Oslo University Hospital

DIGQUAL:

A FIRST STEP TOWARDS STANDARDIZED QUALITY INDICATORS FOR NEUROPHYSIOLOGY LABS

REPORT FROM THE DIGMINE PROJECT GROUP

https://www.ous-research.no/digmine

SUMMARY

Nerve conduction studies (NCS) are dependent of the examining procedure and the equipment settings used. Standardized measurements of high quality are vital for good patient care. The quality committee for clinical neurophysiology in Norway has since 1993 worked extensively to standardize NCS in clinical neurophysiological labs in Norway.

To assess the overall quality of NCS in Norway, we analyzed the statistical distributions and median timelines for 610 000 amplitudes and conduction velocities of the radial, sural and peroneal nerves sampled from 10 different Norwegian neurophysiological labs since 1998 to 2023.

We found considerable differences between labs. The differences were most apparent when comparing amplitudes between large and small hospitals. There were also significant differences between conduction velocities done ortho- vs antidromically on the same segments. All but one lab had at least one change in their median timelines of the analyzed nerves. We also revealed that laboratories in Norway lack standardization in naming of NCS measurements and stimulating sites. Lack of consistent allocation of personnel names to each sampled measurements made internal analysis of the labs difficult.

Our findings show that tracking NCS measurements systematically over time may be useful for assessing and monitoring quality of nerve conduction studies. More work is needed to further develop quality indicators for clinical neurophysiology. This includes development of an environment that can warn laboratories about internal changes or differences between laboratories: Including more nerves than the small sample analyzed in this report may also be useful.

BACKGROUND

Referral to a clinical neurophysiological lab for nerve conduction studies (NCS) or other neurophysiological measurements are necessary for many neurological disorders. Accurate measurements of high quality are important for correct diagnosis. Because the values measured depends a lot on the procedures in the lab, the measuring procedures must be standardized for the results to be comparable.

To solve this comparability problem and increase the quality of the labs, a national collaborative initiative was started in the 1990s through the Norwegian medical association. The quality committee for clinical neurophysiology in Norway published the first guidelines for methods in clinical neurophysiology in 1993-1997. The guidelines were revised by the quality committee for clinical neurophysiology in Norway in 2004-2008, 2016 and 2020.

The DIGMINE project (Figure 1), funded initially by the Norwegian Medical Association and now by Helse Sør-Øst RHF, aims to improve diagnostics by datamining in historical neurophysiological data. The project started at the Oslo University Hospital, but has now established collaboration with 10 other hospitals in Norway (see Figure 2). It is divided into two parts; a quality project and a research project. The quality project aims to investigate and improve the quality of services provided by Norwegian neurophysiology labs.

Figure 1: The idea behind the DIGMINE quality project. By analyzing data from hospitals in Norway and improving standardization and accurate diagnosis setting, we ultimately aim to improve patient care.

Norwegian hospitals have digital databases of neurophysiological data dating back to approximately the year 2000. We have signed data sharing agreements with the collaborating hospitals which has allowed us to extract anonymized historical data from those hospitals and gather the data in one database of 220 000 patients. We have also developed a computer program, DIGQUAL, for visualizing and comparing this data. For this report, we wanted to investigate the quality of the Norwegian neurophysiology labs by analyzing a subset of this historical data.

We assume that the Norwegian population is similar in all parts of the country and thus the statistical distributions of a measurement from the labs should look similar. In the same fashion, if every clinician/technician gets patients assigned at random and they use the same procedures, the statistical distributions of a measurement performed by different personnel should look similar. Similarly, medians of the same measurement over time should also be stable unless there are significant changes in the laboratory, including changes in referral population, changes in lab procedure, and recalibration of equipment.

Figure 2: The participating Norwegian hospitals in the DIGMINE project.

METHODS

We used our developed program, DIGQUAL (Figure 3), to visualize 660 000 conduction velocities and amplitudes of the radial, sural and peroneal nerves sampled from 10 different hospitals in Norway since approximately year 2000.

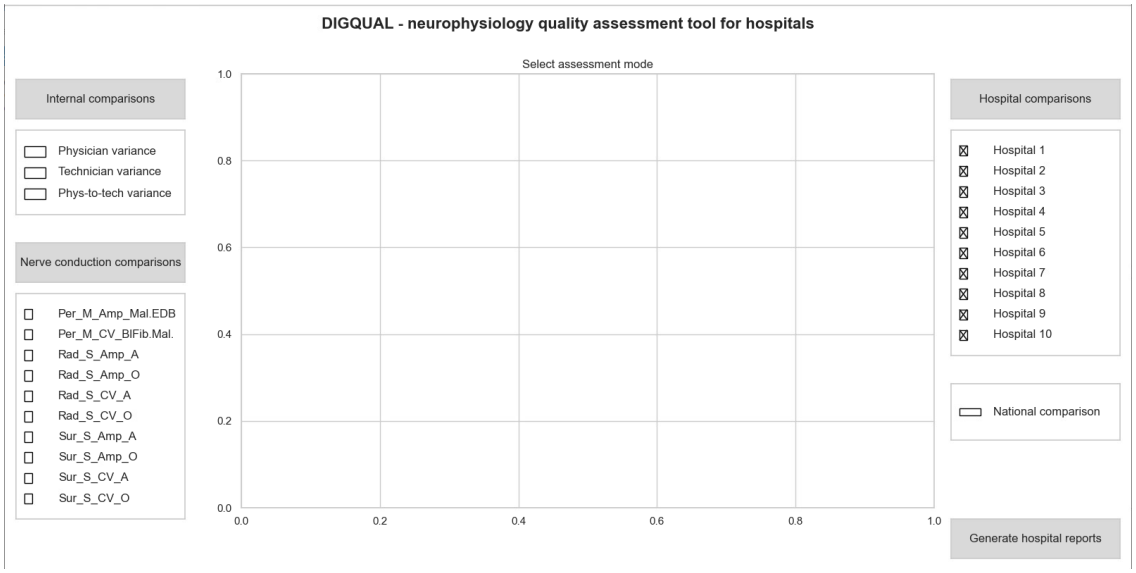

Figure 3: The DIGQUAL program user interface. It is a standalone program fully written in python for assessing coherence between nerve conduction studies between different hospitals as well as internally for each individual hospital. It also has the function to generate pdf reports for each participating hospital. It supports visualizing medians of measurements and statistical distributions of measurements taken at hospitals or by personnel.

We looked at three quality indicators:

1. monthly median timelines (Figure 4)
2. lab statistical distributions (Figure 5)
3. personnel statistical distributions (Figure 6)

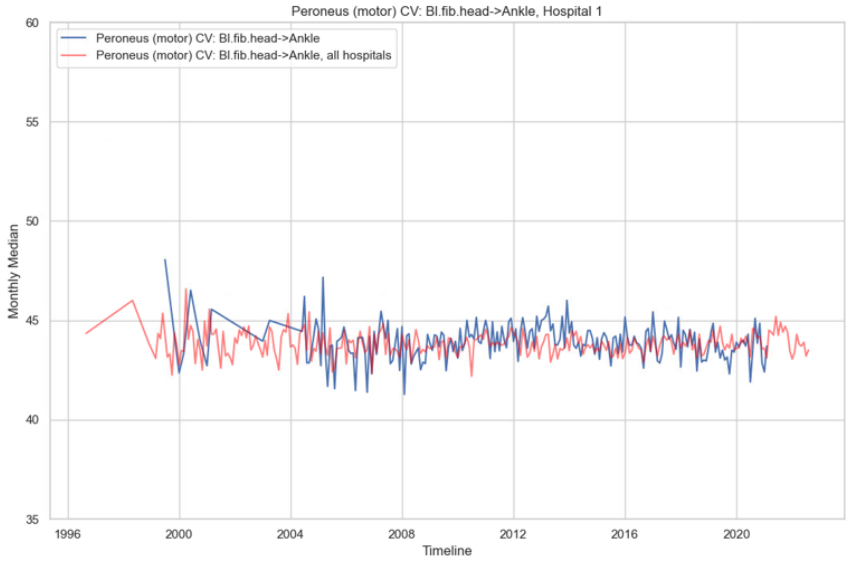

Figure 4: Example of a monthly median timeline of the conduction velocity (m/s) of the peroneal nerve on the below fibula head to ankle segment. This timeline is stable (horizontal) with small amounts of variation. The blue line shows the investigated hospital. The blue line are all the other hospitals for comparison.

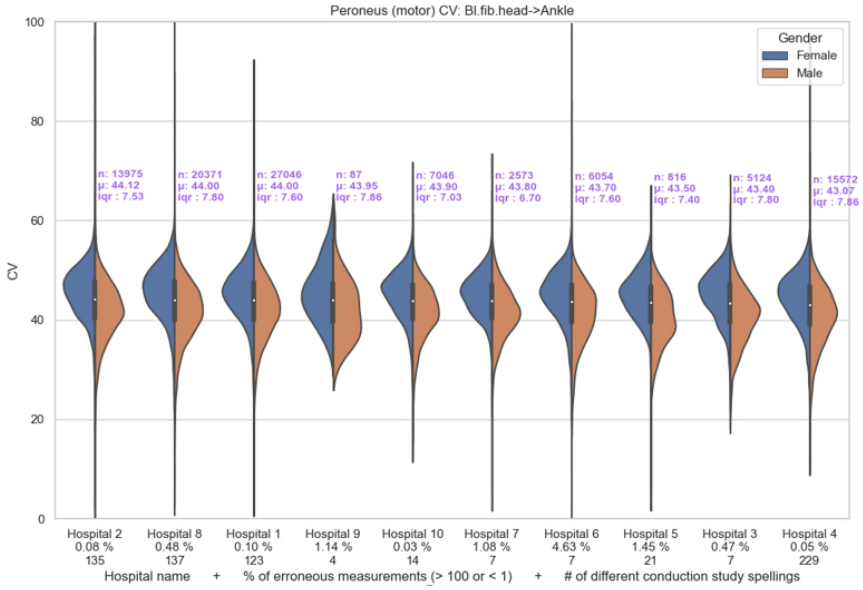

Figure 5: Example of stable hospital statistical distributions of the peroneal nerve conduction velocities (m/s) on the below fibula head to ankle segment. The hospitals are sorted by mean conduction velocity (highest to the left).

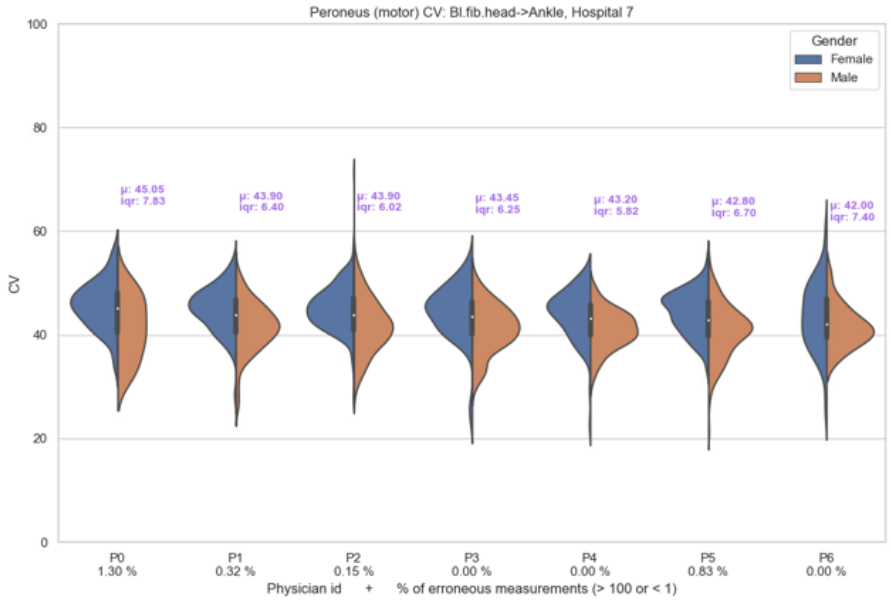

Figure 6: Example of stable clinician statistical distributions of the peroneal nerve conduction velocities (m/s) on the below fibula head to ankle segment. All clinicians are from the same lab. Clinicians are sorted by mean conduction velocity (highest to the left).

RESULTS

We observed significant changes in both median timelines and statistical distributions between the labs. All but one lab had at least one change in their median timelines of the analyzed nerves (see Figure 7 and Figure 8 for examples). The differences in statistical distributions were most apparent when comparing amplitudes between large and small hospitals (Figure 9).

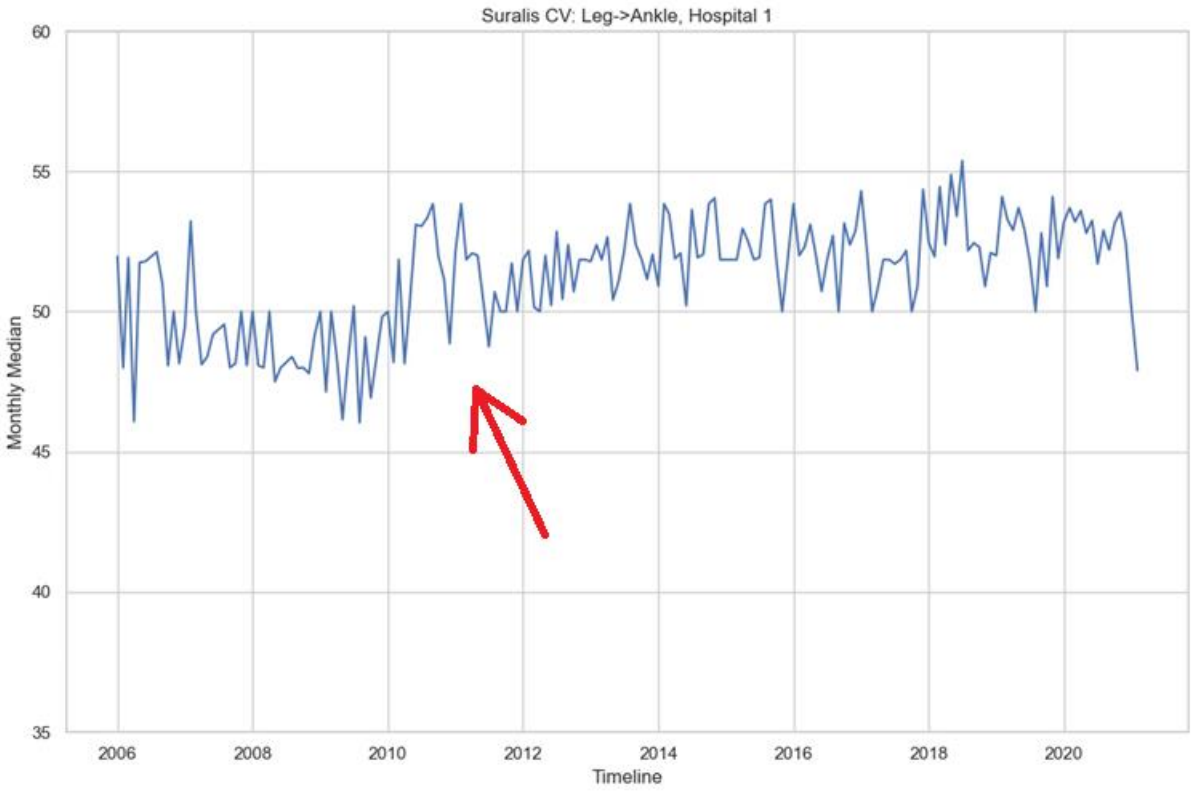

Figure 7: Example of a one time median shift where the monthly conduction velocity median jumps about 3.5 m/s during 2011.

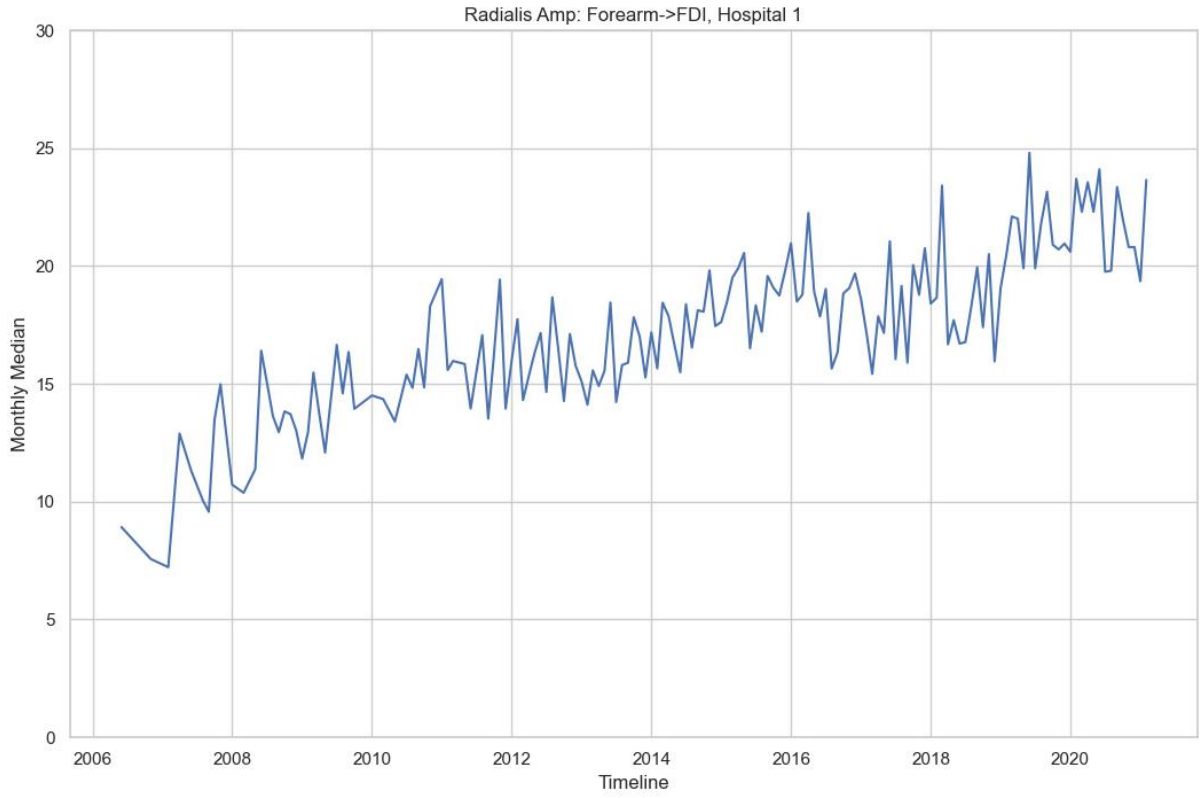

Figure 8: Example of a continuous median shift of the n. radialis amplitudes.

There were also significant differences between conduction velocities done ortho- vs antidromically for the same nerves on the same segments (one example is shown in Figure 10). Lack of consistent allocation of personnel names to each sampled measurements made comparing intra-personnel statistical distributions for the labs difficult and is not included in this report.

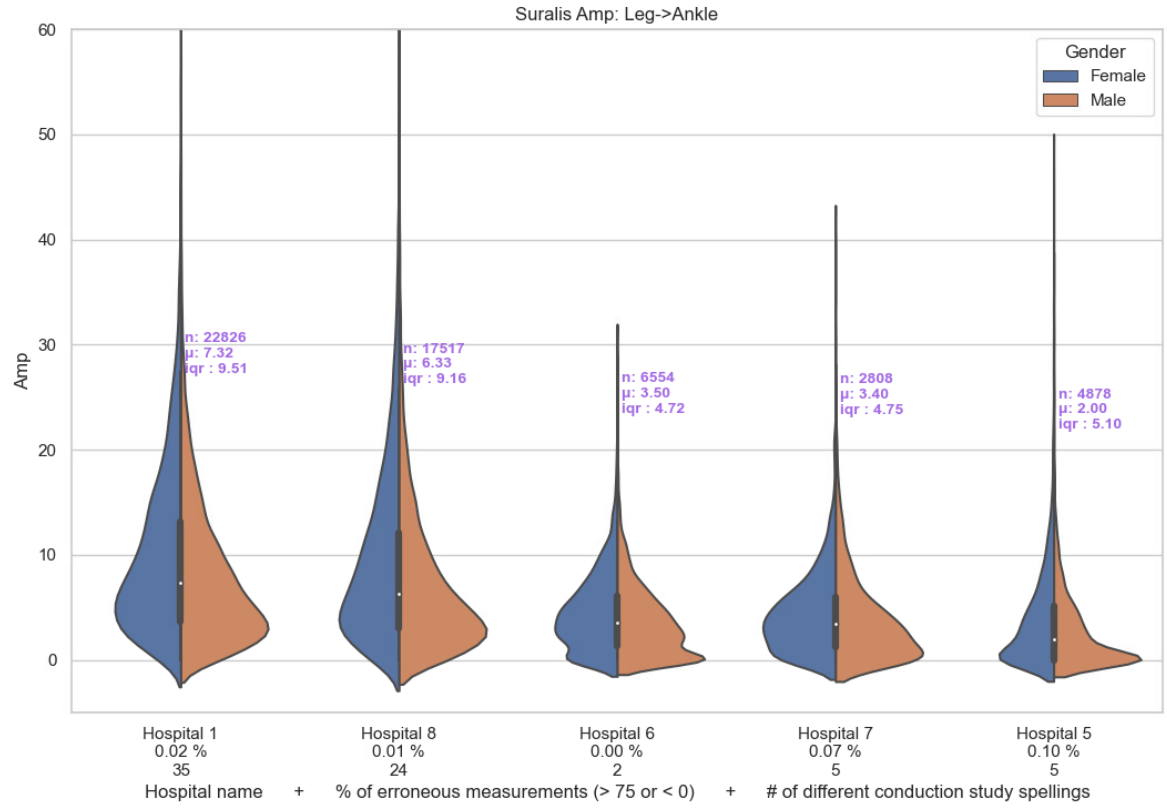

Figure 9: Statistical distribution differences in n. suralis amplitudes when comparing big (the two violin plots to the left) and small hospitals (the three violin plots to the right).

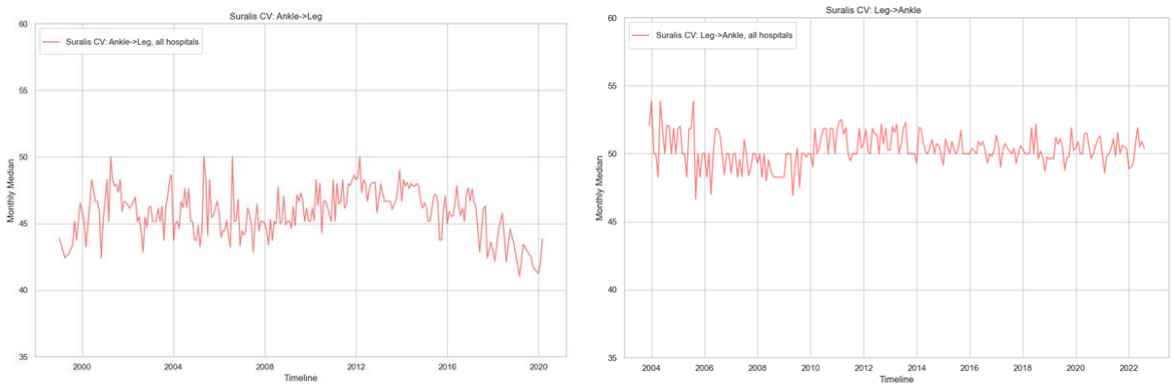

Figure 10: Consistent 5 m/s differences between labs measuring conduction velocities orthodromically (left graph) and labs measuring conduction velocities antidromically (right graph) on the same segment.

We found lack of standardized naming for NCS measurements and stimulation sites. For some hospitals, there were more than 100 different spellings of the same nerve measurement segment.

CONCLUSION AND RECOMMENDATIONS

From this preliminary investigation, we found that despite the extensive work done by the quality committee for clinical neurophysiology in Norway since 1993, there are still quite big differences between the labs and many measurements are not stable over time. This may be caused by changes in quality, insufficient standardization or changes in procedures. This may make comparisons of patient results from different times uncertain, and make it difficult for patients to get follow-ups at different labs.

We also revealed a lack standardization for NCS measurements and stimulation sites. There are also no consistent annotation of the personnel performing the measurements which is required to investigate personnel variability within the lab.

To improve patient care, we recommend the following as the next steps:

- Focus on standardized and correct annotation in neurophysiological labs. This is important to ensure that databases with neurophysiological measurements can be used for meaningful analyses.
- Median timelines and statistical distributions for NCS and other neurophysiological measurements should be evaluated regularly in order to warn labs about changes in quality.