Innovations in Practice: an objective measure of attention, impulsivity and activity reduces time to confirm attention deficit/hyperactivity disorder diagnosis in children – a completed audit cycle

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Background: Diagnosing attention deficit/hyperactivity disorder (ADHD) in children and young people typically relies on clinical observation and subjective parent, teacher and self-reports. The subjective nature of reports combined with contradictory or missing data can result in diagnostic uncertainty and delay. The aim of this study was to assess whether the addition of an objective test of attention, impulsivity and activity (QbTest) as an adjunct to standard ADHD assessment could accelerate the diagnostic process in routine National Health Service (NHS) settings. **Method:** In a pre vs. post-test audit design, case records were examined in 40 cases diagnosed without the QbTest [pre-QbTest group] and 40 cases diagnosed with the QbTest [QbTest group], recording the number of consultations until a confirmed ADHD diagnosis was reached. **Results:** Using Poisson regression, significantly fewer clinician consultations (mean 2.18 vs. 3.05; p < .02) were required to confirm the diagnosis of ADHD when the QbTest was used to augment assessment in comparison to standard assessment as usual. **Conclusions:** The findings suggest that the addition of the QbTest to standard clinical assessment may reduce time to diagnosis and potentially result in cost savings to the NHS. These preliminary data suggest that there is a potentially clinically meaningful benefit of adding the QbTest to routine clinical ADHD assessment and this should be examined next in the context of a randomised controlled trial.

Key Practitioner Messages

- ADHD assessment can be lengthy and heavily reliant on clinical interpretation of subjective reports from parents, teachers and young people.
- This audit found adding the QbTest to standard clinical assessment of ADHD significantly reduces the number of clinician consultations required to confirm a diagnosis.
- First data to suggest that the QbTest may facilitate standard ADHD assessment, resulting in rapid ADHD diagnosis, particularly in cases of missing or conflicting rating scales.
- Future research is required to establish the utility of the QbTest to reduce time to accurate diagnosis and further investigate the effect of this on patient outcome and costs to the NHS.

Introduction

The assessment of attention deficit/hyperactivity disorder (ADHD) in children typically relies on the clinician's judgement and the integration of various forms of subjective information, such as parent, teacher and the young person's report. This process is heavily reliant on subjective interpretation and can be hindered when reports are not completed or contain contradictory evidence. The assessment of ADHD is further complicated by a high co-occurrence with other disorders, making a differential diagnosis difficult,

increasing the number of clinic visits and resulting in substantial expenditure for the National Health Service (NHS) (King et al., 2006).

Adding objective measures of ADHD may help facilitate the diagnostic process. Continuous performance tests (CPT) are neuropsychological tests that typically involve the rapid presentation of visual or auditory stimuli. Participants are requested to respond to a target stimulus but not respond to nontargets. In doing so, the CPT measures the participant's ability to sustain attention and inhibit responses (impulsivity). There are several well-validated CPTs (Conners, 2000; Forbes, 1998;

Sandford & Turner, 2002) and previous research has demonstrated that children with ADHD perform worse on these tasks than children without ADHD (Losier, McGrath, & Klein, 1996). However, a limitation of the traditional CPT is it does not measure the patient's activity level, a core symptom of ADHD.

The QbTest (Qbtech Ltd) is one neuropsychological test that has been designed to measure the three core symptom domains of ADHD: attention, impulsivity and activity. The QbTest combines a computerised CPT with an infrared motion capture of head movement to measure activity during the task. The QbTest requires participants to respond to an infrequently presented stimulus (by pressing a button), but ignores all other stimuli. QbTest provides information on each of the three symptom domains of ADHD and provides a summary report based on deviation from a normative age and gender data set. The QbTest has been approved by the United States Food and Drug Administration (ref: K13382) and although it is not a stand-alone diagnostic tool, several UK NHS ADHD clinics have incorporated the assessment as an adjunct to standard clinical practice. QbTest is easy to administer, with simple participant instructions. Research has demonstrated the QbTest can differentiate ADHD children from normative controls (Oades, Myint, Dauvermann, Schimmelmann, & Schwarz, 2010), with sensitivity and specificity of around 90% (Ulberstad, 2012, Unpublished data). Other research suggests the addition of the QbTest to ADHD assessment can improve clinical decision making. For example, Vogt and Shameli (2011) found that children who were diagnosed with the addition of the QbTest to standard assessment practice were less likely to receive a changed diagnosis 1-year later than those diagnosed without the addition of the QbTest.

A clinically important question is whether using QbTest reduces the overall time and number of clinic visits required to make correct ADHD diagnosis. Despite the adoption of QbTest in several clinics, to date no research has investigated this possibility. The aim of this audit was to assess whether the addition of the QbTest to standard clinical assessment reduced number of visits to reach a diagnosis in routine NHS settings.

Methods

A total of 80 patient records were retrospectively examined in a community paediatric ADHD clinic in Medway NHS Foundation Trust. Case notes were accessed by a member of the Trust's clinical team (KS). The Trust introduced QbTest in July 2012. The baseline audit was conducted on 40 new cases referred to the clinic prior to the introduction of QbTest between June and December 2011 (pre-QbTest group). This time period was selected to reflect the most current practice up to the introduction of the QbTest, but prior to clinicians' having any practice using QbTest. The reaudit was conducted on 40 new cases referred between August 2012 and April 2013 (QbTest group) to reflect clinical practice directly after installation of the QbTest (QbTest group). The time period for both groups was selected to allow 40 cases to have been diagnosed. During this time period, there was no change to the assessment process, except the QbTest. Methods of acquiring parent and teacher information, and the quantity and quality of information, remained unchanged, as did members of the clinical and administration team. All clinicians were experienced in ADHD assessment, with at least 4 years of clinical practice at the time of the first audit.

Inclusion criteria

Patient files were selected using a random-number generator (Schulz & Grimes, 2002). Case notes were included if the case had received a primary diagnosis of ADHD within the time frame specified. For the reaudit, cases were also only included if they had received a QbTest as part of their diagnostic assessment. No cases in the baseline audit had undergone a QbTest. If a file was excluded, the next eligible file along was used. All diagnoses were made according to the ICD-10 criteria for Hyperkinetic Disorder (F90) which broadly equivalent to severe combined subtype ADHD in DSM-IV and DSM-5. A standardised audit tool was used to record the diagnosis and number of clinician consultations that each child had before the diagnosis of ADHD was confirmed.

Forty case notes were included for both the baseline and reaudit, resulting in a total of 80 records. Standard assessment within the Trust involves sending out the Strength & Difficulties Questionnaire (SDQ; Goodman, 1997) to parents and teachers alongside a school information form. At first consultation, the child's developmental history is taken, the Conners' parent and teacher rating scales (Conners, Sitarenios, Parker, & Epstein, 1998a, 1998b) are sent out and the SDQ and school information form is reviewed by the clinician. For each group, additional consultations were made as necessary to make a diagnosis. For cases diagnosed in the QbTest group, the QbTest was conducted by a nurse prior to the patient's clinical consultation. Clinicians were provided with the QbTest result at the second appointment. Qbtech provides training to all clinicians upon installation of the QbTest; this includes multiple practice tests, discussions and demonstrations. Qbtech clinical advisors ensure that every clinician has reached a good standard of test interpretation before they are considered competent to interpret test results alone. In addition, clinical advisors are always available to offer additional test interpretation support when required. It is stressed that the QbTest is not considered a standalone ADHD assessment and should be used to compliment rating scales and clinical interviews and interpreted within the clinical context by qualified healthcare professionals only.

Given this was a clinical audit conducted by staff within the Trust for purposes of service evaluation; ethical approval was not required.

Analysis

A Poisson regression was conducted to compare the mean number of clinician consultations needed to reach a diagnosis between the Pre-QbTest (baseline audit) and QbTest (reaudit) group. Incidence rate ratio was reported as measure of group difference with a 95% Confidence Interval. STATA 13 (StataCorp LP, TX, USA) was used to conduct descriptive statistics and Poisson regression modelling.

Results

The pre-QbTest group consisted of 32 boys (80%) and 8 girls (20%), with a mean age of 8.1 years (SD = 2.4 years range: 4.5–14.6 years); the QbTest group consisted of 28 boys (70%) and 12 girls (30%), with a mean age of 9.2 years (SD = 2.3 years, range: 6.2–13.10 years). All children had received a primary diagnosis of ADHD (ICD-10, F90). Children in the QbTest group were slightly older than those in the pre-QbTest group ($t(39) = -2.23$, $p = .03$); there was no difference in gender between the two groups ($\chi^2 = .730$, $p = .55$). In the pre-QbTest group, 15 children also received a secondary diagnosis: six children received a secondary diagnosis of autism spectrum disorder (ASD), 2 ASD and tic disorder, 2 ASD and dyspraxia, 1 ASD and obsessive compulsive disorder, 1 oppositional defiance disorder, 1 sensorineural deafness, 1 mild epilepsy, 1 Tourette's syndrome. In the QbTest group, 13 children received a secondary

Table 1. Number of clinician consultations until a diagnosis was reached in the Pre-QbTest and QbTest group

	Number of children in which an ADHD diagnosis was made at respective consultation						
	1st consult (%)	2nd consult (%)	3rd consult (%)	4th consult (%)	5th consult (%)	6th consult (%)	7th consult (%)
Pre-QbTest group	4 (10.0)	14 (35.0)	7 (17.5)	9 (22.5)	4 (2.9)	1.0 (2.5)	1 (2.5)
QbTest group	4 (10.0)	27 (67.5)	7 (17.5)	2 (5.0)	0 (0.0)	0 (0.0)	0 (0.0)

Consult = consultation. Percentages are reported in parentheses.

diagnosis: seven children received a secondary diagnosis of ASD, 1 Tourette's syndrome, 1 sensory processing disorder, 1 mild speech and language disorder, 1 emotional difficulties, 1 dyslexia and 1 learning difficulties.

Table 1 shows the number of clinician consultations needed to reach an ADHD diagnosis for both groups. For both groups, most diagnoses were made at the second consultation. However, for the pre-QbTest group 55% (22 patients) required more than two consultations, in the QbTest group only 18% (9 patients) required two or more consultations to confirm an ADHD diagnosis and all diagnoses were made by the fourth consultation.

Poisson regression (Table 2) showed that the children in the QbTest group needed significantly fewer clinician consultations to reach a diagnosis (average two consultations) than children in the pre-QbTest group (average three consultations).

The cost of a consultation within the Trust at the time of audit equated to £108.00. A single QbTest cost the Trust £31.00 (including the cost of the test as a proportion of the lease fee, and a 30 min nurse-led appointment to conduct the test). As such, the total cost spent on ADHD assessment in the pre-QbTest group equated to £13,176, compared to £10,636 in the QbTest group, equating to saving of £2,540. It should also be noted that as the QbTest equipment is leased to clinics, there is no additional start-up cost.

In cases where five or more clinician consultations were required to make a diagnosis, the responsible clinicians were investigated the reasons behind the delay in diagnosis. For 4/6 (66.6%) of cases, inconclusive or discrepancy outcomes from clinical rating scales were cited as the primary reason for delay, one case (17.0%) cited complex comorbidities and one (17.0%) clinician reluctance to make a diagnosis. We chose only to seek clarification from clinicians with five or more consultations to make diagnosis, as given the often complex nature of ADHD it would not be atypical to require a few consultations to confirm a diagnosis (see Table 1). Clinicians were investigated how the QbTest helped to aid

Table 2. Poisson regression comparison of number of clinician consultations until diagnosis

	Mean (min, max consultation)	Total number of consultations to make 40 diagnoses	Poisson Regression IRR (95%CI)
Pre-QbTest group	3.05 (1, 7)	122	0.71 (0.54, 0.94), $p = .02$
QbTest group	2.18 (1, 4)	97	

CI = Confidence Interval.

diagnosis, responses included: the ability to compare the child's performance against a normed data set, the opportunity to directly observe the child's behaviour while performing a task and the provision of an objective, graphical report to compare to subjective reports.

Discussion

To assess whether the QbTest decreased number of clinic visits needed to reach an ADHD diagnosis, we compared the number of clinician consultations required to reach a diagnosis in randomly selected cases who were diagnosed with (QbTest group) and without (pre-QbTest group) the QbTest. Our findings reveal a significant reduction in the number of clinician consultations, from three to two consultations on average, required to confirm a diagnosis when the standard assessment procedure was supplemented with a QbTest. Based on these audit findings, it would be unwise to draw definitive conclusions; however, these preliminary data suggest that the QbTest may facilitate standard ADHD assessment and result in more rapid ADHD diagnosis in children, particularly in cases of missing or conflicting rating scales. The time and cost savings described here are likely to be clinically important if confirmed by a randomised controlled trial. In turn, rapid accurate assessment could facilitate appropriate treatment onset and improve patient outcomes. It could be argued that the pre-QbTest was a more complex client group, with a slightly higher comorbidity of ASD (10%). However, the 10% difference in ASD is unlikely to explain the significant increase in the number of patients diagnosed by the second appointments in the QbTest group (from 18% pre-QbTest to 55% after the introduction of QbTest).

These findings support and extend previous research, demonstrating the utility of the QbTest to aid ADHD assessment in children. Previous research has indicated that QbTest can differentiate ADHD from healthy controls (Oades et al., 2010; Ulberstad, 2012, unpublished data) and result in improved clinical decision making (Vogt & Shameli, 2011). This current study is the first to show this improved decision making may result in a reduction in clinical consultations and cost saving to NHS practice.

A limitation of the study was that the ADHD diagnoses were not independently verified and it is not known if QbTest also facilitated the exclusion of an ADHD diagnosis in non-ADHD cases referred for ADHD diagnostic assessment, limiting the comprehensiveness of these findings. Our findings are limited to the practice of one NHS Trust and a relatively small sample size, and our conclusions should be interpreted within these methodological constraints. Despite this, these findings represent the first insight into the potential of the QbTest to

streamline clinical practice and produce a clinically important time and cost saving to the NHS. This result should be used to inform a future randomised controlled trial comprising a full economic analysis (Hall et al., 2014). Strengths to this audit include the similar composition of children in each group and the random selection of cases. We stress the need for further randomised studies in a larger number of clinical settings to establish whether the QbTest does facilitate both accurate and speedy diagnosis of ADHD and exclusion of ADHD in non-ADHD cases in routine NHS clinics (Hall et al., 2014).

Conclusion

The implementation of QbTest as an adjunct to standard clinical assessment of ADHD in children reduced the number of clinician consultations required to reach an ADHD diagnosis. The clinical utility of the QbTest to streamline and improve ADHD practice is worthy of more rigorous clinical trials.

Acknowledgements

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