Perspectives on functional and hyperkinetic movement disorders
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Chapter 3

CLINICAL DECISION-MAKING IN FUNCTIONAL AND HYPERKINETIC MOVEMENT DISORDERS

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ABSTRACT

OBJECTIVE
Functional or psychogenic movement disorders (FMD) present a diagnostic challenge. To diagnose FMD, clinicians must have experience with signs typical of FMD and distinguishing features from other hyperkinetic disorders. The aim of this study was to clarify the decision making process of expert clinicians while diagnosing FMD, myoclonus and tics.

METHODS
Thirty-nine movement disorder experts rated 60 patients using a standardized web-based survey resembling clinical practice. It provided five steps of incremental information: 1) visual first impression of the patient, 2) medical history, 3) neurological examination on video, 4) the Bereitschaftspotential (BP) and 5) psychiatric evaluation. After full evaluation of each case, experts were asked which diagnostic step was decisive. In addition, interim switches in diagnosis after each informational step were calculated.

RESULTS
After full evaluation, the experts annotated the first impression of the patients as decisive in 18.5% of cases. Medical history was considered decisive in 33.3% of cases. Neurological examination was considered decisive in 39.7%, the BP in 8% and the psychiatric interview in 0.5% of cases. Most diagnostic switches occurred after addition of the medical history (34.5%). Addition of the neurological examination led to 13.8% of diagnostic switches. The BP results led to diagnostic switches in 7.2% of cases. Psychiatric evaluation resulted in the lowest number of diagnostic switches (2.7% of cases).

CONCLUSIONS
Experts predominantly rely on clinical assessment to diagnose FMD. Importantly, ancillary tests do not determine the final diagnosis of this expert panel. In general, the experts infrequently changed their differential diagnosis.
INTRODUCTION

Diagnostic reasoning is a dynamic process. During diagnostic reasoning clinicians use heuristics or problem solving techniques based on their prior clinical experience. (1) Functional or psychogenic movement disorders (FMD) present a diagnostic challenge and the clinician must be familiar and experienced with the clinical manifestations of various types of movement disorders to recognize clinical characteristics of FMD. (2) FMD are a subtype of conversion disorder and comprise abnormal movements which cannot be attributed to other neurological disorders. (2) However, FMD should not be regarded as a diagnosis ‘per exclusionem’ and, therefore, diagnostic criteria advocate the reliance on positive criteria in support of FMD. (3) For instance, improvement of symptoms during distraction, entrainment with voluntary movements, and suggestibility of symptoms all positively support the diagnosis of FMD. (2) The diagnostic process of FMD can be supported by electrophysiological testing with a combined EEG and EMG measurement with jerk-locked back averaging to determine the presence of a Bereitschaftspotential (BP). (4, 5) Until now, however, data is lacking on the perceived importance of ancillary testing in the diagnostic work-up of hyperkinetic movement disorders and if ancillary testing determines the final diagnosis.

Previously, we conducted in a web-based survey to assess inter-rater agreement of 39 well-established clinical experts who diagnosed 60 patients with hyperkinetic movement disorders. (6) The diagnostic process consisted of five standardized diagnostic steps, starting with a first impression on video, followed by medical history, neurological examination on video, electrophysiological data and the results of a standardized psychiatric interview. In the previous study we found that the overall inter-rater agreement on the diagnosis of FMD and two other hyperkinetic disorders (tics and myoclonus) was moderate (mean Kappa = 0.56; SD±0.1). (6) Compared to other studies, the agreement rate is rather good considering the large number of experts and patients participating in our study. (7-9)

The current report is based on the expert panel data, but is analyzed with a different goal. Here we aim to investigate the diagnostic decision making process and the value of each of the five diagnostic steps in determining a final diagnosis among hyperkinetic movement disorders. In addition, we examine if the diagnostic process of patients with FMD differs compared to other hyperkinetic movement disorders. The diagnostic decision making and heuristics of experts clinicians thereby provides highly valuable insight into how experts diagnose functional and hyperkinetic movement disorders. Our research questions are the following. First, which part of the incremental clinical information is considered decisive in diagnosing FMD and other hyperkinetic movement disorders? Second, does the decisive diagnostic step differ for FMD, tics and myoclonus? Last, which diagnostic information results in diagnostic switching by clinicians?
METHODS

A case series of 60 patients with hyperkinetic movement disorders and 39 experts participated in the study. Each expert provided a final diagnosis for each case, without reference to diagnoses of the research team that gathered the cases. The final diagnosis per case varied, as is reflected by the moderate interrater agreement. About half of the patients were diagnosed as FMD by the expert panel. Details of the study have been previously reported.(6) The design of the study is illustrated in Figure 1.

In brief, the selection process of participating clinical experts comprised the following. Experts were invited to participate based on the number of articles published on the topics ‘tics’, ‘Tourette syndrome’, ‘myoclonus’, ‘conversion disorder’ and ‘psychogenic movement disorder’ on ISI Web of Knowledge (http://apps.webofknowledge.com, October 2010). Moreover, we asked the selected experts to recommend additional clinical experts and invited those experts with multiple recommendations. In total, 67 experts were invited of which 42 agreed to take part in the study (response rate 63%). Thirty-nine of the 42 experts who signed the consent form finished the review process (93% finished). The main reason to discontinue the review process was lack of time.

All 60 patients underwent a standardized clinical work-up. In the structured online survey, we serially presented 1) a short video to provide a first visual impression of the patient, 2) the patient’s medical history, 3) neurological examination (including distractibility, suppression and release of jerks) on video, and additional video recordings of the patient and the neurological examination (total duration 25 minutes, available on demand in separate, standardized video clips (e.g. video while the patient was alone in the examination room or functional performance) 4) electrophysiological data (presence or absence of the BP, available in 48 patients), and finally 5) the results of the diagnostic interview for psychopathology (Mini-International Neuropsychiatric Interview-Plus (MINI-Plus);(10) by a neuropsychologist, blinded for subject status. The BP is a movement-related EEG potential indicative of (pre)motor cortex activation. In healthy subjects, the BP precedes voluntary movement.(5) Several studies found a BP can precede the movements in most patients with FMD and in some patients with tics.(5)

At each of the diagnostic steps, the experts could choose FMD, myoclonus or tic as the most likely diagnosis. At the end of each single case, experts were requested to make their final diagnosis. Experts were unable to return to previous answers and had to finish the review of an entire case at once, but could log-out between cases.

To determine the decisive diagnostic step by the rating clinical experts, we first set out to determine which particular diagnostic step in each case was most decisive and therefore contributed most to the diagnostic decisions after completion of each separate case. Second, we assessed the decision making of the physicians based on switches in the diagnosis. The underlying assumption is that a switch in diagnosis at a diagnostic step increases the diagnostic value of that step.
The 60 included cases were randomized into four groups of 15 patients. Each of the 39 clinicians diagnosed only one subset, consisting of 15 patients. Each case comprised four options to switch in final differential diagnosis (four diagnostic steps, see Figure 1). In total, combining all diagnostic steps and all experts together, there were 585 diagnostic switch options (39 experts x 15 cases). Hence, theoretically the total number of diagnostic switch options was 2340 (39 experts each reviewed 15 cases with 4 diagnostic steps per case; = 39x15x4).

The importance of diagnostic steps and switch in differential diagnosis per decision point are summarized using simple descriptive statistics. In the results section, percentages of diagnostic switches are expressed as either; 1) per total diagnostic switch options (number of switches divided by 2340) or 2) per switch options per diagnostic step (number of switches divided by 585). Additionally, we analyzed the association between the number of switches per diagnostic step and the relative increase in (the previously reported) inter-rater agreement per step using Spearman’s rank correlation. The relative increase in inter-rater agreement was calculated as the Kappa coefficient of the consecutive diagnostic step minus the Kappa coefficient of the previous step. The Spearman’s rank correlation was also used to determine the association between the diagnostic value (importance) of each diagnostic step as indicated by the experts and the inter-rater agreement per step. A p-value < 0.05 was considered statistical significant. All analyses were performed in IBM SPSS statistics version 19.0).

**STANDARD PROTOCOL APPROVALS, REGISTRATIONS, AND PATIENT CONSENTS**

The study was approved by the medical ethics committee of the Academic Medical Center in Amsterdam, the Netherlands. All patients were informed about the aim of the study and gave written informed consent to accessibility of their (blinded) medical data, including video recordings, on the hospital server via a secure internet connection. All experts signed a non-disclosure agreement.
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**Figure 1** Overview of the study design

Figure 1 Medical data were incrementally provided in a standardized manner. After each diagnostic step, the expert annotated the current diagnosis. After the final diagnosis was made, we asked the expert which part of the diagnostic process had been decisive per case. Second, we calculated the number of diagnostic switches per diagnostic step per case.

**Figure 2** Diagnostic step considered decisive by experts in the decision making process per diagnosis.

Figure 2 displays the decisive value attributed by the experts per diagnostic step per diagnosis. Diagnostic information was provided incrementally. Each expert annotated per case which diagnostic step had been decisive after making the final diagnosis of each case. Note that all diagnoses are primarily based on the clinical evaluation (first impression, medical history and neurological exam) and not on additional investigations (Bereitschaftspotential (BP) and psychiatric evaluation). In FMD the neurological exam was considered most decisive. For tics, the medical history was regarded as most important for diagnosis and the BP was relatively unimportant. In none of the diagnoses, psychiatric evaluation was considered decisive.
RESULTS

DECISIVE VALUE PER DIAGNOSTIC STEP
When asked to annotate the most decisive information used to determine the final diagnosis across all hyperkinetic disorders, experts regarded the first impression of the patient on video to be most decisive in 18.5% of the cases, medical history as most important in 33.3%, and the neurological examination on video as decisive in 39.7% of cases. The decisive values attributed to the BP (8%) and psychiatric interview (0.5%) were much lower. In tics, the medical history was considered most important in decision making (49% of tic cases). The neurological examination was considered most decisive in decision making in myoclonus (55%) and FMD (40%). The BP was decisive in 10% of myoclonus cases, 12% of FMD cases and 1% of tics cases (Table 1). Figure 2 illustrates the differences between diagnoses in attributed value for each diagnostic step.

DIAGNOSTIC SWITCHES
The total number of diagnostic switches at all decision points was 341 (14.6% of the total of 2340 possible switch options). Most of the switches occurred after the diagnostic decision point following the addition of the medical history (34.5% of the switch options (n=585) possible at this decision point). The addition of the neurological examination led to 13.8% diagnostic switches. The BP results led to 7.2% diagnostic switches and the final addition of psychiatric evaluation resulted in the lowest percentage of switches (2.7% of the switch options). See Table 1 for details.

Spearman's correlation (Rs) was performed to determine the relationship between the number of switches per diagnostic step and the relative increase in the inter-rater agreement per step, and a strong, positive monotonic correlation was found (Rs = 1.00, p < 0.001). In addition, Spearman's correlation was also used to determine the relationship between the diagnostic value (importance) of each diagnostic step as indicated by the experts and the inter-rater agreement per step, which showed no significant association (Rs = -0.60, p = 0.29).
Table 1

<table>
<thead>
<tr>
<th>Incremental medical information</th>
<th>Importance of diagnostic step (%) in decision making as attributed by experts</th>
<th>Switch in diagnosis per diagnostic step (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First video impression</td>
<td>18.5</td>
<td>-</td>
</tr>
<tr>
<td>Medical history</td>
<td>33.3</td>
<td>34.5</td>
</tr>
<tr>
<td>Neurological examination</td>
<td>39.7</td>
<td>13.8</td>
</tr>
<tr>
<td>Bereitschaftspotential</td>
<td>8.0</td>
<td>7.2</td>
</tr>
<tr>
<td>Psychiatric evaluation</td>
<td>0.5</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Table 1 Expert rating of importance of decisive diagnostic steps as reported by experts and the percentage of diagnostic switches per diagnostic step. Diagnostic information was provided incrementally and each expert annotated which diagnostic step had been decisive for each case. The last column lists the switches in diagnosis per diagnostic step. The percentage is expressed as the number of diagnostic switches per consecutive diagnostic step divided by the total diagnostic switch options per step.
**DISCUSSION**

The current study evaluated the clinical decision making of movement disorder experts during the diagnostic process of patients with FMD, myoclonus and tics. Experts regarded the first impression of the patients to be decisive in 18.5% and the addition of medical history to the initial impression in 33.3% of cases. Adding the neurological examination was decisive in 39.7% of cases. A remarkable and important novel finding of this study is the relatively low attributed value of additional investigations of either the BP or psychiatric tests. In the current study we show for the first time that the diagnostic value (importance) of the diagnostic step as indicated by the expert clinicians did not correlate significantly with the inter-rater agreement per step. Our findings imply that FMD, tics and myoclonus are diagnoses based on expert opinion, and that experts’ heuristics on how to arrive at this diagnosis may vary considerably.

We observed differences between patient groups in the importance attributed by clinicians to the various diagnostic steps. In tics, the medical history was judged as the most important when added to the initial video, but in myoclonus and FMD addition of the neurological examination was rated most decisive. In only 8% of cases the clinicians considered the BP of most importance to establish the diagnosis of ‘laboratory supported’ FMD. This finding implies that either the expert was confident in the diagnosis and the BP only further strengthened the expert opinion, or in contrast, the BP does not provide extra diagnostic information. Thus, although the use of the BP is advocated in literature, in clinical practice the BP appears to be of less importance based on the decision making of this expert panel.(4,11)

Interestingly, the standardized psychiatric interview was considered of low importance (only 0.5% of the evaluated cases) and resulted in differential diagnostic switches in just 2.7% of cases. Indeed, a previous survey of movement disorders specialists concluded that psychiatric evaluation is not regarded as the decisive factor in the diagnosis of FMD.(12) Accordingly, the revised diagnostic criteria of the DSM-5 have removed the prerequisite of identifiable psychological etiology. Thus, the current findings are in line with this notion, suggesting that experts diagnose FMD based on the medical history and neurological examination, and not on additional information of psychiatric co-morbidity. In all, movement disorder specialists in our study rather rely on clinical evaluation instead of ancillary testing such as BP measurements or psychiatric evaluation to diagnose hyperkinetic movement disorders.

In this study, we found that experts infrequently alter their first diagnosis. One possible explanation for the low number of differential diagnostic switches is framing. The diagnostic error of framing implies overvaluing of (an item of) clinical information that is presented early in the diagnostic process which stops differential diagnostic reasoning and anchors the final diagnosis.(1,13) For example, in case of an acute onset in a young female patients’ history might prompt the differential diagnosis of FMD and divergent details in the case
history thereafter are discarded. With respect to case descriptions, we have taken the utmost care to prevent framing effects by using standardized sentences for the case history in order to prevent persuading of experts by subtle wording to focus on certain aspects of a case more than others.

We explicitly chose our study setup using a predefined order of diagnostic steps because our interest was for our study to resemble clinical practice instead of presenting information in a random order. The standardized order might in itself have degraded the importance of the ancillary measurements; the further down the line information is presented, the higher the likelihood those experts have already anchored their initial judgement on the final diagnosis. Although the psychiatric evaluation was presented at the last diagnostic step, experts were able to annotate also this diagnostic step as the most important for the differential diagnosis decision making. This was, however, not the case.

Furthermore, the consecutive order of information does make it difficult to definitely ascribe one step to being most important. This is because evaluation of the decisive value of a step in part includes the information presented in the previous steps. This bias induced by the consecutive order would tend to favour the latter steps as being most important. In contrast, the findings of this study demonstrate the opposite, which implies this is not a significant error in our study design. Our conclusions are further supported by the findings of a well-known study on relative contributions of history taking and ancillary investigations to diagnose patients in general medicine. It was also found that medical history taking is relatively more important to establish a diagnosis.

A drawback of our study is the lack of information on motives of the clinicians for not switching in differential diagnosis. It could be that the non-switching was a result of a lack of added value of the next step information as judged by the experts, or the consequence of the fact that current diagnosis was strengthened by the added information. Future studies should therefore investigate this aspect in the decision making process as well.

A limitation of our study is the lack of a ‘gold standard’ to establish the diagnosis FMD. Currently the diagnosis FMD is based on ‘expert opinion’ and therefore we only assessed concordance of opinion (inter-rater agreement) amongst expert clinicians in the previous and current study. In the set-up of the study we specifically chose not to label our own diagnoses as the ‘gold standard’, because additional information was available to the organizing team, for instance non-verbal information gathered during the ‘real life examination’. Up to now, no comparison has been performed of diagnostic agreement of experts on the diagnosis of movement disorders during real life examination compared to video based diagnosis. Therefore, it could be that the inter-rater agreement of real-life assessments of clinicians is higher than video-based assessment and this may influence the generalisability of our findings.
In this study, internationally renowned experts participated and some experts experienced time constraints, reflected in the response rate and the inability to finish the full review process, which are drawbacks of our study. However, as 93% of the experts were able to finish the study in time we feel confident that the results reflect the opinion of all experts.

Regarding electrophysiological testing, we provided information on the presence of absence of the BP and not EMG burst durations, which might have influenced the certainty of the myoclonus diagnosis (a very brief duration indicates myoclonus). Finally, although standardized psychiatric evaluation (MINI-Plus) does detect major psychiatric diagnoses, it is possible that psychiatric subtleties were omitted, which could have influenced the low diagnostic value of psychiatric evaluation.

In conclusion, we demonstrated that the first impression of a patient together with medical history and neurological examination anchors the diagnosis of the expert clinician while diagnosing hyperkinetic movement disorders. Importantly, ancillary testing, both the BP as well as a standardized psychiatric evaluation, did not determine the final diagnosis of this expert panel. The findings of this study provide an incentive to standardize clinical decision making through consensus meetings for the development of guidelines for the diagnosis FMD.

**ACKNOWLEDGEMENTS**

REFERENCES