The clinical utility of QbTest in supporting the assessment and monitoring of Attention-Deficit/Hyperactivity Disorder (ADHD): What do paediatricians need to know?

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ABSTRACT

The assessment of Attention-Deficit/Hyperactivity Disorder (ADHD) typically relies on subjective observer reports from parents, teachers, or the young person, combined with clinical observation and history. Children and young people often experience lengthy delays to assessment and medication initiation resulting from conflicting or missing observer reports and diagnostic uncertainty. However, more recently, a computerised test of attention, impulsivity and activity (QbTest) has been implemented as an adjunct to standard clinical practice, with the aim to provide a more objective measure of ADHD symptoms. Here, we discuss the evidence for the clinical utility of QbTest to aid in the assessment and monitoring of ADHD. Drawing on key literature and real-world case studies, we show the potential benefits that QbTest may have in creating service efficiencies for ADHD care, but also note limitations in diagnostic accuracy, importantly demonstrating that QbTest should supplement and not replace standard care. We review key barriers and facilitators to implementation, to aid decision making and planning in how to integrate QbTest in paediatric services.

Keywords: attention deficit hyperactivity disorder; ADHD; QbTest; diagnosis; assessment; monitoring; continuous performance test

INTRODUCTION

Attention-Deficit/Hyperactivity Disorder (ADHD) affects approximately 3-5% of school-aged children and young people in England. The core symptoms of ADHD are developmentally inappropriate attention difficulties, impulsivity and hyperactivity, which must be pervasive (i.e., occurring in different settings), persistent and impairing. ADHD frequently co-occurs with other neurodevelopmental (e.g., Autism Spectrum Disorders and tics) and psychiatric disorders (e.g., conduct problems, anxiety and depression), resulting in a complex picture of symptoms. From a behavioural standpoint, children with ADHD find it difficult to focus, which can result in poor educational, occupational and social outcomes. There is increasing recognition that ADHD is a lifelong condition, and thus requires timely access to evidence-based treatment to optimise outcomes. However, the assessment process for ADHD can be lengthy, resulting in delays to treatment initiation.

There is no single test to diagnose ADHD. Traditionally, assessment of ADHD relies primarily on the clinician's judgement, which is informed by direct observations of the young person (e.g., in the school environment), detailed developmental and clinical history, and is supplemented by standardised questionnaires or rating scales completed by parents, teachers and – where appropriate – the young person. However, these reports are subjective, can often be contradictory or not completed in a timely manner, and there is no guidance on how to best integrate these differential sources of information. Thus, it is perhaps not surprising that there can be both delays and discrepancies regarding ADHD diagnostic decisions. Furthermore, infrequent follow-ups and conflicting subjective reports may lead to inaccurate detection of partial or sub-optimal response to medication.

The addition of standardised, more objective, computerised tests of ADHD symptoms may help overcome some of these shortfalls. One type of neuropsychological test of attention where young people with ADHD often show worse performance compared to neurotypical children, is the continuous performance test (CPT). In this task, visual stimuli are rapidly presented on a computer and the young person is asked to respond when a target stimulus appears but withhold responding to non-target stimuli. As such, the test can measure sustained and selective attention as well as impulsivity, which are two core symptom domains of ADHD. A systematic literature review has shown mixed evidence for the utility of 'traditional' CPTs in supporting assessment and management of ADHD (Hall et al., 2016). However, this study highlighted that using CPTs that also measure physical activity (the third symptom domain of ADHD) may be helpful. The most well researched and best implemented CPT with these characteristics (i.e., also including a measure of activity) is QbTest.

What is QbTest?

The QbTest (Qbtech Ltd; https://www.qbtech.com/) is a commercially available test that combines a computerised CPT with an infra-red motion tracker, therefore assessing core symptom domains of ADHD (attention, impulsivity and activity). During the QbTest, the young person sits on a chair in front a computer screen and is instructed to press a hand-held responder button when the target stimuli appear on the screen. Throughout the test, the young person wears a headband with a marker attached; an infra-red camera detects the movement of the marker (see Figure 1). The test lasts approximately 20 minutes.

There are two versions of QbTest, one for children aged 6-12 years and one for children aged 12+ years. For the younger age group, the computerised attention test is a simpler

target detection, in which children are asked to press the responder button when a circle appears on the screen but withhold responding when a cross appears. The test for the older age group presents a stream of blue and red squares and circles. The young person is asked to respond when two consecutively presented colour and shape symbols appear.

<<INSERT FIGURE 1 >>

The QbTest is conducted in the clinic setting, in a quiet room with appropriate lighting. During the test, a trained observer sits in the room and monitors the young person. The observer can be any appropriately trained professional, including healthcare assistants. Although it is not the focus of this present article and is less researched, more recently Qbtech Ltd have developed "QbCheck", a version of QbTest that can be conducted in the young person's home (https://www.qbtech.com/adhd-tests).

The QbTest computes a report that visually displays the young person's performance in the three symptom domains of ADHD and computes a summary score for each which is based on deviation from an age-and-gender matched normative dataset (see Figure 2). A clinician who is qualified to make an ADHD diagnosis can then include the QbTest report to inform their clinical decision-making. The QbTest report should also be shown to the family and can be used to help communicate how the clinician reached their diagnostic decision. The QbTest has received FDA approval, is CE marked and meets ISO27001 standards for data security. However, the test is designed to supplement and not replace standard clinical decision-making, as such, it should be included alongside other measures, including clinical interviews and rating scales.

QbTest should not be used as a freestanding diagnostic or screening test. Qbtech Ltd provide training to both administrators and interpreters of the QbTest as part of the installation phase, on-going advice is also provided by a Qbtech Clinical Advisor. The cost of QbTest ranges £23-96 per unit (excluding Value Added Tax).

<<INSERT FIGURE 2 >>

Is QbTest a clinically valid tool?

Although QbTest should not be used as freestanding diagnostic test, it is relevant to explore its diagnostic accuracy. Diagnostic accuracy is typically described in terms of *sensitivity* (a positive test correctly identifying a child who has ADHD) and *specificity* (a negative test correctly identifying a child who does not have ADHD). Outside of its intended clinical use, QbTest does not have a diagnostic cut-off or threshold for ADHD diagnosis; therefore, studies that have examined sensitivity and specificity have had to use arbitrary cut-offs. Although some research has indicated good sensitivity and specificity (around 80-90%), others have found low ranges as low as 47% for sensitivity. Additionally, some research has shown that QbTest may be effective in discriminating between ADHD cases and healthy controls but may be less accurate in differentiating ADHD from other neurodevelopmental conditions. Overall, research suggests that QbTest scores predict the presence or absence of ADHD better than chance, but not sufficiently well to be used alone as a diagnostic or screening test. It is important to note that previous studies have typically compared QbTest as stand-alone tool against the clinician decision as the comparator group. This raises two concerns. First, the QbTest has not been designed or authorised for use as stand-alone diagnostic tool, thus it is arguably misleading to judge it as such outside its intended use. Second, there is no single approach to ADHD assessment that guarantees 100% accuracy in

detecting ADHD, considering that no valid biomarkers for this condition have been found yet. Some research has explored the validity of QbTest in addition to standard rating scale or assessment-as-usual and found the QbTest either improves or does not hinder diagnostic accuracy. There is a need for further research to explore the clinical validity of QbTest using designs that align with the intended use of the tool. However, the mixed findings on accuracy are useful to serve as a reminder that QbTest should be used as a tool to supplement and not replace usual assessment practices (see Figure 3).

<<INSERT FIGURE 3 >>

How can QbTest support ADHD assessment?

A large randomised controlled trial ("AQUA-Trial") explored the impact of implementing QbTest in Child and Adolescent Mental Health (CAMHS) and Paediatric clinics in England (Hollis et al., 2018). Children awaiting ADHD assessment were randomised to receive either QbTest plus standard clinical assessment, or standard clinical assessment alone (i.e., QbTest was performed but the result was withheld from clinicians). The trial found that clinicians that had access to a QbTest report were more likely to make a diagnostic decision confirming or ruling out ADHD within 6-months compared to when they did not have a QbTest report. The trial also found that that having a QbTest report reduced the length of appointments by 15%, increased clinicians' confidence in making a diagnostic decision, and doubled the likelihood of excluding ADHD. Adding QbTest had no overall effect on diagnostic accuracy when compared to a research ADHD diagnosis (i.e., there was no evidence of a 'trade-off' between faster but less accurate diagnoses). Furthermore, interviews with clinical staff and patients revealed the test was viewed favourably (Hall et al., 2017). For example,

both clinicians and families valued the tool for helping improve communication and understanding/explaining why the diagnostic decision was made (this demonstrates the need for clinicians to discuss the report fully with the family). Moreover, families reported it helped them understand their child's symptoms better and facilitate conversations with schools/educational professionals. Clinicians particularly noted the value in supporting conversations with families as to why an ADHD diagnosis was not made, and they perceived QbTest to be a valid tool to support assessment. However, there has been mixed opinion as to whether QbTest should be used for all cases or reserved only for the most complex. Some clinicians felt that in straightforward cases there was no need to add the time and cost of a QbTest appointment in the pathway, whereas others felt that, for QbTest to have maximum impact, it should be used early in the pathway as part of standard practice. There has also been mixed feeling as to whether QbTest is useful for complex patients. Some clinicians have reported the test being particularly useful to aid in distinguishing ADHD from non-ADHD behaviours, whereas others have found the test results too difficult to interpret if the case was not straightforward (e.g., when ADHD co-occurred with other conditions). Other clinicians have found the objective measure of activity to be particularly helpful in adolescents. It is probable that these differences in opinions may be explained by the clinician's confidence and experience with interpreting the test, and highlights the importance of the on-going clinical advice provided by QbTest advisors on report interpretation.

Based on the promising findings of the AQUA-Trial, the East Midlands Academic Health Science Network (AHSN) supported the implementation of QbTest within the East Midlands. Implementing QbTest reduced the time from assessment to diagnosis by 153 days (median), producing a 33% cost reduction to sites and return on investment (ROI) of £84,460. Since April 2020, the AHSN has been working with CAMHS and

Paediatric sites across England to further roll-out QbTest on a national scale. As of September 2022, QbTest was implemented in 65% National Health Service (NHS) Trusts in England. Interestingly, the evaluation of this roll-out has demonstrated that QbTest appears particularly beneficial for paediatric services, resulting in a 19% release in clinical time, compared to 9.2% in CAMHS. Figure 4 shows a case study of the impact of implementing QbTest in one Paediatric service in England. Overall, the AHSN national evaluation showed a large variation in the potential impact of QbTest, which may reflect how efficient the services were prior to QbTest installation, or differences in where and how QbTest is used in the pathway (e.g., on all or some cases, prior to the first assessment or after) or differences in clinical confidence/skills in QbTest interpretation. Optimising QbTest within the clinical pathway requires further research.

<<INSERT FIGURE 4 >>

Can QbTest help with medication monitoring?

Although less researched than the assessment process, there is also clinical interest in using QbTest to support monitoring of medication. Evidence has shown that QbTest is sensitive to the effects of methylphenidate, and that the impact of this can be detected on the test as little as one hour post intake. Figure 2b shows a QbTest report after a single dose of methylphenidate. Some clinicians have reported feeling more confident initiating medication as result of conducting QbTest as part of assessment, providing them with confidence in their diagnostic decision. Studies have also demonstrated that using QbTest after a single methylphenidate dose may be useful in picking up partial or non-responders. Identifying this early may support clinicians in their titration schedule or decisions to switch to a different drug. However, further research is required

to explore if QbTest can facilitate earlier treatment optimisation. During qualitative interviews, clinicians have also revealed having observed that conducting a QbTest on/off medication can sometimes be useful to promote adherence to the drug, particularly for teenagers who may be questioning whether they still need to take medication. They have also reported the benefits of QbTest in identifying when to stop titrating medication and allowing them to realise an optimum dose has been reached at a lower level than they would have previously prescribed. Additionally, clinicians have reported that having a QbTest on-medication can often help identify that other issues may be present, particularly in cases where parents may still be reporting problematic symptoms or behaviours despite a more normalised QbTest report.

Barriers and facilitators to implementation

Several key barriers and facilitators to implementing QbTest in clinical practice have been identified (Hall et al., 2017). QbTest is a commercial product and thus comes at a cost to the health service. Furthermore, the test requires time for a trained professional to administer it and interpret the results. To help navigate this, QbTest may be conducted by a trained healthcare assistant, although interpretation should still be done by an individual able to make an ADHD diagnosis. In general, these costs are off set against the savings made due to release in clinical time; however, sites can face challenges as to how to fund the QbTest. This often requires submitting a business case to their service managers and conducting a small-scale audit evaluation of the impact within their service to demonstrate the impact. Following the national AHSN Focus ADHD programme, local AHSNs are likely to be willing to help with adoption and commissioning advice. Logistically, sites often report difficulties in identifying a quiet

room in which they can use QbTest. Although QbTest can be set-up and dismantled relatively quickly, sites often prefer to leave the equipment set-up. Additionally, sites may experience problems with how to best embed QbTest in their clinical pathway, which requires careful consideration. QbTest instructions are also only available in the English language, which may be problematic for services covering regions of high ethnic minority populations. Furthermore, there are some children who cannot complete QbTest, such as those with an impairing physical disability or learning difficulties.

Facilitators to QbTest adoption include the relatively impressive evidence base, including real-world evaluations, which demonstrates the service efficiencies and cost-savings that can be gained. The support provided by Qbtech Ltd in terms of initial training and on-going clinical and technical advice has been noted to be a significant facilitator. Although we would not advocate QbTest replacing any part of the care-pathway, some sites have chosen to reduce school observations because of implementing QbTest. As school observations are lengthy and not all services have the capacity to conduct them, QbTest may be helpful in offering a direct observation of the young person in a standard setting. Additionally, the positive feedback from patients and families has been noted to be a driving-force behind adoption. Table 1 summarises key barriers and facilitators to adopting QbTest.

<<INSERT TABLE 1>>

Conclusion

In summary, there is both research and real-world evaluation evidence to demonstrate that implementing QbTest in clinical services, particularly in Paediatric services, is likely to result in service efficiencies, such as a reduction in the number of clinical

appointments needed to make a diagnostic decision. Further research is needed to explore the potential of QbTest to aid medication monitoring in young people; however, the available evidence indicates this is promising. QbTest has now been implemented in the majority of NHS Trusts in England, providing opportunity for further real-world evaluation. The feedback from both clinicians and families highlight that QbTest is generally well received and is considered a positive addition to the care pathway. Particularly, QbTest can play an important role in facilitating communication between the clinician and family, the parent and child and school. Given the wide-spread implementation of QbTest in England, the barriers to adoption and implementation are well documented, and include issues with staff time, clinic resources and the cost. However, the potential clinical release and cost-savings because of implementing QbTest may off-set some of these barriers. It is important to be mindful that the diagnostic accuracy of QbTest does not support its use as a stand-alone tool. Clinicians should remember that the intended use of QbTest is as a tool to support, rather than replace, standard clinical assessment and decision making.

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Tables

Table 1. Key barriers and facilitators to implementation

Barriers	Facilitators
Staffing (costs, time, training)	Training provided by Qbtech Ltd. Potential savings to service.
Funding	Funding advice provided by Qbtech Ltd and local AHSNs. Commissioning QbTest as part of local ADHD/ neurodevelopmental pathway.
Logistical set-up challenges (identifying room)	Positively viewed by patients and families
Identifying place in pathway.	Large evidence base to demonstrate clinical and service efficiencies and cost-savings
Intervention only available in English	Test can be conducted by a trained healthcare assistant

Figure captions

Figure 1. QbTest equipment set-up

Figure 2a and 2b. Example QbTest report pre medication initiation (2a) and after a single dose of Methylphenidate (2b)

Figure 3. Combining QbTest with standard clinical practice

Figure 4. Case study implementing QbTest