

Audit of CTS screening guidelines

Introduction and background

Robin Kennett

NHS requirements

- Reduced waiting times
- Delivery of service close to patient's home
- Choice of provider
- Standardization of results, maintenance of quality

Why perform Clinical Neurophysiology?

To

- **confirm a clinical diagnosis**
- assess severity of the median nerve lesion
- provide an objective baseline for future comparison
- exclude alternative disease

Why perform Clinical Neurophysiology?

To

- confirm a clinical diagnosis
- **assess severity of the median nerve lesion**
- provide an objective baseline for future comparison
- exclude alternative disease

CTS Grading Scale

- 0 Normal conduction
- 1 Very mild CTS
- 2 Mild CTS
- 3 Moderate CTS
- 4 Severe CTS
- 5 Very severe CTS
- 6 Extremely severe CTS

CTS Grading Scale

- 0 No neurophysiological abnormality
- 1 Very mild CTS Abnormality on 2 or more sensitive tests.
Examples of sensitive tests:
- palm/wrist median-ulnar sensory velocity comparison, increased
 - second lumbrical-interosseous distal motor latency difference,
 - reduced terminal latency index (<0.34).
- 2 Mild CTS Median sensory velocity <40 m/s, and $<50\%$ reduction in median SNAPs compared with contralateral side, or DML <4.5 ms
- 3 Moderate CTS Reduced median SNAPs and DML >4.5 ms
- 4 Severe CTS Absent median SNAPs and DML >4.5 ms
- 5 Very severe CTS DML >6.5 ms, and Reduced APB CMAPs (>0.1 mV)
- 6 Extremely severe CTS APB CMAP <0.1 mV, severely wasted muscle

CTS: carpal tunnel syndrome; DML: distal motor latency; APB: abductor pollicis brevis; CMAP: compound muscle action potential; SNAP: sensory nerve action potential.

Why perform Clinical Neurophysiology?

To

- confirm a clinical diagnosis
- assess severity of the median nerve lesion
- **provide an objective baseline for future comparison**
- exclude alternative disease

Why perform Clinical Neurophysiology?

To

- confirm a clinical diagnosis
- assess severity of the median nerve lesion
- provide an objective baseline for future comparison
- **exclude alternative disease**

Production of guidelines

- Aim
 - To produce a short document that is easy to understand
 - To set out minimum standards for all CTS screening, fulfilling the objectives
 - To be suitable for audit

Consult the Oracle the Delphi method



Introduction to recommendations

- evidence based
- relevant to the current and future working practices of the specialty in the UK
- in a form that is auditable
- achievable

ABSTRACT: The first *AAEM Carpal Tunnel Syndrome (CTS) Literature Review* (1993) evaluated the sensitivity and specificity of nerve conduction studies (NCSs) and needle electromyography (EMG) to confirm a clinical diagnoses of (CTS) based upon a critical review of 165 articles from the literature through May 1991. This new report includes all of the information from the first review and 113 additional articles from the literature through December 2000. The authors concluded that median sensory and motor NCSs are valid and reproducible clinical laboratory studies that confirm the clinical diagnoses of CTS with a high degree of sensitivity (>85%) and specificity (>95%) and that the clinical practice recommendations published in 1993 remain valid. Needle EMG studies were not as sensitive or specific as NCSs to diagnose CTS although they are useful to document axonal nerve pathology. In future research studies to evaluate the usefulness of NCSs and needle EMGs to diagnose CTS, the authors recommend that (1) the physician performing and interpreting the NCS and needle EMGs be blinded to the diagnosis of the subjects (normal, CTS patient, or disease control) to avoid observer bias and (2) the clinical diagnosis of CTS be made according to a new set of consensus clinical diagnostic criteria presented in this report to provide a more uniform population of CTS patients.

SECOND AAEM LITERATURE REVIEW OF THE USEFULNESS OF NERVE CONDUCTION STUDIES AND NEEDLE ELECTROMYOGRAPHY FOR THE EVALUATION OF PATIENTS WITH CARPAL TUNNEL SYNDROME

Charles K. Jablecki MD, Michael T. Andary, MD, MS, Mary Kay Floeter, MD, PhD, Robert G. Miller, MD, Caroline A. Quartly, MD, FRCP(C) Michael J. Vennix, MD, John R. Wilson, MD

Muscle & Nerve Supplement X 2002 S925

AAEM PRACTICE TOPIC IN ELECTRODIAGNOSTIC MEDICINE

American Association of Electrodiagnostic Medicine
421 First Avenue S.W., Suite 300 East, Rochester, MN 55902 (507/288-0100)

© 2002 American Association of Electrodiagnostic Medicine
Muscle Nerve 25: 918-922, 2002

PRACTICE PARAMETER FOR ELECTRODIAGNOSTIC STUDIES IN CARPAL TUNNEL SYNDROME: SUMMARY STATEMENT*

AMERICAN ASSOCIATION OF ELECTRODIAGNOSTIC MEDICINE, AMERICAN ACADEMY OF NEUROLOGY,
and AMERICAN ACADEMY OF PHYSICAL MEDICINE AND REHABILITATION

Table 1. Comparison of pooled sensitivities and specificities of EDX techniques to diagnose CTS.

Technique	Pooled sensitivity*	Pooled specificity*
A Median sensory and mixed nerve conduction: wrist and palm segment compared to forearm or digit segment	0.85 [†] (0.83, 0.88)	0.98 [†] (0.94, 1.00)
B Comparison of median and ulnar sensory conduction between wrist and ring finger	0.85 (0.80, 0.90)	0.97 (0.91, 0.99)
C Median sensory and mixed nerve conduction between wrist and palm	0.74 [†] (0.71, 0.76)	0.97 [†] (0.95, 0.99)
D Comparison of median and ulnar mixed nerve conduction between wrist and palm	0.71 (0.65, 0.77)	0.97 (0.91, 0.99)
E Median motor nerve conduction between wrist and palm	0.69 [†] (0.64, 0.74)	0.98 [†] (0.93, 0.99)
F Comparison of median and radial sensory conduction between wrist and thumb	0.65 (0.60, 0.71)	0.99 (0.96, 1.00)
G Median sensory nerve conduction between wrist and digit	0.65 [†] (0.63, 0.67)	0.98 [†] (0.97, 0.99)
H Median motor nerve distal latency	0.63 [†] (0.61, 0.65)	0.98 [†] (0.96, 0.99)
I Median motor nerve terminal latency index	0.62 [†] (0.54, 0.70)	0.94 [†] (0.87, 0.97)
J Comparison of median motor nerve distal latency (second lumbrical) to the ulnar motor nerve distal latency (second interossei)	0.56 [‡] (0.46, 0.66)	0.98 [‡] (0.90, 1.00)
K Sympathetic skin response	0.04 (0.00, 0.08)	0.52 (0.44, 0.61)

Introduction to Recommendations

- **Standards** represent the minimum that must be achieved in all cases
- **Guidelines** are suggestions that may be helpful in some clinical circumstances, but are not needed in all
- **Options** may be used in some departments but are generally less widely used or needed than guidelines

The process of case selection should identify patients where a **Standard** model is appropriate and others where a **Guideline** or **option** is appropriate. Thus, patients selected for confirmation of a clinically suspected condition may be dealt with using standards alone, whereas guidelines and options will usually be needed to assess the severity of a condition or to predict prognosis. These recommendations are not intended for use in unselected patients where a clinical differential diagnosis exists: for these patients a medically qualified practitioner has to take a history and examine the patient before deciding the most appropriate investigation protocol to perform. Although the recommendations are of necessity prescriptive, they do not exclude protocols created for use in any individual department depending on local practice and resources. Despite this, if there is a deviation from a **standard**, the reasons should be documented.

Essential pre-requisites

1. The tests are a part of clinical medicine
2. They should be performed by trained and accredited staff
3. The environment must be safe
4. Tests are part of a diagnostic process
5. Reports should be signed by those who can vouch for the data
6. Medico-legal responsibility has to be explicit
7. Case selection should match competence of examiner
8. Adequate data storage needed
9. Standards not binding

Standards for CTS (1)

- **Standard 1**

Cases are selected only for the verification of suspected CTS, not for investigation of a differential diagnosis

- **Standard 2**

Before starting testing the patient is identified and the clinical information from the referral verified

- **Standard 3**

Hand temperature is measured and maintained above 30°C

- **Standard 4**

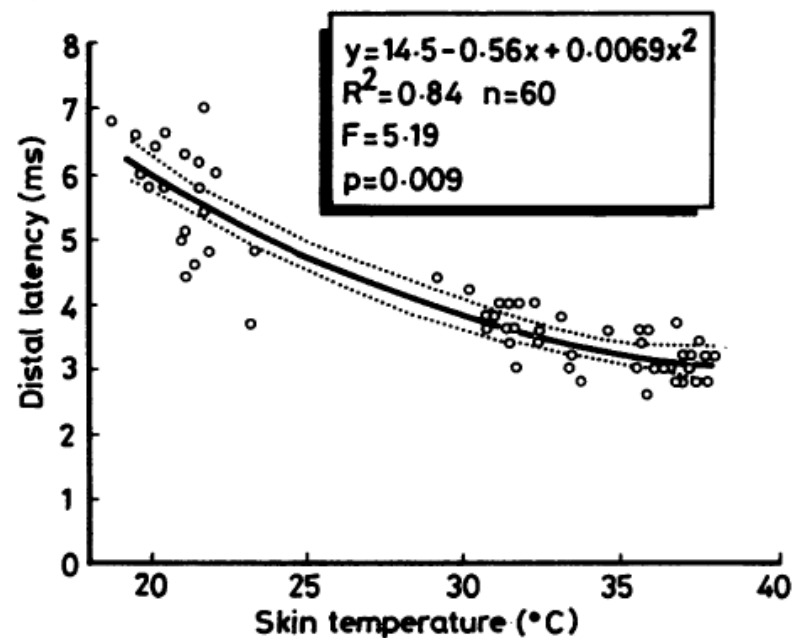
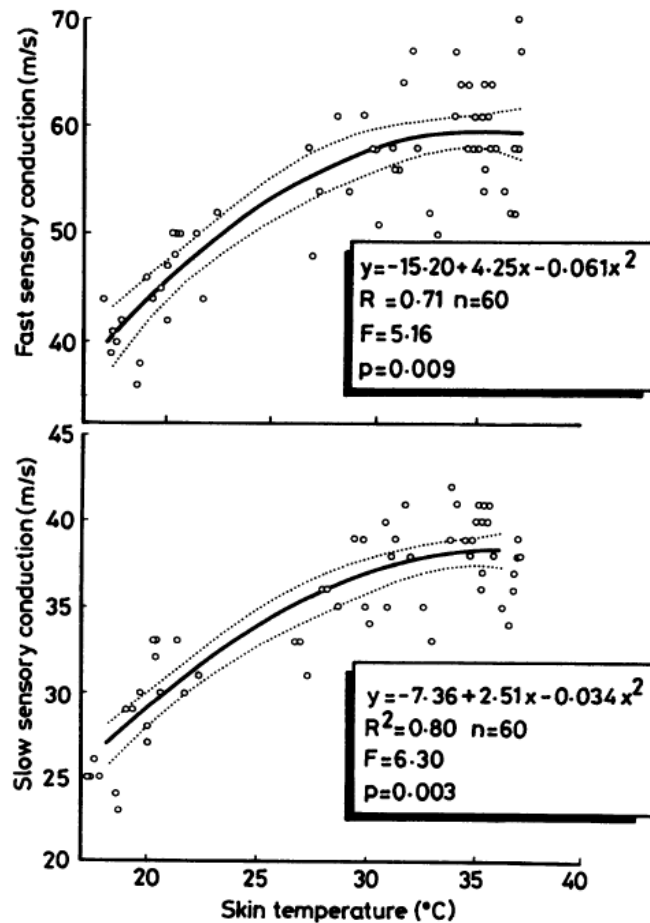
Sensory nerve conduction is performed on a median digital sensory nerve in the most affected hand using surface electrodes and measuring response amplitude and latency/velocity. A comparative test of conduction in a digital nerve not innervated by the median nerve is performed in the same hand

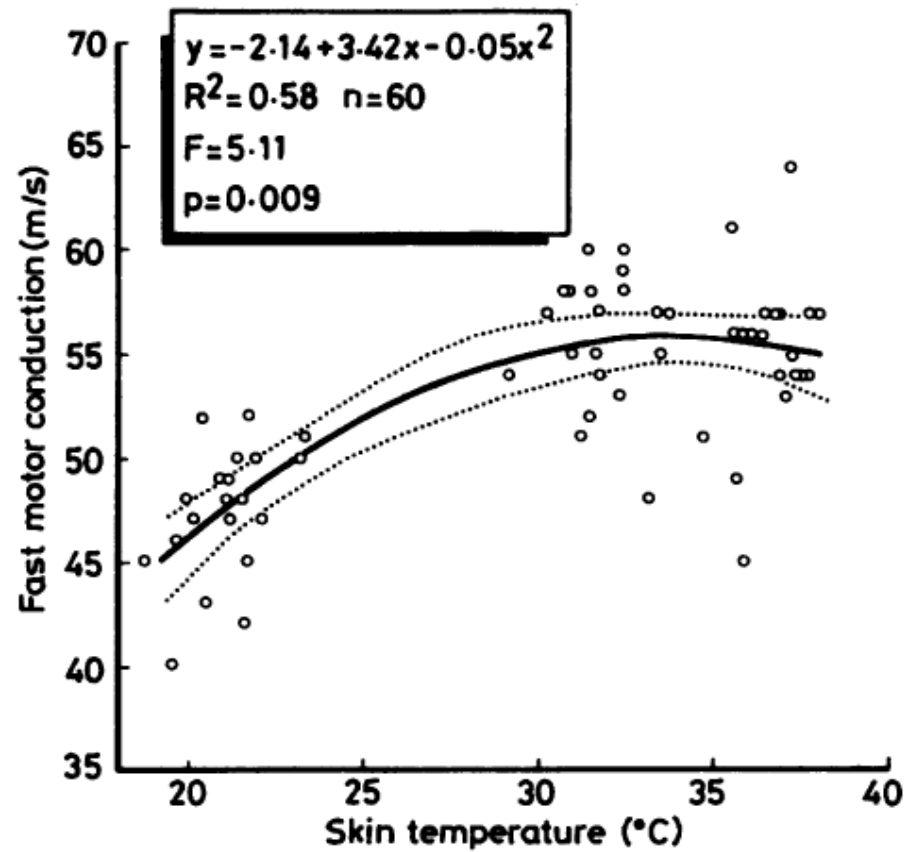
The non-linear relationship between nerve conduction velocity and skin temperature

K TODNEM,* G KNUDSEN,† T RIISE,‡ H NYLAND,* J A AARLI*

From the Department of Neurology, Haukeland Hospital, University of Bergen, Norwegian Underwater Technology Centre,† and Section for Medical Informatics and Statistics,‡ University of Bergen, Bergen, Norway*

SUMMARY Median motor and sensory nerves were examined in 20 healthy subjects. Superficial stimulating and recording electrodes were used, and the nerves were examined at natural skin temperature, after cooling and after heating of the arm. The conduction velocity for the fastest and slow conducting sensory fibres (temperature range 17–37°C), and for the fastest conducting motor fibres (temperature range 19–38°C) increased non-linearly with increase in skin temperature. Similarly, distal motor latencies increased non-linearly with decrease in skin temperature. The effect of temperature was most pronounced in the low temperature range, and change in conduction velocity per degree centigrade was reduced toward higher skin temperature. Sensory nerve response duration increased linearly with decline in skin temperature. Sensory and motor amplitude did not show any significant relation to skin temperature.





Standards for CTS (1)

- **Standard 1**

Cases are selected only for the verification of suspected CTS, not for investigation of a differential diagnosis

- **Standard 2**

Before starting testing the patient is identified and the clinical information from the referral verified

- **Standard 3**

Hand temperature is measured and maintained above 30°C

- **Standard 4**

Sensory nerve conduction is performed on a median digital sensory nerve in the most affected hand using surface electrodes and measuring response amplitude and latency/velocity. A comparative test of conduction in a digital nerve not innervated by the median nerve is performed in the same hand

Standards for CTS (2)

- **Standard 5**

A test of median motor nerve conduction across the wrist in the affected hand is performed using surface electrodes and measuring response amplitude and latency/velocity

- **Standard 6**

The report of the investigation contains the numerical data. It makes a statement on any abnormality detected. The qualification of the practitioner performing the investigation and report is identified

- **Standard 7**

The report is signed by the practitioner taking medico-legal responsibility for it

Guidelines for CTS (1)

- **Guideline 1**

Referrals are screened before allocation of patients by a medically qualified practitioner to assess appropriateness of clinical question posed

- **Guideline 2**

A focussed patient history and examination are recorded, including the presence of co-existing disease

- **Guideline 3**

Sensory digital nerve conduction as per **standard 4** is performed in the contra-lateral hand

- **Guideline 4**

A second test of median sensory nerve conduction is performed. This may include: Median palmar sensory study; Median/Ulnar palmar ratio; Median/Radial sensory latency comparison to thumb; Median/Ulnar sensory latency comparison to ring finger.

Guidelines for CTS (2)

- **Guideline 5**

Motor nerve conduction in the ulnar nerve is performed in the affected limb using surface electrodes and measuring response amplitude and latency/conduction velocity

- **Guideline 6**

Median motor nerve conduction is performed in the contralateral limb as in **standard 5**

- **Guideline 7**

The patient is seen by a medically qualified practitioner at the end of the test to verify the clinical presentation, make a clinico-electrophysiological correlation, to include this in the final report, and to answer any clinical questions the patient may have

- **Guideline 8**

The report details any technical factor that could influence the results

Options for CTS

- **Option 1**

A second test of median motor nerve conduction is performed, such as Median/Ulnar motor latency comparison to second lumbrical and second interossei

- **Option 2**

Needle EMG recording of median innervated arm muscles is performed by a medically qualified practitioner. This may include recording of abductor pollicis brevis response following median nerve stimulation, but not as a substitute for **standard 5**

- **Option 3**

F wave latencies are recorded

- **Option 4**

The report contains illustrations of recorded waveforms

CTS Standards

(BSCN Web site version)

- **Standard 1**
Before starting testing the patient is identified and the clinical information from the referral verified.
- **Standard 2**
Hand temperature is measured, recorded and maintained above 30 degreesC.
- **Standard 3**
Sensory nerve conduction is performed on a median digital sensory nerve in the most affected hand using surface electrodes and measuring response amplitude and latency/velocity. A comparative test of conduction in a digital nerve not innervated by the median nerve is performed in the same hand.
- **Standard 4**
A test of median motor nerve conduction across the wrist in the affected hand is performed using surface electrodes and measuring response amplitude and latency/velocity.
- **Standard 5**
Median motor nerve conduction in the forearm is performed on the affected limb using surface electrodes and measuring response amplitude and latency/conduction velocity.
- **Standard 6**
The report of the investigation contains the numerical data. It makes a statement on any abnormality detected. The professional status of the practitioner performing the investigation and report is identified.
- **Standard 7**
The report is signed by the practitioner taking medico-legal responsibility for it.

CTS Standards (Web version)

- **Standard 1**
Before starting testing the patient is identified and the clinical information from the referral verified.
- **Standard 2**
Hand temperature is measured, recorded and maintained above 30 degreesC.
- **Standard 3**
Sensory nerve conduction is performed on a median digital sensory nerve in the most affected hand using surface electrodes and measuring response amplitude and latency/velocity. A comparative test of conduction in a digital nerve not innervated by the median nerve is performed in the same hand.
- **Standard 4**
A test of median motor nerve conduction across the wrist in the affected hand is performed using surface electrodes and measuring response amplitude and latency/velocity.
- **Standard 5**
Median motor nerve conduction in the forearm is performed on the affected limb using surface electrodes and measuring response amplitude and latency/conduction velocity.
- **Standard 6**
The report of the investigation contains the numerical data. It makes a statement on any abnormality detected. The professional status of the practitioner performing the investigation and report is identified.
- **Standard 7**
The report is signed by the practitioner taking medico-legal responsibility for it.

Joint National Audit Project

BSCN/ANS Standards for NCS in CTS

Bloomsbury Suite
Friends House 173 Euston Road
London NW1 2BJ

Presented by J.S.Holman

Itinerary

1. Response Analysis

2. Pre-test analysis

- Identification of patient and clinical information.
- Hand temperature measurement.

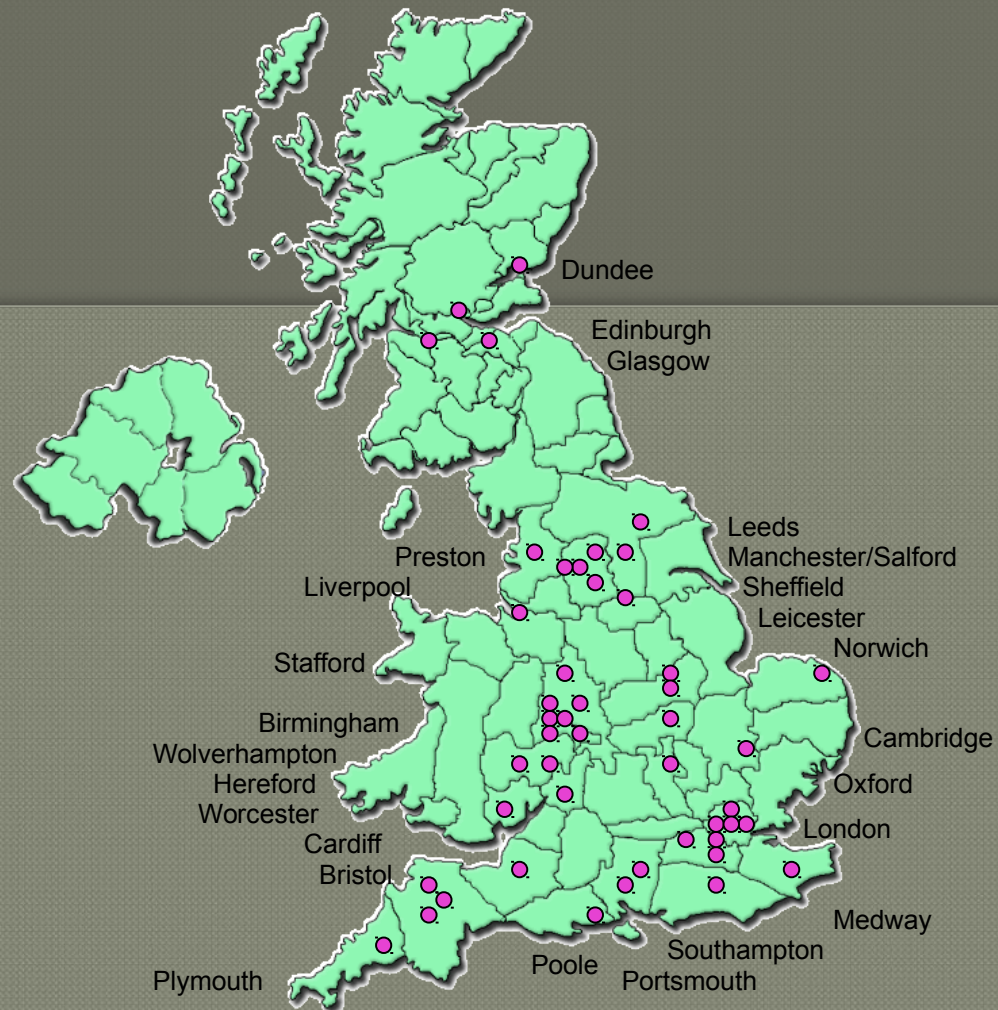
3. Recording analysis

- Sensory nerve comparative test
- Test of median motor nerve conduction across the wrist.
- Motor nerve conduction in the forearm

4. Report analysis

- The investigation report.
- Abnormality reporting analysis.
- Professional status of reporter and recorder identified.
- Responsibility marking.

Response analysis



Response analysis

30 Centres contributed data across Great Britain, Wales and Scotland.

591 Individual studies recorded and submitted.

20 Is the Mode of responses received.

19.7 Is the Mean of the responses received.

20 Is the median of the responses received.

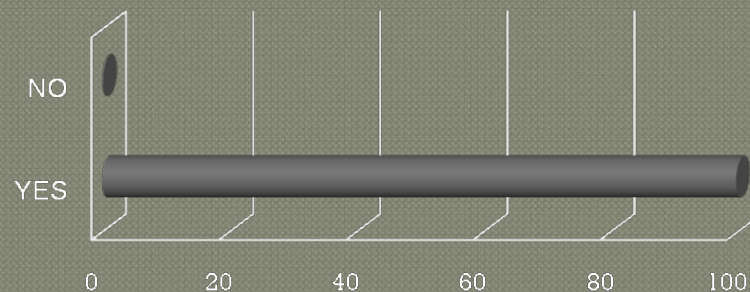
9 – 25 Was the range of responses received.

Pre-test analysis

1. Before starting testing the patient is identified and the clinical information from the referral verified.

Number of responses = 591 of which YES = 590 (99.8%) and NO = 1 (0.2%)

Number of patients identified and compared to the referring clinical letter (%).



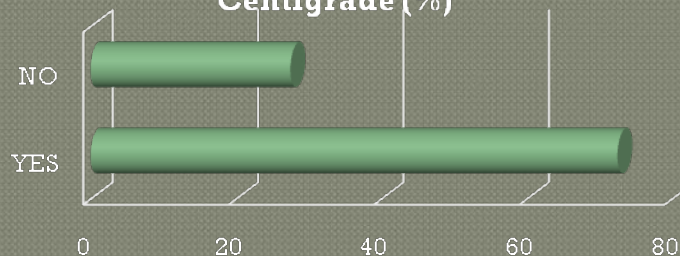
	YES	NO
Series1	99.8	0.2

Pre-test analysis

2. Hand temperature is measured, recorded and maintained above 30 degrees Centigrade.

Number of responses =591 of which YES = 429(72.5%) and NO = 162 (27.5%)

**Hand temperature is measured, recorded
and maintained above 30 degrees
Centigrade (%)**



	YES	NO
Series1	72.5	27.5

Pre-test analysis

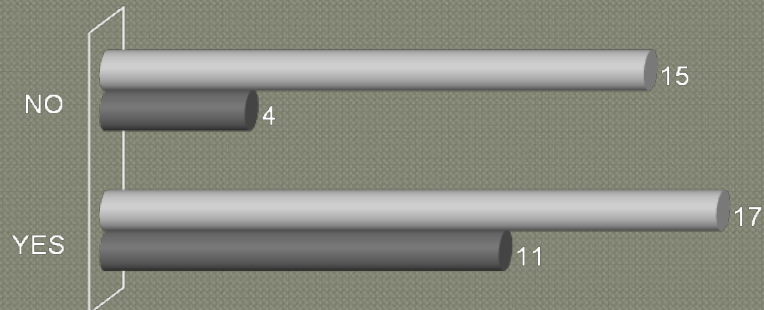
Centre analysis (N=30)

Affected by a YES response = 17 (57%)
> 3 = 17 (57%), of which all responses were YES = 11 (64.7%)

Affected by a NO response = 15 (50%)
1 = 3 (20%)
2-3 = 1 (6.7%)
>3 = 11 (73.3%), of which ALL responses were NO = 4 (36.4%)

Departmental Adherence to hand temperature measurement.

- Response type made by department
- All department responses are the same

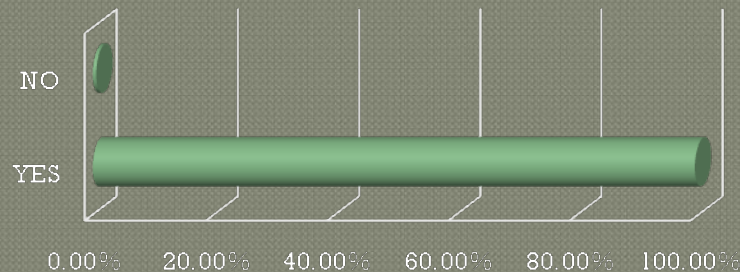


Recording analysis

1. Sensory nerve conduction is performed on a median digital sensory nerve in the most affected hand using surface electrodes and measuring response amplitude and latency/velocity.

Number of responses =591 of which YES =588 (99.4%) and No = 3 (0.6%). 2 centres affected (6.7%)

Performed sensory nerve conduction on a median digital nerve in the affected hand.



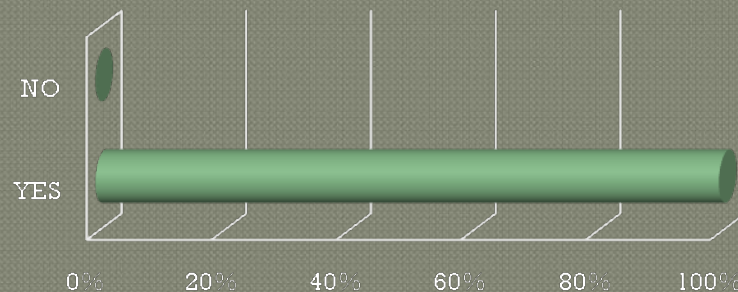
	YES	NO
Series1	99.40%	0.60%

Recording analysis

2. A comparative test of conduction in a digital nerve not innervated by the median nerve is performed in the same hand.

Number of responses = 591 of which YES = 591(100%) and NO = 0 (0%)

Numbers of comparative digital nerve test performed for a study



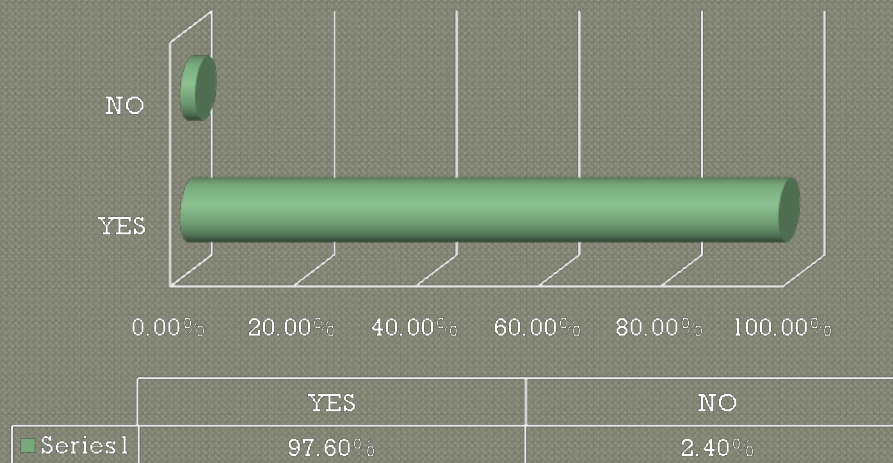
	YES	NO
Series1	100%	0%

Recording analysis

3. A test of median motor nerve conduction across the wrist in the affected hand is performed using surface electrodes and measuring response amplitude and latency/velocity.

Number of responses = 591 of which YES = 577 (97.6%) and NO = 13 (2.4%) of which a total of 1 (3.3%) centre affected.

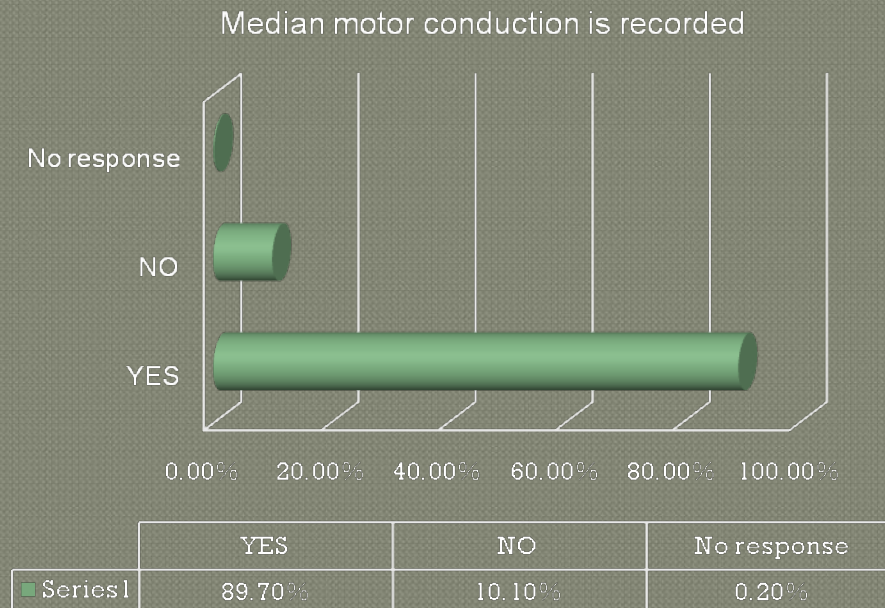
Responses that employed a test of the median motor nerve in the affected hand.



Recording analysis

4. Median motor nerve conduction in the forearm is performed on the affected limb using surface electrodes and measuring response amplitude and latency/conduction velocity.

Number of responses = 591 of which YES = 530 (89.7%) and NO = 60 (10.1%) . No response = 1 (0.2%)



Recording analysis

4. Median motor nerve conduction in the forearm is performed on the affected limb using surface electrodes and measuring response amplitude and latency/conduction velocity – by centre.

Centre analysis (N=30)

Affected by a YES response = 29(96.7%)

1 = 1 (3.4%)

2-3 = 0(0%)

> 3 = 28(96.6%), of which all responses were YES = 23 (79.3%)

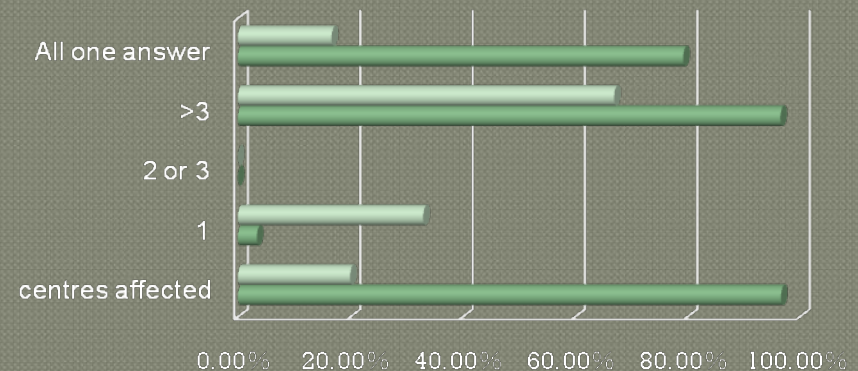
Affected by a NO response= 6(20%)

1 = 2(33%)

2-3 = 0 (0%)

>3 = 4(67%), of which ALL responses were NO = 1 (16.7%)

Centre analysis of median motor conduction responses

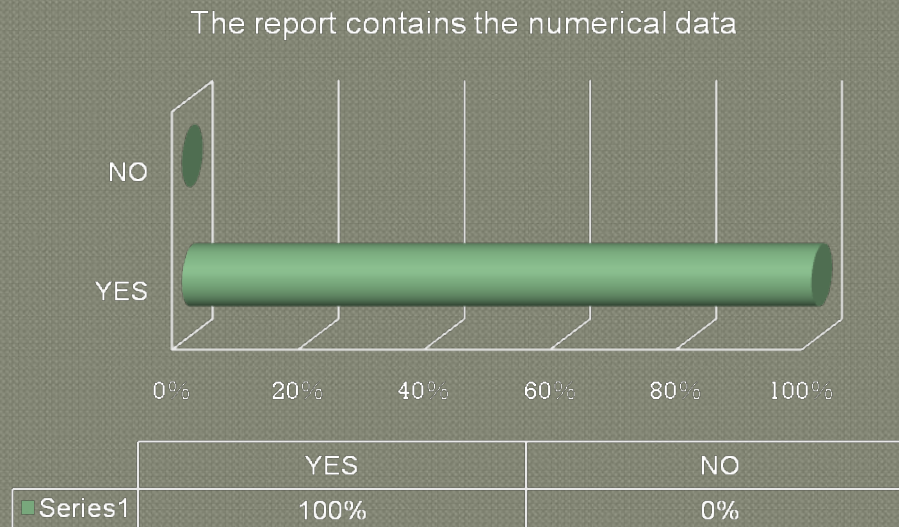


	centres affected	1	2 or 3	>3	All one answer
■ NO	20%	33%	0%	67%	16.70%
■ YES	96.70%	3.40%	0%	96.60%	79.30%

Post-test (Report) analysis

5. The report of the investigation contains the numerical data.

Number of responses =591 of which YES = 591(100%) and NO = 0 (0%) .



Post-test (Report) analysis

6. Abnormal results recorded .

Number of responses =591 of which YES = 391(66.2%) and NO = 200 (33.8%) .

Centre analysis (N=30)

Affected by a YES response = 30(100%)

1 = 0 (0%)

2-3 = 0(0%)

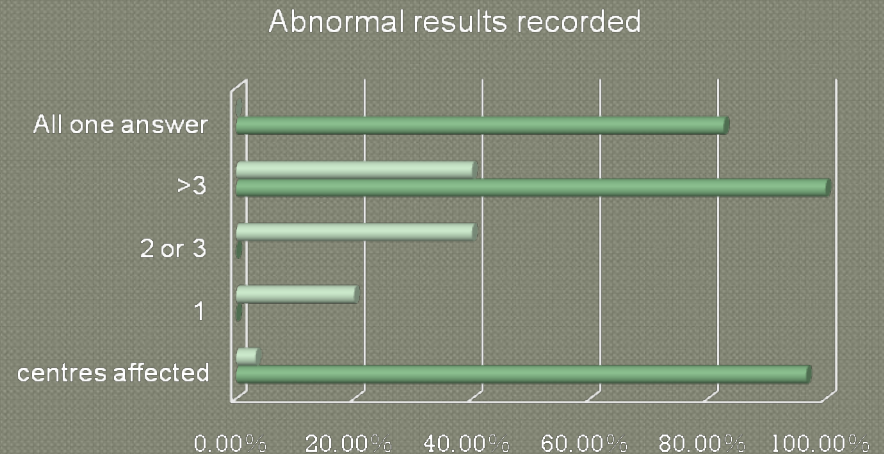
> 3 = 30(100%), of which all responses were YES = 1 (3.3%)

Affected by a NO response= 29(96.7%)

1 = 0(0%)

2-3 = 2 (6.9%)

>3 = 27(93.1%), of which ALL responses were NO = 0 (0%)



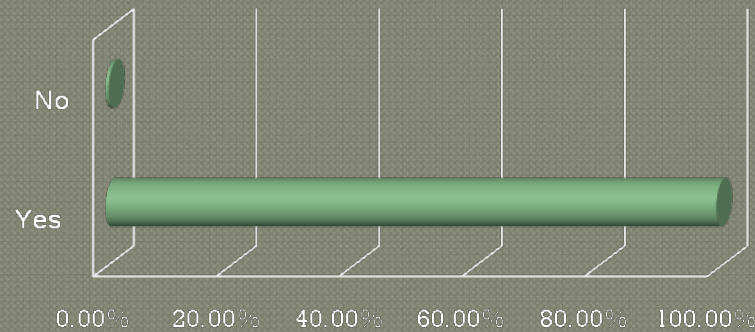
	centres affected	1	2 or 3	>3	All one answer
■ NO	3%	20%	40%	40%	0.00%
■ YES	96.70%	0.00%	0%	100.00%	82.70%

Post-test (Report) analysis

7. The report makes a statement on any abnormality detected.

Number of responses = 391 of which YES = 388 (99.5%) and NO = 3 (0.5%) .

Makes a statement on any abnormality detected



	Yes	No
■ Series1	99.50%	0.50%

Post-test (Report) analysis

7. The report makes a statement on any abnormality detected – by centre.

Number of responses = 391 of which YES = 388 (99.5%) and NO = 3 (0.5%) .

Centre analysis (N=30)

Affected by a YES response = 30 (100%)

1 = 0 (0%)

2-3 = 0 (0%)

> 3 = 30 (100%), of which all responses were YES = 29 (96.7%)

Affected by a NO response = 1 (3.3%)

1 = 0 (0%)

2-3 = 1 (100%)

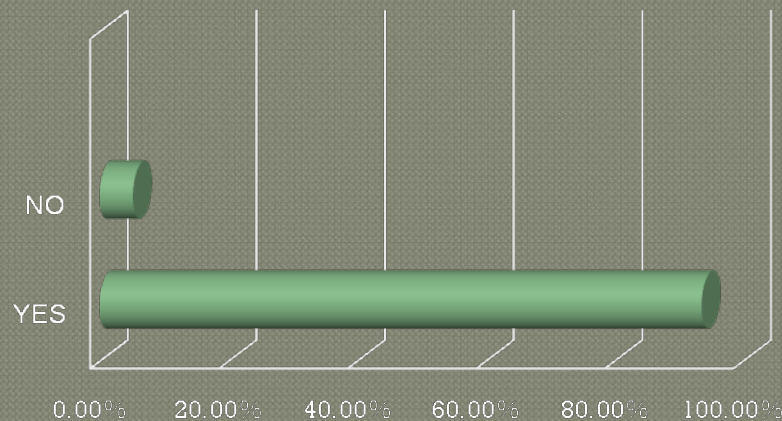
> 3 = 0 (0%), of which ALL responses were NO = 0 (0%)

Post-test (Report) analysis

8. The professional status of the practitioner performing the investigation and report is identified.

Number of responses =591 of which YES = 553(93.6%) and NO = 31 (5.2%) . No response = 7 (1.2%).

Professional status of reporter is identified.



	YES	NO	
■ Series1	93.60%	5.20%	

Post-test (Report) analysis

8. The professional status of the practitioner performing the investigation and report is identified – centre analysis.

Number of responses = 591 of which YES = 553(93.6%) and NO = 31 (5.2%) . No response = 7 (1.2%).

Centre analysis (N=30)

Affected by a YES response = 29(96.7%)

1 = 0 (0%)

2-3 = 0(0%)

> 3 = 29(100%), of which all responses were YES = 24(82.7%)

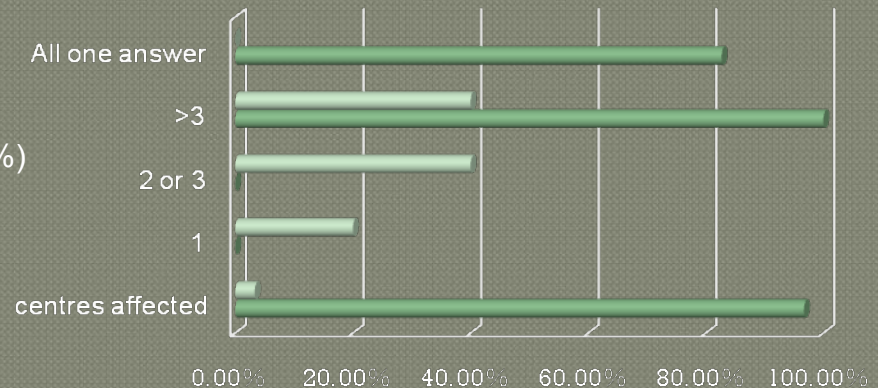
Affected by a NO response= 5(16.7%)

1 = 1(20%)

2-3 = 2(40%)

>3 = 2(40%), of which ALL responses were NO = 1 (50%)

The professional status of the practitioner is identified
- by centre

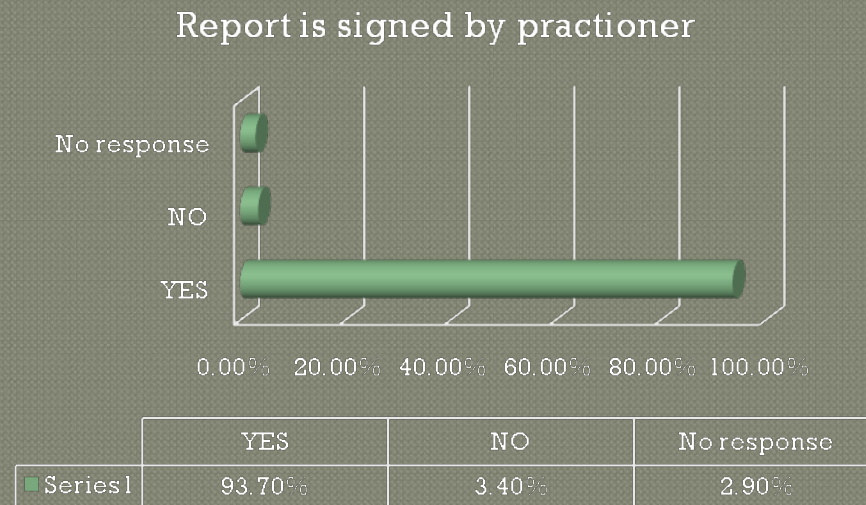


	centres affected	1	2 or 3	>3	All one answer
■ NO	3%	20%	40%	40%	0.00%
■ YES	96.70%	0.00%	0%	100.00%	82.70%

Post-test (Report) analysis

8. The report is signed by the practitioner taking medico-legal responsibility for it.

Number of responses = 591 of which YES = 554 (93.7%) and NO = 20 (3.4%) . No response = 17 (2.9%).



No response analysis

One centre which accounted for 76.2% (17) of the no response population commented that the report was countersigned by the consultant..

Summary

The findings of this study can be summarised as below:

BEFORE RECORDING

Before testing the patient is identified, clinical information sought in the majority of cases (99.8%).

Hand temperature is measured, recorded and maintained to <30 degrees Centigrade in the majority of cases (72.5%)

RECORDING

In most cases (99.4%) sensory nerve conduction is performed on a median digital nerve in the most affected hand. Amplitude, latency and velocity are all measured.

A comparative test of conduction in a digital nerve NOT innervated by the median nerve is performed in ALL cases. Amplitude, latency and velocity are all measured.

A test of median motor nerve conduction across the wrist, in the affected hand, is performed in nearly all of the cases (97.6%). Amplitude, latency and velocity are all measured.

Median motor conduction at the forearm is performed on the affected limb on most occasions (89.7%). Amplitude, latency and velocity are all measured.

REPORT

The report contains (100% of cases) the numerical data, abnormal results are recorded and a statement of abnormality is made (99.5% of cases).

The report contains the status of the professional (93.6% of the cases) and is signed (93.7%) by the individual taking responsibility for it.

Recommendations

Based on the audit results.....

We, the BSCN and ANS Audit group offer

NATIONAL CTS recording STANDARD of PRACTICE.

This comprises of the following::

1. Identify and verify the identity of the patient. Gather clinical information and record/maintain peripheral hand temperature at ≥ 30 degrees centigrade.
2. Sensory median nerve to be recorded in the affected hand with a comparative NON median nerve. Amplitude, latency and velocity are all measured.
3. Motor nerve conduction to be recorded at the wrist and elbow of the affected limb with a comparative NON median nerve. Amplitude, latency and velocity are all measured.
4. The report should contain the numerical data, identification of the professional recording the data and a signature of the individual taking medico-legal responsibility for it. A statement of ANY abnormal results should be made.

The standard does not indicate non standard testing that may be used to enhance marginal changes. These should be used then documented as if adhering to the standard.

Acknowledgements

To all those that contributed to this audit.

To all those that contributed to the initial development of this audit

To all those on the audit committee

To the ANS and BSCN for continuing support

AND FINALLY BUT NOT LEAST

To our families that gave up their time to allow us to provide you with an outcome.