

# A Short Communication Based on: A Bayesian Network Meta-analysis: Comparing the Clinical Effectiveness of Local Corticosteroid Injections using Different Treatment Strategies for Carpal Tunnel Syndrome

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## Abstract

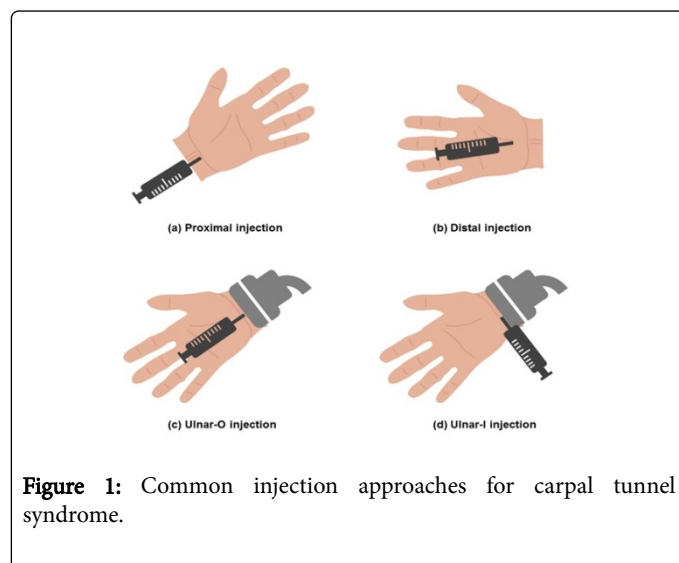
Why do we choose this topic? Local corticosteroid injections are commonly used to improve the short-term symptomatic severity and the functional status of the hands affected by carpal tunnel syndrome. We searched and categorized different treatment strategies for carpal tunnel syndrome.

## Abbreviation:

Ulnar-O: Ultrasound-Guided Out-Plane; Ulnar-I: Ultrasound-Guided In-Plane

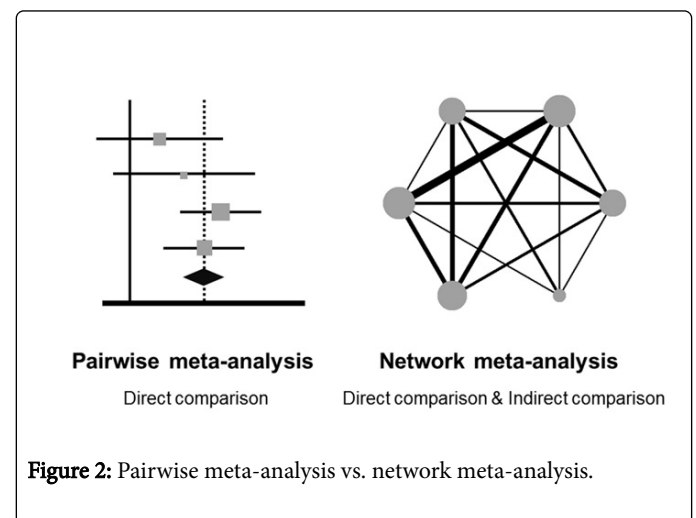
## Background

However, to our knowledge, no network meta-analysis has been conducted to assess the comparative effectiveness of different injection approaches to improve the severity and function of the hands affected by carpal tunnel syndrome. This study is intended as a useful guide for patients to understand the role of different injection approaches in improving the severity and function of the hands affected by carpal tunnel syndrome (Figure 1).



**Figure 1:** Common injection approaches for carpal tunnel syndrome.

We conducted a meta-analysis to compare the clinical effectiveness of local corticosteroid injections using different injection approaches (Figure 2).



**Figure 2:** Pairwise meta-analysis vs. network meta-analysis.

Bayes' theorem describes the probability of the process that changes the prior probability to posterior probability based on new information. There are three ways to acquire the prior probability: [1] Massive prior information; [2] subjective probability estimated by experts or decision-makers; [3] suppose all conditional probabilities are the same [2]. A conditional probability measures the probability of an event given that another event has occurred, and a posterior probability is the conditional probability that is assigned after the relevant evidence is taken into account [1]. The main concept of an uncertain reality of a hypothesis at the beginning, but knowing to obey the probability distribution of the hypothesis, is called prior probability. Moreover, according to Bayes' theorem, an update of posterior probability follows after acquiring new evidence. Since not all events include massive historical information or repeatable

experiments, for the circumstances lack of experience, contain too less information or have no frequency probability, a Bayesian network is allowed to adopt subjective probability, i.e., presenting the subjective judgment regarding credible interval (CrI) of the occurrence of the event using subjective probability [1]. Subjective probability is a graphical statistic inference model that analyzes relationships between variables using a set of randomized variables. It also can correct the posterior probability of related uncertain quantity based on updated new evidence at any time through multiple inference and deduction.

This study analyzed multiple uncertain hypotheses involved in the judgment of complex and wide-range uncertain quantities regarding the management of carpal tunnel syndrome using local corticosteroid injections. In addition, through the process of decomposition and recombination, this study also used the Bayesian network to present the inference relations between individual uncertain event and target hypothesis as well as the cause and effect relationships between nodes. Based on the method proposed by Cipriani, Higgins, Geddes, & Salanti [4], the assessment of hypothesis is the evidence or sample data observed from the most bottom node, and the updated results derived from layer-by-layer inference of network architecture. Each node of a Bayesian network shall have its own prior probability, and individual arrow is equipped with the likelihood ratio of inference. Therefore, in Bayes' theorem, the probability of each event derives from the calculation of likelihood ratio from previous node, which is then corrected step-by-step until the hypothesis node [2].

This study used the Bayesian network to process the inference relationship of local corticosteroid injections treatment for carpal tunnel syndrome. Each node in the research network represents an uncertain event, and every single arrow indicates the direction of deduction. Hence, a complete Bayesian network must comprise the prior probability of individual node and the intensity of individual inference, which is known as the likelihood ratio of the evidence. The Bayesian network is a "directional non-cyclic graphic", i.e., there are directional arrows to link the inference relations between associated nodes, and these connections cannot form a circular loop [4]. According to the inference relations between the evidence and target hypothesis, the inference relations between Bayesian network nodes can be divided into: (1) A single evidence inference, which means that only one evidence points to one hypothesis node; (2) multiple evidence inference, which indicates that several evidence lead to one hypothesis node; and (3) multiple inference relations, i.e., two or more levels of evidence result in one hypothesis node [4]. This was a multi-level inference research.

### Correction of inconsistency in a Bayesian Network

Since the mid-level nodes of multi-level inference relations in a Bayesian network are derived from the inference of other nodes and their uncertainties, the prior probability of a certain node could be inconsistent with the probability derived from previous nodes [3]. Tu et al. has proposed a screening method to confirm the inconsistency between nodes. This study did not perform corrections for inconsistency [5].

A Bayesian network consists of a set of nodes connecting with single evidence, multiple evidence and multiple levels of inference relations. Therefore, the inference relations between uncertain events can be decomposed and simplified, and subsequently summarized into the meta-analysis. However, in comparison with other statistical methods, the Bayesian network is a very powerful tool and thus relies on

computing. Moreover, a Bayesian network is becoming more and more significant following the information era. A Bayesian network not only can analyze historical data using subjective probability, but also can increase the accuracy of decision-making through statistical methods. Since Bayes' theorem still can calculate future probability under the circumstances that lacks of insufficient sample size using prior probability, there will no analysis failure due to insufficient data. Bayes' theorem uses likelihood ratio to correct prior probabilities, and then applies acquired posterior probabilities to perform assessment and make decisions. Along with the development of meta-analysis, system managers are able to screen useful information from the big data, deduct in accordance with Bayes' theorem, and consequently reduce medical risks and increase the accuracy of decision-making regarding caring policies [6].

	Clinical response versus placebo	
	Median OR (95% CrI)	SUCRA
Ulnar-I	128.30 (9.76 to 2299.00)	98% **
DI	7.00 (0.53 to 118.80)	46%
PI	8.85 (3.00 to 33.15)	54%
	Change in symptom severity scale versus placebo	
	Median MD (95% CrI)	SUCRA
Ulnar-I	-1.16 (-1.95 to -0.38)	95% **
Ulnar-O	-0.78 (-1.43 to -0.16)	64%
PI	-0.58 (-0.95 to -0.22)	40%
	Change in functional status scale versus placebo	
	Median MD (95% CrI)	SUCRA
Ulnar-I	-0.74 (-2.00 to 0.52)	78% **
Ulnar-O	-0.63 (-1.67 to 0.43)	67%
PI	-0.46 (-1.11 to 0.21)	48%

OR = odds ratio, MD = mean difference, CrI = credible interval, SUCRA = surface under the cumulative ranking curve, DI = distal approach corticosteroid injection, PI = proximal approach corticosteroid injection, Ulnar-I = ultrasound-guided in-plane injection, Ulnar-O = ultrasound-guided out-plane injection. \*\*The best injection approach.

**Table 1:** Summary results of network meta-analysis: posterior ORs or MDs with their 95% credible intervals of all treatment strategies and SUCRA values (Adapted from Chen et al.).

### Conclusions

The Ulnar-I approach was the most effective treatment for clinical response, change in symptom severity scale, and change in functional status scale among the injection approaches for carpal tunnel syndrome (Table 1).

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