies, as well as randomized controlled trials.

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