Screening for Difficulties in General Intellectual Functioning and Academic Attainment in Children with Sickle Cell Disease and Epilepsy.

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Declaration.

I confirm that as part of this thesis the literature review, research report and critical appraisal submitted have been produced by my own work and have not previously been submitted for any other academic award.

Helen Matthews

Thesis Abstract.

Sickle Cell Disease and Epilepsy are childhood chronic diseases that are prominently seen in neuropsychological services. Although different in aetiology and symptomology, they share many similarities in associated difficulties in physical, psychosocial and cognitive functioning.

Literature Review: A systematic review of the literature investigating the relationship between family factors and psychosocial outcomes of children with SCD was conducted and is presented. The quality of the research articles included in the review was assessed using a standard appraisal tool. The review concludes a number of family variables appear to be associated with psychosocial outcome of children with SCD. Clinical implications and suggestions for future research are discussed.

Research Report: The study examined the feasibility of a screening tool predictive of general intellectual functioning and academic attainment in children with SCD and epilepsy. Neuropsychological assessment scores were obtained from an acute teaching trust who had administered them via routine clinical practice. A stepwise multiple linear regression and comparisons between high and low scoring children were utilised to generate a model for the predictive screening tool. The screening tool which emerged consisted of the WISC-IV subtests 'block design', 'coding' and 'digit span' with the addition of 'vocabulary' for children with epilepsy and 'similarities' for children with SCD being predictive of intellectual functioning. 'vocabulary' and 'digit span' were predictive of academic attainment.

The study also examined the association of difficulties on a parent completed questionnaire with problems identified on a neuropsychological assessment measuring attentional abilities. A cross-tabular analysis revealed no significant association.

Clinical implications, recommendations and limitations of the research are discussed. A critical appraisal of the research is also presented.

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Critical Appraisal:	2013
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The Relationship between Family Factors and Psychosocial Outcome of Children with Sickle Cell Disease: A Critical Review of the Literature.

Target Journal: Journal of Pediatric Psychology (Appendix D).

Abstract:

Objective:

The aim of this review was to systematically investigate the relationship between family factors and psychosocial outcomes of children with Sickle Cell Disease (SCD). Previous research has suggested that various family related variables are predictive of outcome in children with chronic illness, but there appears to be little research focusing specifically on SCD.

Method:

A comprehensive search of the literature was carried out between September 2012 and March 2013 in four electronic databases (PsychInfo, Ovid, Medline and Embase). Articles published in the years 2000-2013, were peer-reviewed and in English Language were included if they met the imposed inclusion criteria.

Results:

There were eight studies which met the criteria to be included in the review. Family variables emerging from the review found to be associated with psychosocial outcome of children with SCD were socio-demographical information; family functioning; carer stress; family income; and parental locus of control.

Conclusion:

A number of family related factors appear to be associated with outcome in children with SCD. Family factors are a very broad concept consisting of a large variety of variables, therefore the studies did not consistently measure the same family variable. This made synthesis difficult and conclusions should be made tentatively. Clinical implications are suggested which included services adopting a proactive approach to supporting children with SCD and their families. Future research should aim to replicate the findings of previous studies and qualitative explorations would be beneficial.

Introduction.

Sickle Cell Disease (SCD) is one of the most common types of haemoglobinopathies; a range of inherited disorders of red blood cell haemoglobin. It is a genetic autosomal recessive disorder evident in approximately 1 in every 2400 births in the UK (Sickle Cell Society 2005) and primarily causes red blood cells to take on the form of a crescent or sickle shape deforming the normal biconcave shape of the erythrocyte. The irregularity of red blood cell shape comprises and hinders their ability to flow smoothly through arterioles and fine capillaries. This reduces efficiency of organ oxygenation. The sickle-shaped cells can also become tangled together causing vaso-occlusive crises which may result in ischaemia and acute pain.

Although found at low frequency in all populations, the prevalence rate of SCD is higher for people of Black Caribbean and Black African origin (NHS Sickle Cell and Thalassemia Screening Programmes, 2010), and presents diversely with a wide range of clinical manifestations and degrees of severity. The most common symptoms and complications relate to chronic and recurring acute episodes of pain, however infections, eye damage, renal disease, organ damage, delayed puberty, organ failure and stroke are also reported. Whilst improvements in the healthcare of people with SCD are notable, average life expectancy is lower than that in the general population; approximately 42 years for males and 48 years for females for the more severe HbSS sickle cell. Death is most often the result of stroke during a crisis or overt organ failure, predominantly renal (Platt *et al*, 1994).

Children with SCD require specialist support in both hospital and community settings. Hospital admissions for children with SCD are most commonly required due to the episodes of pain associated with vaso-occulsion crises but may also be necessary if a child experiences many other medical complications such as stroke, lung damage, renal disease and osteomyelitis. Children with SCD have been reported to have poorer outcomes in many areas in comparison to healthy peers. Quality of life is negatively affected by debilitating chronic and acute pain, frequent hospitalisation during recurrent episodes of pain and the constant risk of organ failure (McClish *et al*, 2005). Children with SCD have been reported to experience pain more often with longer durations, were seven times more likely to miss school and were unable to take part in their favourite activities in comparison to their non-SCD peers (Fuggle *et al*, 1996).

In addition to adverse physical outcomes, psychological and psychosocial consequences are also evident. Neurocognitive impairments, reduced quality of life as a consequence of restrictions in daily functioning, inappropriate pain coping strategies and frank psychological morbidity were found in a substantial review (Anie, 2005). This non-systematic review noted many variations between the studies examined regarding design, and use of standardised measures militating against consensus. Strength of evidence is also compromised by a failure to explicitly appraise research quality.

More recently Panepinto and Bonner (2012) have examined both adults and children with SCD in a review to determine factors associated with their health-related quality of life. Gender, age, pain, medical and neurobehavioural co-morbidities as well as familial demographics (parental education and family income) and disease-related symptoms were all associated with HRQL. Although this paper clearly delineated research studies conducted on adults from those on children, less helpfully the review findings were not synthesised independently.

The recent reviews of psychological outcomes have not focused on the relationship between family factors and outcomes of children with SCD. This seems an omission given the impact of SCD, as with other chronic childhood illnesses, is likely to affect the entire family cognitively, emotionally and behaviourally (Burlew *et al*, 1989). The family must learn about the illness, deal with the emotional anxieties and uncertainties that are generated by the illness and incorporate treatment regimens whilst maintaining other family functions (Panepinto, Hoffman & Pajewski, 2009).

Such relationships and potential predictive family factors have been explored in other chronic conditions revealing family socioeconomic status and demographic variables demonstrate few consistent relationships with child functioning (Daniels *et al*, 1987). By contrast, family system variables appear more powerful predictors of adaptation and adjustment than biomedical indices. This has been most powerfully demonstrated in children with heterogeneous brain tumours where strongest predictors of adjustment behaviours and behaviour problems were family related and demographic variables (Carlson-Green *et al*, 1995). High resilience appeared related to the family system as a whole and not specific, individual family factors (Cohen, 1999) with positive psychological adjustment in children associated with more adaptive family relationships and parental adjustment (Drotar, 1997). Yet whilst family variables appear powerful predictors, they have not been examined for children with SCD and only one unsystematic review encompassing all chronic childhood conditions was published over a decade ago (Cohen, 1999). An up-to-date review examining the relationship between family variables and outcomes of the child with SCD would be timely.

The aim of the review:

The aim of this review was thus to systematically investigate the relationship between family factors and psychosocial outcomes of children with SCD. To frame and to focus

the review, outcome was defined to include psychosocial quality of life, health related quality of life, SCD symptom severity, behavioural problems, and physical health outcomes. Information regarding outcome should have been collected from self-report measures including quality of life, health questionnaires, behaviour checklists and also from information extracted from the child's medical files i.e. number of hospital admissions/contacts with healthcare services. Family variables which emerged from the review included socio-demographic information; family functioning; carer stress; family income; and parental perception of control.

Method.

Search Strategy:

A comprehensive literature search was carried out to identify studies relevant for this review in September 2012 and again in March 2013 in the following databases: PsychInfo ,Ovid, Medline and Embase. The search terms applied to each database were as follows: Sickle Cell* AND quality of life OR happiness OR mental health OR life satisfaction OR well-being OR wellbeing OR family function OR family life. In order to maximise the chance of identifying all of the relevant literature, search terms were exploded with the use of text word and thesauruses. Additional filters that were placed on the search included only child and/or adolescent (0-18 years) with a diagnosis of SCD. Included studies were required to be peer-reviewed, written in English and a time restriction was used so that only studies published between the years 2000 and 2013 were retrieved. Studies published before the year 2000 had been included in a previous review (Cohen, 1999) therefore the time restriction was imposed to avoid replication and focus on studies that had been published since. Each study had to include a

validated self-report measure of outcome (i.e. quality of life, behaviour, health) which was completed by the child participant and/or their primary caregiver. For all the studies retrieved from the search, titles and abstracts were read and articles removed if they appeared to be irrelevant. The remaining articles were then thoroughly examined and inclusion/exclusion criteria applied to identify the relevant articles to be reviewed.

Assessment of Quality:

Studies that met the inclusion criteria were then quality appraised. Research quality for each paper was assessed using an adapted version of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cohort, case-control, and cross-sectional studies (combined) (Von Elm *et al*, 2007). Twelve of the original 22 items (see Appendix A) were selected as guided by previous research in other neurological conditions (Eccles & Simpson, 2010). Each statement was rated as positive if the paper provided sufficient detail and negative if it did not. The sum of the positive criteria created the total quality score. The quality of the research papers were deemed as 'high' if they were scored equal or greater than nine points, 'moderate' if they scored 5-8 and 'low' if they scored equal or less than four points.

Analysis:

Once the study was deemed appropriate for the review, the following data was extracted; sample size, main characteristics of the sample, details on family variables, demographics, design, measures, statistical analysis and major findings (Appendix B). If missing data was evident, study authors would be contacted; however this was not necessary for the current review.

A meta-analysis of the results was not considered feasible given the wide variation in family variables and outcomes reported and also due to the variability in measures and designs of the studies. A narrative synthesis was therefore conducted. The studies explored the relationship between family variables and child outcome as well as making comparisons with non-SCD children.

Results.

There were 674 articles retrieved in the initial search which included duplicates. The titles and abstracts were screened and those that were not considered to be relevant to the study were removed, as were any duplicates. There were 105 studies remaining which were potentially able to be included in the study. After further examination and application of exclusion criteria, eight articles remained to form the material which met the inclusion criteria. A flow diagram of the search process can be seen in Figure 1

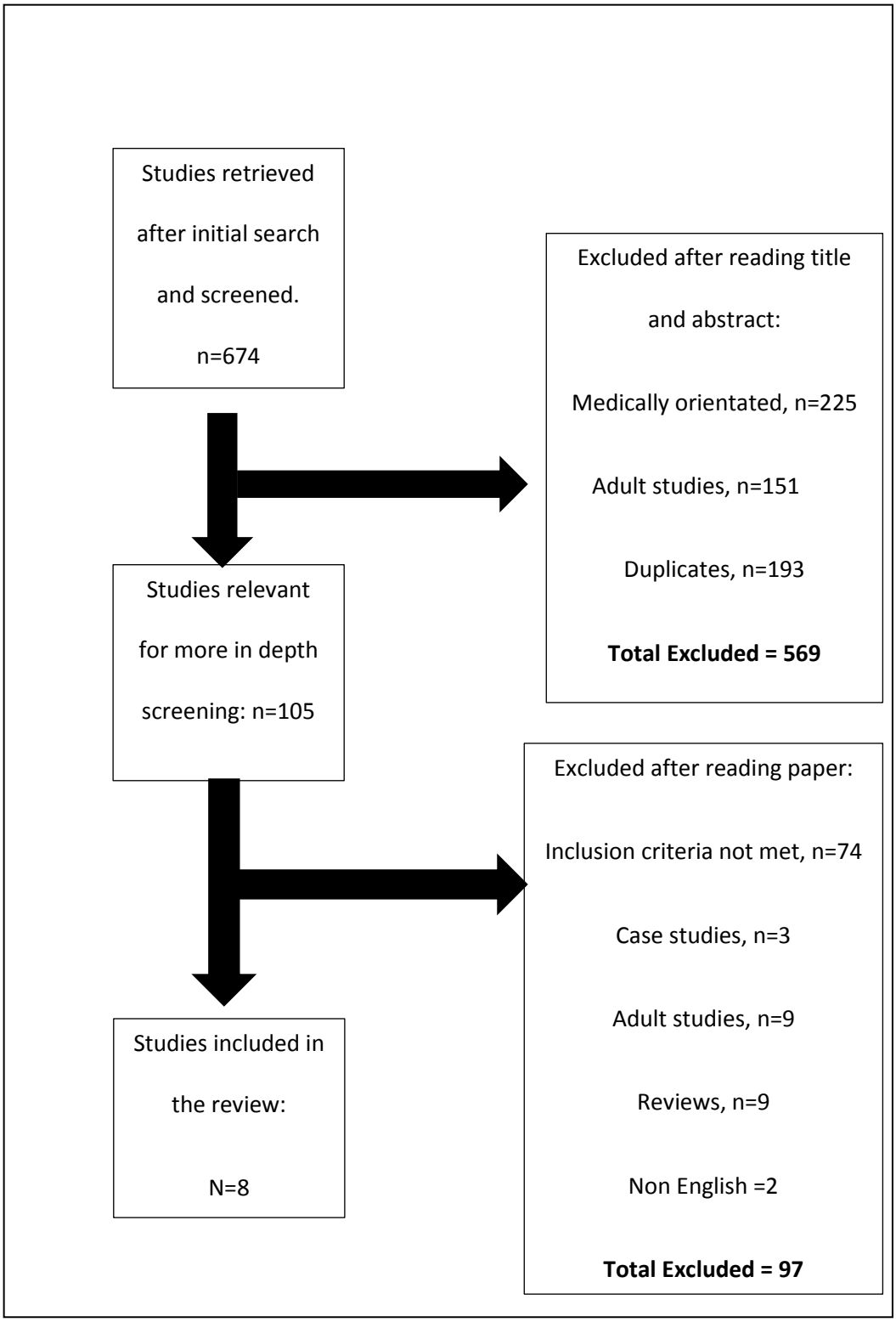
Studies retrieved after initial search and screened. n=674
Excluded after reading title and abstract:
Medically orientated, n=225
Adult studies, n=151
Duplicates, n=193
Total Excluded = 569
Studies relevant for more in depth screening: n=105
Excluded after reading paper:
Inclusion criteria not met, n=74
Case studies, n=3
Adult studies, n=9
Reviews, n=9
Non English =2
Total Excluded = 97
Studies included in the review:
N=8

Figure 1: Flow Chart showing the selection process of studies included in the literature review.

Study Characteristics:

A summary table of the eight included studies can be seen in Appendix C. All of the studies were conducted in the USA and the majority of the participants included in the sample had sickle cell anaemia (HbSS). The majority of studies (n = 6) included children with the milder form of beta thalassemia Hbβ^{+} two of which also included children with the more severe form of beta thalassemia Hbβ° (Panepinto *et al* , 2005; Panepinto *et al*, 2009). One study did not give any details of the other forms of SCD included in addition to HbSS (Barakat *et al*, 2008). However, this paper reports part of another non-included study (Barakat, Patterson & Tarazi *et al*, 2007) in which the same sample of children are described in more detail. This study was not included in the current review as it did not report an outcome measure for the children

Over half the studies recruited participants via attendance of routine visits at specialist haemoglobin clinics (Barakat *et al*, 2008; Panepinto *et al*, 2005; Panepinto *et al*, 2009; Palermo *et al*, 2008). Participants were also recruited during inpatient stays in which they were receiving treatment in hospital (Barakat *et al*, 2005; Lutz *et al*, 2004) and one study recruited participants during both routine clinic visits and during inpatient stay (Barakat *et al*, 2007). Only one study recruited participants from a pool of people who had already enrolled in The Co-operative Study of Sickle Cell Disease (Thompson *et al*, 2003).

With the exception of one study which only used information obtained by children with and without SCD (Palermo *et al*, 2008) and another which utilised caregivers only

(Barakat *et al*, 2005), the majority of the studies used both children with SCD and their caregiver to obtain data. One study also included information obtained by healthy siblings (Barakat *et al*, 2007).

Regarding measurement, family factors were investigated using a variety of measures. In total, four studies measured familial socio-demographic variables (Barakat *et al*, 2007; Barakat *et al*, 2008; Panepinto *et al*, 2005; Palermo *et al*, 2008), three measured family functioning which included a variety of psychosocial variables (Barakat *et al*, 2005; Lutz *et al*, 2004; Thompson *et al*, 2003), one measured family income (Panepinto *et al*, 2009), two measured carer stress in relation to caring for a child with chronic illness (Barakat *et al*, 2007; Barakat *et al*, 2008)), and one also included parents' perceived locus of control (Barakat *et al*, 2005).

Sociodemographic information was obtained via the Pediatric Inventory for Parents (PIP), which was used to measure caregiver stress related to coping with a child with chronic illness in two studies (Barakat *et al*, 2007; Barakat *et al*, 2008), the Family Environment Scale (FAS) in one (Thompson *et al*, 2003) and via non specified standard questionnaires completed by parents in the remaining two studies (Panepinto *et al*, 2005; Palermo *et al*, 2008). The measures used to ascertain family function included the McMaster Family Assessment Drive (FAD) used in two studies (Barakat *et al*, 2005; Lutz *et al*, 2004) and the Family Environment Scale (FAS). Parents perceived locus of control was measured using the Parent Locus of Control Scale (PLOC).

To investigate outcome for children with SCD, all of the studies with the exception of two (Barakat *et al*, 2008; Thompson *et al*, 2003) utilised psychosocial quality of life. Four of the studies measured health related quality of life (Barakat *et al*, 2007; Panepinto *et al*, 2005; Panepinto *et al*, 2009; Palermo *et al*, 2008). SCD symptom

severity was investigated in four studies (Barakat *et al*, 2005; Barakat *et al*, 2007; Lutz *et al*, 2004; Palermo *et al*, 2008), behavioural problems in three studies (Barakat *et al*, 2008; Lutz *et al*, 2004; Thompson *et al*, 2003) and physical health outcomes in one study (Barakat *et al*, 2008).

The most common measure used to investigate both psychosocial and health related quality of life in the children with SCD was the Child Health Questionnaire (CHQ) .This was completed by the child in two studies (Barakat *et al*, 2008; Panepinto *et al*, 2005), and by the caregiver (CHQ-PF) in another (Palermo *et al*, 2008). The Pediatric Quality of Life Questionnaire (PedsQL) was used in a single study (Panepinto *et al*, 2009). Two studies used the Miami Pediatric Quality of Life (MPQOL) to assess only psychosocial quality of life in children (Barakat *et al*, 2005; Lutz *et al*, 2004).

There were no measures deployed to assess disease severity and health outcome. In studies which explored the formal variable in their study, a composite score was created by reviewing medical files which provided information on number of admissions, frequency of pain episodes and contacts made with SCD services.

The three studies which measured behavioural difficulties in children with SCD all used the Child Behaviour Checklist (CBCL).

Study Designs:

The majority of the studies employed a cross-sectional design (n=7) and investigated the relationship between various family-related variables and outcomes of children with SCD. Only one study employed a longitudinal prospective design (Thompson *et al*, 2003).

Five studies compared children with SCD to the published normative data of healthy children (Barakat *et al*, 2002; Thompson *et al*, 2003; Panepinto *et al*, 2005; Panepinto *et al* 2009; Thompson *et al*, 2003). One of these studies also used healthy siblings of the participants with SCD as a comparator population who were matched according to age and gender (Panepinto *et al*, 2009). One study used the normative data from other paediatric populations (Barakat *et al,* 2008). A further study examined the normative data of mothers of healthy children and of children with congenital heart conditions as comparisons (Barakat *et al*, 2005). Five studies used participants' ages to make comparisons, two of which also made comparisons between the sexes (Lutz *et al*, 2004; Thompson *et al*, 2003). Only two studies made comparisons between the SCD genotypes (Barakat *et al*, 2005; Barakat *et al*, 2007).

In all studies, with the exception of one (Thompson *et al*, 2003), attempts were made to assess the relationship of the child's quality of life with a number of demographic and disease variables. Three studies also attempted to assess behaviour outcomes (Lutz *et al*, 2004; Thompson *et al*, 2003; Palermo *et al,* 2008). Six of the studies used correlational analysis and two of these studies additionally employed a stepwise regression model (Panepinto *et al*, 2005) and an ordinal regression model (Panepinto *et al*, 2009). A further study also used a hierarchical regression model (Palermo *et al*, 2008). A MANOVA was utilised in one study (Thompson *et al*, 2003) and two studies used ANOVA (Barakat *et al*, 2005; Barakat *et al*, 2008).

Assessment of Quality:

The findings of the quality assessment rated all studies as of high quality except for one rated as moderate quality (Lutz *et al*, 2004). All of the studies provided the location of participant recruitment, reported a full descriptive of the variables of interest to the

study, provided a full description of the statistical methods used and also discussed limitations of the study. All of the studies provided clear information on sampling strategy and information regarding the recruitment process. Details were reported on how many people did not respond/withdrew from the study and all were able to obtain some information to explain the reasons participants chose not to take part. The majority of the studies described how they defined the diagnosis of sickle cell type presented by each participant. The three studies that did not give an adequate account of such diagnosis of the sickle cell type (Lutz *et al*, 2004; Panepinto *et al*, 2005; Panepinto *et al*, 2009) provided a description of disease severity as opposed to phenotypes (i.e. HbSS, HbSC, Hbβ^{+}).Three studies did not provide information on the reliability and validity of the measures used to assess quality of life (Lutz *et al*, 2004; Palermo *et al*, 2008 ,Thompson *et al*, 2003). Only one study provided no information or measures of disease severity for the participants (Thompson *et al*, 2003). Two studies did not provide details of inclusion criteria for the sampling of participants (Barakat *et al*, 2005; Lutz *et al*, 2004) and two studies did not report the mean age of the participants (Lutz *et al*, 2004; Panepinto *et al*, 2009), although all of the studies did report the sex of the participants. Only two of the studies discussed relevant power issues and effect sizes (Barakat *et al*, 2005; Palermo *et al*, 2008)

Main Findings of the Studies:

Parent Locus of Control: Parental locus of control was investigated in one study (Barakat *et al*, 2005). Parents who reported an internal style locus of control were significantly more likely to report higher levels of HRQL for their child. Internal locus of control was significantly related to higher levels of rated self-competence and was associated with social competence. However there were no significant associations with

emotional stability or the total score obtained on the HRQL measure with parental locus of control.

Parent Coping Style: One study investigated the relationship of parental coping style with family functioning and child quality of life (Lutz *et al*, 2004). An active parental coping style was significantly correlated with better family functioning and higher quality of life in the child with SCD.

Disease-Related Parent Stress: Two studies explored the association of disease-related parent stress of children with SCD (Barakat *et al*, 2007; Barakat *et al*, 2008) with both reporting significant associations. The studies reported significant negative correlations between disease-related stress and the child's health related quality of life. One of these studies reported that disease-related stress served as a mediator between pain frequency and the child's physical and psychosocial HRQOL (Barakat *et al*, 2008). Care giver stress was significantly associated with more SCD complications and more health care utilisation (Barakat *et al*, 2007).

Parent Education: Parent education was examined in two studies. It was concluded that higher maternal level of education was significantly associated with higher levels of child psychosocial HRQL (Panepinto *et al*, 2005). However, there were no significant associations found between the educational level of the mother and the risk of behaviour problems in children with SCD (Thompson *et al*, 2003).

Family Income: The relation between family income and a child's wellbeing with SCD was investigated in two studies (Panepinto *et al*, 2009; Palermo *et al*, 2008): both reported that lower family income was associated with poorer child physical HRQL. Surprisingly it was also reported that children with SCD in families with higher income reported worse psychosocial HRQL outcomes (Palermo *et al*, 2008). Parents also rated

their own child's overall HRQL significantly lower when the family income was at the lowest level (Panepinto *et al*, 2009).

Family Functioning: Four of the studies explored the association of family functioning with the outcome of a child with SCD. One study (Lutz *et al*, 2004) reported that higher child-reported family functioning was significantly associated with the child's active coping style and better quality of life. However, they found no significant associations with parent-reported family function and the child's adjustment, also supported in findings of another study (Barakat *et al*, 2008). Significant associations in family functioning and child adjustment were supported in the third study (Thompson *et al*, 2003). Higher levels of family conflict were significantly associated with risk of sustained child behaviour problems. Over a period of a year, increases in behavioural problems were significantly related to increases in family conflicts. The findings of this study were supported by another (Palermo at al, 2008), which also found that poor behavioural adjustment in the child was related to a higher baseline for family functioning, especially family conflict, although this was not statistically significant.

Comparisons:

Healthy norms and other illnesses: Over half the studies reported comparisons between children with SCD with the norms of healthy peers or children with other illnesses. Parent/caregiver stress was reported to be significantly lower than published norms for parents with healthy children (Barakat *et al*, 2007) and of the published norms of other paediatric samples (Barakat el al, 2008). Children with SCD reported significantly lower levels of physical HRQL (Panepinto *et al*, 2005) and psychosocial HRQL (Panepinto *et al* , 2009) than did their healthy peers. Parents of children with SCD reported higher levels of external locus of control compared to mothers of healthy

children as well as mothers of children with congenial heart problems (Barakat *et al*, 2005).

Sex: Although all the studies reported the number of males and females used in the research, only two studies undertook gender comparisons (Lutz *et al*, 2004; Thompson *et al*, 2003). One study reported that male children with SCD were significantly more likely to report higher disability stress and lower family functioning than female children (Lutz *et al*, 2004). The same study also reported that girls with SCD were reported by their parents/caregivers to have a significantly better quality of life in comparison to the ratings given to boys. In terms of the risk of children with SCD experiencing behavioural difficulties, there were no significant differences found between males and females (Thompson *et al*, 2003).

Age: There were five studies which made age comparisons between the children with SCD. Older children reported significantly higher disability stress than younger children (Lutz *et al*, 2004). Interestingly, the same study also reported that parents/caregivers of children with SCD reported higher levels of HRQL for older children then they did for younger children. Teenagers reported significantly higher physical HRQL functioning (Barakat *et al*, 2008) and worse psychosocial HRQL (Panepinto *et al* 2009) than younger children. However, this finding was not reflected in another study (Panepinto *et al*, 2005) where no reported significant differences in age and child reported HRQL were found. The risk of behavioural difficulties also had no significant associations with the age of the child (Thompson *et al*, 2003). ,

SCD: Two studies investigated differences between sickle cell genotypes. One study reported no significant differences between the varying types of SCD and parental locus of control (Barakat *et al*, 2005). There were reported differences in healthcare

utilisation; children with HbSS had significantly more contact with health services than the children with the HbSC and Hbβ genotypes (Barakat *et al*, 2007). In terms of disease severity, significantly lower scores on physical HRQL were found in children with more SCD- related complications (Panepinto *et al*, 2005) but was not related to parental locus of control (Barakat *et al*, 2005).

Discussion.

The studies included in this review explored the relationship between familial variables and outcomes of children with SCD. As family as an entity encompasses many different elements and concepts contributing to complex system, papers used many different variables to represent this (from family income to more nebulous, family functioning). 'Outcome' was also characterised in a number of forms to include psychosocial and health related quality of life, behavioural problems, physical health and symptom severity. Unsurprisingly this implies diverse tools to measure the construct such that consensus on predictors is not possible. However, given as most of the studies were rated as 'high' quality, the suggested predictors would appear to be fairly robust.

A number of family-related factors thus appear related to the outcome of children with SCD. Unsurprisingly, it appears that the presences of more positive and stable dimensions to family systems are associated with a better outcome both psychologically and behaviourally for the child with the disease.

Parental coping style and parental locus of control was found to be related to the child's HRQL in sickle cell. When parents reported a more active coping style and felt that they had more control over their child's physical outcome, children were reported to have a

better quality of life. This is consistent with research on children with other chronic health conditions where relationships between a more adaptive psychological adjustment for parents and their child have been made (Drotar, 1997; Daniels, 1987).

Similarly, children of parents who had low levels of disease related stress were more likely to have better reported quality of life, fewer disease-related complications and health care utilisations, consistent with a recent review of the literature in SCD (Panepinto & Bonner, 2012). Several studies have found a relationship between maternal distress and child adjustment as reported by the mother (Wallander *et al*, 2003). Although the relationship may be influenced by maternal report bias, maternal reports on the child's adjustment may also be influenced by the child's behaviour and the mood of the mother at the time of completing the report questionnaire (Walker *et al*, 1989)

Lower family income was associated with poorer physical quality of life in children with SCD. This may be due to children being unable to attend hospital appointments as the parent cannot afford the travel expenses or time off work to facilitate this. However, higher family income surprisingly was associated with lower psychosocial quality of life in children. This may be explained by parents in higher income families spending more time working and therefore less time in the family home or with their child.

The findings of the review have indicated that family functioning shows association with outcome in children with SCD. In particular, higher family conflict was associated with increased behaviour problems in the child. There has been consistent support for the role of family functioning in outcome and adjustment of children with chronic illnesses which may be explained by the positive effect of family cohesion on the

child's coping strategies (Wallander *et al*, 2003). It is therefore likely concluded that poor family functioning may have a negative effect on the child's coping strategies.

Comparator Studies:

Overall, three studies suggest that children with SCD have lower levels of physical and psychological quality of life when compared to healthy peers. There were inconclusive findings for the comparisons of outcome between males and females with SCD. One study suggested that there were no differences between the two sexes and another suggesting that males reported greater disability stress than females.

There were also findings on age differences. Some studies suggested that older children with SCD reported poorer outcomes than younger children with the disease where other studies found no significant differences in outcome of children of different ages. Older children may report poorer outcomes due to developmental process and emotional turbulence characterised in adolescence. Further complications and challenges to this normal developmental process may be added to in children with chronic illnesses as delays in growth and puberty are associated with the disease (Reiter-Purtill & Noll, 2003). This may result in low self-esteem and the young person may be treated as less mature than their biological age by adults and peers (Suris, Michaud & Viner, 2004).

Unsurprisingly, children with the more severe HbSS genotype were found to have significantly more healthcare utilisation than children with HbSC and Hbβ genotype. Children with HbSS will have more sickle cells circulating in their blood compared to the other types. Therefore they are likely to experience more frequent episodes of crisis and are susceptible to haemolysis (accelerated rate of red blood cell destruction) causing a severe haemolytic anaemia, which can sometimes be fatal (Allison, 1954).

To date, there does not appear to be a much research into the relationship between family factors and outcome of children with SCD. However, it appears that in the little research available, various family variables are predictive of behavioural outcomes and psychological and physical quality of life in children with SCD.

Limitations:

There are a number of limitations which should be taken into consideration when interpreting the findings of the review. Firstly, the review comprises a limited number of studies, although sufficiently methodologically robust, which explored the relationships between family factors and outcome of children with SCD. Conclusions drawn must therefore be tentative.

The majority of the studies obtained participants from a single site, in some cases hospital settings where a child was experiencing pain crises. With the exception of one, all of the studies employed a cross-sectional design and were deficit focused rather than affective focused. Therefore, the rating of psychosocial outcomes and family factors may have been rated more negatively than if they were taken when the child was not experiencing crisis. Future research employing community samples where children may not be 'in crises' during the data collection period may enhance validity.

The overall qualities of the studies were rated high with the exception of one, which was rated as moderate quality. However, only two of the studies made reference to the power of the analysis. It does not appear that any of the studies had sufficient power to their analysis and the stability of the regressions in the studies would be undermined. Future research would benefit from the use of larger samples to increase the power of the analysis used.

Family factors are a very broad concept and consist of a huge variety of variables. The studies in the review did not consistently focus on the same family related variables nor did they use the same measurement tools for outcomes. This has made it difficult to synthesise the material and draw upon consistencies or discrepancies between them.

The studies which were used in the current review were all based in the United States and were in English language. There is a greater prevalence of SCD in other countries; however, these were not included. Coping may be considered more important in Western traditions and therefore might have less relevance to other countries. Also, the United States health care system is largely provided by private organisations and individuals will need to buy medical insurance if it is not provided by their employer. Therefore, populations used in these studies may have excluded a significant amount of the SCD population, in particular those from less wealthy families.

Clinical Implications:

The results of this review suggest that physical and psychological related quality of life and behavioural difficulties are generally more negative in children with SCD who have poorer family functioning. Further research is needed to explore which family factors appear to have a stronger influence, whether that's positive or negative, on the psychological wellbeing of the child. This would help to guide more systemic support and/or intervention in clinical practice.

As the research in this area appears to be in its infancy, the findings would need to be replicated before recommendations and changes are made to clinical practice. However, assessing family variables when children and their families are seen in clinic may help to identify areas of support. Children and families would benefit from services taking a

more proactive approach rather than waiting for a crisis requiring more intensive and urgent intervention.

Future research would also benefit from qualitative methodology to explore and generate a better understanding of the experiences and perceptions of both the child and the family in SCD.

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Research Report

Screening for Difficulties in General Intellectual Functioning and Academic Attainment in Children with Sickle Cell Disease and Epilepsy.

Abstract.

Introduction: Academic attainment is one of the key indices of child development and difficulties in this area have been associated with long term detrimental consequences. Sickle cell disease (SCD) and epilepsy are two of the prominent childhood chronic illnesses causing difficulties in academic attainment and schooling. Cognitive difficulties experienced by these populations as a direct result of their illness have been predominantly demonstrated in attentional skills and executive functioning. Although assessing for cognitive difficulties is desirable, it is not often feasible due to constraints of the illnesses and service resources. A screening tool would offer a feasible way to screen more children in these paediatric samples allowing for early intervention and support to be put in place thus facilitating academic attainment.

Method: Neuropsychological assessment scores were obtained from a Paediatric service and entered into an SPSS database. Stepwise multiple linear regression was used to identify subtests from the WISC-IV which would form a model predictive of academic attainment (Word Reading subtest from WIAT-II) and comparisons between high, medium and low FSIQ scores were used to identify which subtests would be predictive of general intellectual difficulties in each clinical group. Cross-tabular analysis explored associations of difficulties on a parent completed questionnaire (SDQ) with problems identified on a neuropsychological assessment (TEA-Ch).

Results: Subtests 'block design', 'similarities', 'digit span', and 'coding' formed a model to identify difficulties in intellectual functioning in children with SCD and subtests 'symbol search', 'coding, 'digit span' and 'vocabulary' in children with epilepsy. The latter two subtests were predictive of Word Reading. There was no significant association between problems identified on the SDQ and TEA-Ch.

Conclusion: A feasible screening tool has been suggested to successfully screen for academic and intellectual difficulties in children with SCD and epilepsy. Clinical implications, limitations and future research are discussed.

Introduction:

Academic Attainment and issues of underperformance:

One of the key indices of child development is academic attainment within the school context: measured in the UK through Standard Attainment Tests (SATs) and formal examinations i.e. GCSE and A-Level (The Schools White Paper, 2010). There are many factors which have been suggested to contribute to academic attainment including good teacher-student relationship and school environment (Esposito, 1999), non-cognitive skills of the child such as persistence, motivation and self-efficacy (O'Connell & Sheikh, 2009), personality characteristics and general intelligence (Laidra *et al*, 2006).

General school-related difficulties may have a long term detrimental impact on the developing child and adult. They may be at increased risk of school dropout, be less likely to continue with further education (Reilly & Neville, 2011) comprising less occupational opportunities and financial security (Maslow *et al*, 2011). Specific academic difficulties may also adversely affect the child's self-esteem, via peer comparison and may feel inferior if they do not perform as well. Parental, teacher and

self-expectations may also contribute to negative self-evaluation (Weiner, 2000) and underachieving children appear vulnerable to increased risk of ridicule and bullying.

Such difficulties, whilst evident in the general child population, are perhaps more evident in those with chronic illness whose psychological well-being, interactions with peers and academic performance are compromised (Sexson & Madan-Swain, 1995). Substantial research exists to demonstrate that academic attainment is adversely affected by experience of living with chronic illnesses. Children with chronic illnesses will experience more school absences than their healthy peers (Cook *et al*, 1985; Fowler *et al*, 1985), often being a result of medical necessities such as appointments and hospitalisations. Poorer academic performance may be evidenced as the child attempts to constantly to 'catch up' with peers and may struggle in subjects where they are required to build upon their previous knowledge (Sexson & Madan-Swain, 1995). Whilst support may be provided for the physical consequences of the illness, similar support required to address the child's educational needs are often overlooked (Thies, 2009). Teachers may attribute cognitive difficulties to an illness and therefore may not make adaptations or refer for specialist support to help the child with any learning difficulties (Sexson & Madan-Swain, 1995).

Chronic illnesses most predominantly causing difficulties for attainment and schooling more generally are sickle cell disease (SCD) and epilepsy. Although the two illnesses are very different in aetiology, they share similar neurological consequences which are considered to compromise academic attainment.

Both of these conditions can cause lesions in different parts of the brain and therefore there are no generalised neurological profiles for children with these conditions. However, research has suggested that the frontal lobes and unilateral temporal lobes are

most commonly affected (Whitfield, 2010; King *et al*, 2008; Kral *et al*, 2001; Berkelhammer *et al*, 2007). Lesions in these parts of the brain would typically be associated with deficits in executive, language and memory abilities.

Sickle Cell Disease:

Sickle Cell Disease (SCD) is a group of genetic autosomal recessive disorders evident in approximately 1 in every 2400 births in the UK and mainly affects Black Caribbean, Black African and Black British people (Sickle Cell Society 2005). It is characterised by the production of abnormal haemoglobin. The disorders are classified according to genotypes with the three predominant forms including Sickle Cell Anaemia (H*b*SS), Sickle Cell Beta Thalassemia (H*b*Sβ°/ H*b*Sβ^{+}) and Sickle Cell Haemoglobin C (H*b*SC). Sickle Cell Anaemia is considered to be the most severe of the disorders presenting earlier with a higher frequency and severity of symptoms compared to other sickle cell disorders.

SCD causes red blood cells to take on the form of a crescent or sickle shape deforming the normal biconcave shape of the erythrocyte. Due to the shape of these red blood cells, their ability to flow smoothly through arterioles and fine capillaries is greatly hindered. The sickle-shaped cells can also become tangled together causing vaso-occlusive crises which may result in ischemia, acute pain and often organ damage. Children with SCD are at risk of experiencing overt stroke that have physical indications (Kral *et al*, 2001). Children with SCD may have particular vulnerabilities. They are at increased risk of overt stroke which is often manifest with clear physical indications (Kral, Brorn & Hynd, 2001). Figures suggest that approximately 30% of children with SCD will have experienced a stroke before they are 18 years old (Ohene-Frempong *et al*., 1998) often associated with cognitive difficulties. However, they are

also at risk of silent infarcts which may go unnoticed for considerable periods of time with significant and adverse impact on their cognitive functioning.

Comprehensive literature reviews considering the neuropsychological profiles of children with SCD has highlighted the importance of cognitive assessment (Edwards *et al* 2007; Kral *et al* 2001). Reviews have demonstrated children's poor performance in many cognitive domains post- infarct including comprised intellectual functioning, language and verbal abilities, visual motor and visual spatial processing and performance, sequential memory and academic performance (King *et al*, 2008; Kral *et al*, 2001; Berkelhammer *et al*, 2007). These reviews argue that neuropsychologists should use measures to assess abilities associated with the frontal lobes given they are commonly affected by overt strokes and silent infarcts.

In a review of the literature spanning over four decades, Kral *et al*.(2001) surmised that children with SCD who had silent infarcts, demonstrated subtle neurocognitive deficits compared to children who had no evidence of infarcts on their MRI. These deficits were less severe than in children who had experienced overt stroke. They could be detected by measures of attention and executive functioning, sensitive in the detection of silent infarcts. The review's conclusions were tempered by inclusion of studies whose samples were small and lesion location not controlled. Neuropsychologists were alerted to the need to incorporate measures that assess frontal lobe functions (attention, concentration and executive function).

The use of cognitive screening has previously been examined for children who have been identified as having experienced overt strokes and silent infarcts. In a review of the effectiveness of cognitive screening in SCD, Debaun *et al*. (1998) examined children with SCD who had experienced silent infarcts and those who had experienced overt

strokes, as well as siblings who had experienced neither. Broad based neuropsychological assessments revealed that measures of attention and executive domains were more effective at identifying children with silent infarcts. In particular, the Test of Variable Attention (TOVA) had a sensitivity rate of 86% and specificity rate of 81% for identifying children with silent infarcts and 95% sensitivity in identifying overt strokes.

Whilst the majority of the research on cognitive impairments in children with SCD appears to focus on those who have experienced stroke, it is important to note that all children with SCD are at risk of cognitive deficits. Children who have SCD without stroke generally have lower cognitive performance in comparison to healthy siblings or peers (King *et al*, 2008; Schatz *et al*, 2008).

Epilepsy:

Epilepsy is the most serious common chronic neurological condition with a prevalence of 5-10 in every 1000 and a lifetime incidence rate of 2.5% (Gurd *et al*, 2010) with genetic causes (genetic propensity, intrauterine infection and illness) being considered dominant precursors to congenital malformation of the brain. Between 30 and 50 million people worldwide have epilepsy (Wendling, 2008) with approximately 30% of new cases diagnosed before 18 years of age (Lezak *et al*, 2012).

Epilepsy comprises a group of conditions whose predominant symptoms are recurrent seizures- episodic disturbances of behaviour or perception resulting from hyperexcitability and hypersynchronous discharge of nerve cells in the brain associated with various aetiologies (Lezak *et al*, 2012). Seizures may involve motor, sensory autonomic or psychic disturbance which may occur in isolation or in combination. Infancy and childhood see the highest incidence of seizures of the human lifespan with

a fifth of children who experience unprovoked seizures eventually developing epilepsy (Zupanc, 2010).

Diagnosis for epilepsy requires the presence of at least two unprovoked seizures and is categorised by seizure type (focal/partial or general) and whether aetiology is known (symptomatic), suspected (cryptogenic) or unknown (idiopathic). EEGs are used to support diagnosis and MRI and CT scans can play a vital role in establishing aetiology and in pre-surgery investigations.

The epileptic activities in partial seizures begin in a localised region of the brain. Although the activity can begin in any area of the cortex, the temporal lobes are more susceptible as the epileptogenic region (Thompson, 2010). The epileptic activities in generalised seizures involve the entire cortex and the loss of consciousness and awareness of the event to the individual occur (Black & Hynd, 1995). Absences are the most common type of seizures in children resulting in a brief arrest in consciousness where atypical absences may present with involuntary jerking movements of the body.

There has been surprisingly little focus on particular neuropsychological deficits consequent on epilepsy and their impact on children's academic achievement (Reilly & Neville, 2011). A review by Reilly and Neville (2011) suggested low achievement (performance below mean for a particular academic area) is more common than underachievement (performance lower than expected from their IQ).

Previous research has suggested that academic vulnerability in children with epilepsy is based on specific cognitive deficiencies rather than a generalised cognitive impairment. Children considered to be making 'satisfactory' academic performance and those deemed to be making 'poor' academic achievement, assessed via neuropsychological battery assessments, revealed significant differences between the groups in verbal skills

and in skills of attention and concentration, suggesting that poorer academic achievement was associated with lower levels of these skills (Seidenberg *et al*, 1988) . These findings have been given more recent support with Fastenau *et al* (2004) finding measures of verbal, memory, executive/attention and working memory skills to be strongly related to academic achievement in reading, maths and writing.

More recent research has explored the relationship between attention and attainment. In children with well controlled epilepsy, Williams *et al* (2001) concluded academic attainment in these children was comparable to national norms of healthy peers ,with auditory attention being the only variable to make a unique contribution. They argued that inattention may reduce the child's ability to attend to auditory information in the environment and would support evidence for a common underlying neuropsychological deficiency as primary contributor to specific cognitive difficulties.

Seizure control also appears associated with cognitive performance. Jones *et al* (2010) compared children who experienced complex partial epilepsy, childhood absence epilepsy and healthy controls in a two year follow up study. Children with poor seizure control at baseline were more likely to demonstrate a decline in overall intelligence and non-verbal reasoning skills. This decline, irrespective of IQ remained of similar magnitude over time, with an improving trajectory of performance which did not narrow the gap with performance of their peers. These findings highlight importance of screening for difficulties that children with epilepsy may experience, irrespective of IQ.

Many children who have epilepsy will take Antiepileptic Drugs (AED) to help control the seizures. As demonstrated in the previous research mentioned above, cognitive functioning appears to be less affected when seizures are controlled for. However, it is important to acknowledge that for children whose epilepsy is controlled, difficulties

may still be experienced. Children may be required to take multiple medications in attempt to adequately control seizures. However, the medication is likely to have adverse side effects as all AEDs are known impair cognitive functioning and should be closely monitored for impacts on learning and performance at school (Roberts, 2003).

Screening:

Given the known vulnerabilities of these patient groups, assessing and establishing cerebral problems should be sort as early as feasible. Indeed services are structured to support this: children with SCD are screened on an annual basis via Transdoppler imaging to identify unusual arterial blood flow indicative of increased risk of stroke. Timing of imaging is crucial in this process (Gebreyohanns & Adams, 2004) and further detail optimal timing for scanning could enhance the tools of predictive capacity.

Children with epilepsy are considered for neuropsychological assessment. This normally occurs if they have been identified as having educational difficulties; when abnormalities in the cognitively important brain regions have been highlighted by MRI or if there have been any complaints in cognitive functioning/decline. Regular screening may ensure that the child is assessed before any difficulties are picked up and therefore allow for earlier identification and/or intervention.

Although parents and teachers may provide useful information on a child's functioning and wellbeing, their report accuracy has limitations. In children with SCD, parents have been shown to report their child's health related quality of life significantly lower than their child has rated themselves (Panepinto *et al*, 2005; Panepinto *et al*, 2007). Research in paediatric long-term survivors of cancer also suggest that neurocognitive assessments are better predictors of academic functioning than parent questionnaires (Krull *et al*, 2008).

For children with epilepsy, teachers have been shown to be influenced by the knowledge of epilepsy diagnosis. This has often led to the teacher underestimating the academic abilities of the child (Katzenstien *et al*, 2007). Such flawed evaluation strongly argues for enhanced objective assessment.

To this end, employing a full neuropsychological battery would be advantageous in identifying cognitive difficulties in these vulnerable children. However, practicability is an issue given the number of hours required to deliver extensive assessments and the need for children to miss school, exacerbating any absences already caused by illness management itself. An effective and more time efficient screening tool would address this dilemma whilst helping guide intervention to help improve academic achievement.

Discrete neuropsychological screening tools could provide an earlier detection of those who would benefit from a more intensive assessment, particularly between routine annual neurological assessments, and would allow more immediate medical intervention, possibly mitigating likelihood of overt stroke. It would also allow for specific educational support to be put in place for the child to help maximise their academic functioning given early rehabilitation may improve the recovery of function (Coelho-Mosch *et al* 2005).

Therefore the main aim of the research was to identify subtests in a comprehensive battery of neuropsychological assessments currently used in paediatric services which would be predictive of overall general intelligence and attainment. The study also aimed to explore whether a parent completed questionnaire could be used to highlight difficulties in the child's attentional abilities.

Method

Study Design:

The study used a cross sectional single point sample design to collect data routinely recorded by the host trust in which the study was conducted. Data comprised that elicited via administration of standard neuropsychological tests supplemented by the parent-completed questionnaires. The usual battery of assessments administered by the host service contained measures of academic achievement (Wechsler Individual Achievement Test – 2nd Ed (WIAT-II)) general intelligence (Wechsler Intelligence Scale for Children – 4th Ed (WISC-IV)), attention (Test of Everyday Attention for Children (TEA-Ch)), and learning (California Verbal Learning Test – 2nd Ed (CVLT-II)) (see materials section). The latter of these assessments did not form the part of the test items used in the current research due to the long administration which would mean that the assessment alone would be a longer duration than would be ideal for the screen.

A multiple linear regression was used to predict academic abilities from age-correlated standard scores on each subtest from the cognitive screening. The outcome variable was the Word Reading subtest from the WIAT-II. The predictor variables were the subtests of the WISC-IV which explained the most variance, as identified by a stepwise linear regression analysis.

Full Scale IQ scores (FSIQ) obtained on the WISC-IV were used to categorise participant into 'high', 'moderate' and 'low' scoring groups of general intellectual functioning. Mean scores for each subtest were compared within the groups and those with the largest differences were identified as the subtests which would be most predictive of intellectual difficulties in children with SCD and children with epilepsy.

One sample t-tests were also used to compare the mean scores obtained on each subtest by children in each of the health conditions with published normative data.

Participants:

The aim of the research was to identify the best subtests to create an effective screening tool to predict overall intelligence and academic achievement; it was unclear how many predictor variables would be used in the regression. It was suggested that up to four predictor variables in total would be sufficient and be able to be administered in an acceptable amount of time. To achieve adequate power in regression models, it is suggested that at least 10 participants per predictor variable should be used (Howell, 2007). Therefore this meant that at least 40 participants would be required if the maximum of 4 predictor variables were to be used.

Participants for this study were children diagnosed with SCD or epilepsy who were seen for an annual or needs based assessment by a Paediatric Neuropsychology department based in an acute teaching hospital in the Midlands, UK. Participants could be included if they were between 6-16 years of age. This particular age range was imposed in the inclusion criteria as the child version of the neuropsychological tests used were only standardised and suitable for children within this age range. Due to the nature, norming and availability of the neuropsychological assessments, participants were required to be fluent in English language. Children were excluded from the research if they had experienced a prior head injury or had other genetic disorders or unrelated neurological conditions.

There were 42 children who met the criteria and were used in the study. There were 9 children who had a diagnosis of SCD and 33 with a diagnosis of epilepsy. A more

detailed summary has been presented in the results section so will not be repeated here (See Table 1 for more details).

Measures/Questionnaires used:

Materials:

Strengths and Difficulties Questionnaire (SDQ) – Goodman (1997).

The parent completed questionnaire (SDQ) was administered as part of routine clinical practice at the host service. The SDQ is a 25 item behavioural screening questionnaire for children aged between 4 and 16 years of age, and is completed by the child's parents. The 25 items are divided into five scales: Emotional Symptoms (5 items); Conduct Problems (5 items); Hyperactivity/Inattention (5 items); Peer Relationship Problems (5 items); and Prosocial Behaviour (5 items).

The sum of the 20 items from scales 1-4 is used to generate a total difficulties score, with higher scores indicating greater difficulties. Overall scores are rated as normal (>13), borderline (14-16) or abnormal (17-16). Satisfactory reliability in terms of internal consistency (Cronbach's alpha: 0.73), cross informant correlation (mean: 0.34) and retest stability after 4-6 months (mean: 0.62) have been established on a sample of 10,438 British children 5 to 15 years old (Goodman, 2001).

Wechsler Intelligence Scale for Children - 4th Edition (WISC-IV) - Wechsler (2003).

The WISC-IV is used to measure intellectual ability for children aged between 6 and 16 years, 11 months and allows measurement of overall intelligence (Full Scale IQ) as well

as division into a child's verbal (verbal IQ) and non-verbal (Performance IQ) abilities. The assessment also provides the assessor with a Verbal Comprehension Index (VCI), Processing Speed Index (PSI), Perceptual Reasoning Index (PRI) and a Working Memory Index (WMI). The WISC-IV is comprised of 10 core subtests and 5 optional ones. The following 7 core subtests were administered to the children as part of an index-based short-form of the WISC-IV (Crawford *et al*, 2010).

Block Design – Block Design (BD) is a subtest which measures visuo-spatial skills and motor execution. Children are presented with blocks which all have two white sides, two red sides and two sides which are red and white split down the diagonal. Children are given two, four or nine blocks depending on the item number. They are required to construct the blocks to replicate visually presented material as quickly as they can.

Vocabulary – Vocabulary (VO) is a measure of verbal comprehension where the child is required to provide definitions for words. It involves skills in verbal fluency, concept formation, word knowledge and word usage.

Similarities – Similarities (SI) is a subtest requiring children to describe how words representing common objects or concepts are similar. It measures skills involving logical thinking, verbal concept formation and verbal abstract reasoning.

Matrix Reasoning – Matrix reasoning (MR) is a subtest which measures visual processing, and abstract, spatial perception which may be influenced by concentration, attention and perseverance. The task requires the child to complete the missing portion of coloured/visually patterned matrices from a selection of five options.

Digit Span – Digit span (DS) is a measure of attentional capacity requiring the child to repeat a string of randomly ordered numbers spoken by the assessor. The string of

numbers starts at two digits and increases after the child has correctly repeated at least one of two trials. The test is split into three parts; the first requiring the child to repeat the numbers in the order that they were presented; the second to repeat the numbers in the opposite order that they were presented; finally in numerical order from the smallest value to the largest. Digit span involves auditory attention and short-term retention capacities.

Coding – Coding (CD) is a subtest which consists of rows of small blank squares below a randomly assigned number. A key is positioned at the top of the page which contains numbers 1-9 each with a nonsense symbol underneath. The child is required to use the key to copy the correct symbol in the blank spaces under the randomly presented numbers. They have two minutes to complete as many as they can from left to right, line by line without missing any. This task is highly dependent on speed and also measures skills in motor persistence, visuo-motor coordination, response speed, visual scanning and sustained attention.

Symbol Search – Symbol search (SS) is a task which measures skills of visual perception and recognition that requires the child to determine the presence or absence of a target geometric symbol in a group of symbols. Performance on this task is also associated with speed, accuracy, attention and concentration.

Raw scores obtained on each subtest are converted into standardised scaled scores which have a mean of 10 and Standard Deviation of 3. The scaled scores of particular subtests are summed together to form index scores to measure Verbal Comprehension (vocabulary & similarities), Perceptual Reasoning (block design & matrix reasoning), Working Memory (digit span) and Processing Speed (coding & symbol search). The four indices are combined to produce a Full Scale IQ (FSIQ).

The internal reliability of the WISC-IV is excellent with the majority of subtests having high reliability (r=.80-.89) and composite scores having very high internal validity (r>.90). Test-retest stability is also of high standards with most subtests having high reliability (r>.80).

Test of Everyday Attention for Children (TEA-Ch) – Manly (1999)

The TEA-Ch was used to assess the different attentional capacities in children aged between 6 and 16 years old. It is comprises nine subtests which measure child's ability to: selectively attend; sustain their attention; divide their attention between two tasks; switch attention from one thing to another; and withhold (inhibit) verbal and motor responses.

Raw scores for each subtest are converted into standardised scaled scores (M=10, SD=3) and percentiles which are based on normative data. The normative data was based on 293 Australian children aged between 6 and 16 years. There is no information on the internal reliability reported in the manual which accompanies the test. This may be due to the speeded nature of the tasks (Strauss *et al*, 2006). Data on test-retest reliability obtained from 55 children demonstrated that the majority of the subtests had adequate (N=3, r=.70-.79) to high (N=4, r=.80-.89) reliability (Strauss *et al*, 2006).

Wechsler Individual Achievement Test – 2nd Edition (WIAT-II) – Wechsler (2005).

The WIAT-II is a comprehensive test battery of which measures academic achievement in children and young people aged between 4 and 21 years, 11 months. It was designed to cover each of the seven areas traditionally used to diagnose learning disabilities (i.e.

word reading, word comprehension, mathematics calculation, mathematics reasoning, listening comprehension, oral expression, and written expression) (Strauss *et al*, 2006). The test comprises five composite scores (Reading, Mathematics, Written Language, Oral Language and Total Composite). The WIAT-II has good internal reliability with all composite scores (r=.83-.99). In particular the Word Reading (r=.97-.99) and the Total Composite (r-.98) exceed the recommended standard of .95 for diagnostic purposes (Strauss *et al*, 2006). Most of the individual subtests are reported to be in the high to very high range (>.80-.90).

The subtest 'Word Reading' (WR) was used in the current research as the measure of academic attainment. Due to the nature of the data collection already being carried out by the clinical service, this was the only subtest of the WIAT-II which was administered in the majority of assessments.

Word Reading comprises a 131 item word list which the participant is required to read out loud. If they are unable to read a word or give the incorrect pronunciation on seven consecutive words, the task is discontinued. Raw scores are converted to age equivalent standard scores based on normative data.

Procedure:

A proposal of the research was submitted to the NHS Research and Design Department and to the University of Leicester's Ethical Committee for approval (Appendix F). As data had already been collected as part of routine clinical practice, it was not considered necessary to seek approval from the NHS Research and Ethics Committee. The original research proposal consisted of a sample of children with a diagnosis of SCD. The aims of the proposed study were to identify a screening tool that may be predictive of silent infarcts. It became apparent during the data collection period that there were few

complete data sets of children with SCD already available. The researcher was able to utilise their role as a Trainee Clinical Psychologist within the host trust to attempt to administer the routinely used battery of neuropsychological assessments on children who were waiting to be assessed on the waiting list. Unfortunately, the majority of patients did not attend their appointments. Due to the time restrictions imposed to complete the research, it was decided through supervision with both the academic and field supervisor to change the direction of the research allowing the inclusion of children with epilepsy. All of the assessments on children with epilepsy had already been carried out,

The data of the children who met the inclusion criteria had been collected as part of routine clinical practice by a Paediatric Neuropsychologist and Trainee Clinical Psychologists in the in an acute teaching trust within the Midlands. Basic demographic information (sex, age and diagnosis), scaled scores obtained from the neuropsychological battery of assessments and parent completed questionnaires were inputted by the researcher into the statistical software package SPSS (version 20) for analysis.

Ethical Considerations:

Informed Consent: The scores for the neuropsychological assessments and the parent completed questionnaires had been obtained as part of the routine clinical practice. There was no identifiable information obtained or used by the researcher as part of the study. For these reasons it was not considered necessary to obtain consent from the participants or their parents/guardians.

Confidentiality: As the proposed research was carried out with using data from patients seen at the Paediatric Neuropsychology service, the researcher abided by their policies

on confidentiality. Data was transferred into the database at the clinic where the patient files were held. No identifiable patient information was used by the researcher.

Potential harm to the participant. It was considered that the current research would not cause any risk of harm to participants. Participants had already taken part in the assessments as part of the routine clinical service and were not required to do anything additional to what they have already done for the purpose of the research.

Results.

Data Analysis:

In order to examine findings and address the research questions, the following were undertaken: Independent sample t-tests were used to test for differences on the criterion variables (FSIQ and Word Reading). Comparisons were made between children with epilepsy and SCD and also between males and females. Pearson's correlation co-efficient was used to explore any associations with age and scores obtained on these criterion variables. One sample t-tests were used to identify which subtests for each of the clinical groups differed from the normative population.

A stepwise multiple linear regression analysis was undertaken to identify which of the WISC-IV subtests contributed to the model which best predicted the Word Reading subtest from the WIAT-II. A multiple linear regression was deemed the most

appropriate method of analysis as it permitted predictions of scores on one variable to be made on the basis of scores obtained on several other variables (Brace *et al*, 2006). Given that the criterion variable was classed as continuous data and predictor variables were interval data, the prerequisites of using this type of analysis were satisfied. Preliminary analyses were performed to ensure that there were no violations of normality, linearity, multicollinearity and homoscedasticity. Since the aim of the study was to identify which combination of subtests might provide the best prediction of Word Reading, a 'stepwise' regression was adopted. In this method, each variable is entered in sequence. If a variable contributes to the model it is retained and all other variables reassessed to examine whether they still contribute to the model being removed if they fail to contribute (Brace *et al*, 2006). This would allow the least amount of effective predictor variables to be included in the overall model.

To identify which subtests of the WISC-IV would be most effective in contributing to a model to predict general intellectual abilities, children were categorised by their FSIQ score into the categories 'low scoring' (FSIQ = <70), 'moderate scoring' (FSIQ = 70-85) and 'high scoring' (FSIQ = >85). The average scores for each risk group were compared against one another and the number of standard deviations from the norm was identified.

Total scores on the SDQ were categorised into one of two categories; 'no identified concerns' (16 points or below) or 'identified concerns' (17 points or higher). Scores obtained from each subtest on the TEA-Ch were considered to indicate attentional problems if they fulfilled the following criteria: if a child obtained at least one scaled score which was 1.5 SD lower than average or at least two scaled scores which were 2SD lower than average. A 2x2 Chi-square analysis was carried out to explore any

associations with concerns identified on the SDQ with attentional difficulties evidenced from the scores of the TEA-Ch.

Descriptive Statistics:

There were 42 children in the total sample, comprising 21 males and 21 females with a mean age of 11 years and 1 months (age range 6yrs 1mth – 16yrs 6mths) (See Table 1).

Within the group nine children (4 males and 5 females) carried a diagnosis of SCD (mean age 8yrs and 1mth, range 6yrs 1mth – 16yrs 6mths), and one child with SCD had evidence of silent infarct. The ethnicity of all children with SCD were classed as 'Black/British' with the exception of one child who was classed as 'Mixed White/Black Background'.

There were 33 children (17 males and 16 females) who had a diagnosis of epilepsy (mean age 11yrs 10mths, range 7yrs – 16yrs 5mths). Of these children, twenty-four were classed as 'White/British' ethnicity, four as 'Asian/British', two as 'Any Other Mixed' and two as 'Other White'. (All of the children with a diagnosis of epilepsy were prescribed medication to affect seizure control.

Table 1: Demographics of participants.

Demographic	Total Sample	Sickle Cell Disease	Epilepsy Group
Age (Mean) (Range)	 11yrs, 1mths 6yrs 1mth – 16yrs 6mths	 8yrs, 1mth 6yrs 1mth – 16yrs 6mths	 11yrs, 10mths 7yrs 16mth – 16yrs 5mths
Sex (Male) (Female)	 21 21	 4 5	 17 16

Inferential analyses

Comparisons:

FSIQ:

Children with SCD achieved a higher FSIQ (Mean = 92.22) when compared to children with epilepsy (Mean = 75.42). The mean difference between the two conditions was 16.8 and 95% Confidence Interval for the estimated population mean was between 5.97 and 27.63. The effect size was large (d= 1.11). An Independent t-test revealed the difference between the mean scores achieved on the FSIQ for children with SCD and epilepsy to be significant (t = 3.13, df = 40, p = 0.003, two-tailed).

Females scored slightly higher on FSIQ (Mean = 79.62) than males (Mean = 78.42). There was a mean difference of 1.19 with a 95% Confidence Interval of -11.1 and 8.72. There was a small effect size (d = 0.07) but the difference between the male and female scores was not considered statistically significant (t = 0.24, df = 40, p = 0.809, two-tailed).

There was a slight negative correlation between age and FSIQ but this trend was not significant (r = -0.203, N = 42, p = 0.09).

WIAT-II Word Reading:

A significant difference in the mean score achieved on the 'Word Reading' subtest between the two conditions was revealed (t = 2.75, df = 22, p = 0.012, two-tailed). Children with SCD (Mean = 102) scored significantly higher than children with epilepsy (Mean = 84). There was a mean difference of 18 and a 95% Confidence Interval between 4.41 and 31.59. The effect size was large (d = 1.22).

Female children (Mean = 90.45) scored higher than males (Mean = 88.23) on the 'Word Reading' subtest. There was mean difference of -2.22 and a 95% Confidence Interval

between -17.76 and 13.31. The effect size was small (d = 0.13) and the mean score difference between males and females was not significant (t = -0.306, df = 14.479, p = 0.764, two-tailed). Levene's Test for Equality of variance was significant suggesting that variance was not equal.

There was a slight negative correlation between age and Word Reading score but this was not considered to be statistically significant (r = -0.142, N = 24, p = 0.509).

Comparisons of individual subtest means of children with epilepsy and children with SCD with normative population.

One sample t-tests were conducted to compare the average scores obtained by children

Subtest	Normative Sample Mean Score	SCD Sample Mean Score	Mean Difference	Standard Deviation	P-Value

with SCD on each subtest of the WISC-IV with normative sample published in the WISC-IV Technical Manual (p.69) (Table 2). In the subtest 'Matrix Reasoning', children with SCD (Mean =11) achieved higher scaled scores on average compared to the normative sample (Mean = 9.8), although this difference was not significant (t(8) = 0.849, p = 0.421). However, there were two individuals who scored considerably higher than the others (scaled scores of 17 and 18). Thus this mean score is not based on a normal distribution. On all other subtests, children with SCD scored lower on average than the normative sample, however the difference was only statistically significant in the subtest 'Coding' (t(8) = -2.647, p = 0.029).

Table 2: Comparisons of Mean Scores obtained by SCD Sample with Normative Sample.

BD	9.7	8.33	1.36	2.25	0.133
SI	9.8	8.22	1.58	3.70	0.237
DS	9.9	9.67	0.23	3.08	0.826
CD	10.2	7.89	2.31	2.62	0.029
VO	10	9.22	0.78	2.82	0.432
MR	9.8	11	1.2	4.25	0.421
SS	10	7.89	2.11	4.48	0.196

The average scores obtained on each subtest by the children with epilepsy was compared to a published normative sample (WISC-IV Technical Manual, p.69) using one sample t-tests (Table 3). Children with epilepsy scored significantly lower than the normative sample in all subtests; 'Block Design' ($t(32) = -9.812$, $p<0.01$); 'Similarities' ($t(32) = -4.401$, $p<0.01$); 'Digit Span' ($t(32) = -7.796$, $p<0.01$); 'Coding' ($t(32) = -9.565$, $p<0.01$); 'Vocabulary' ($t(32) = -7.601$, $p<0.01$); 'Matrix Reasoning' ($t(32) = -7.388$, $p<0.01$); and 'Symbol Search' ($t(32) = -7.198$, $p<0.01$).

Table 3: Comparisons of Mean Scores obtained by Epilepsy Sample with Normative Sample

Subtest	Normative Sample Mean Score	Epilepsy Sample Mean Score	Mean Difference	Standard Deviation	P Value
BD	9.7	7.33	2.37	3.09	<0.01
SI	9.8	7.03	2.77	2.81	<0.01
DS	9.9	5.91	3.99	2.94	<0.01
CD	10.2	5.88	4.32	2.56	<0.01
VO	10	6.24	3.76	2.84	<0.01
MR	9.8	6.64	3.16	2.46	<0.01
SS	10	6.45	3.55	2.83	<0.01

Figure 2 shows the mean subtest scores for the SCD sample, the epilepsy sample and the normative sample.

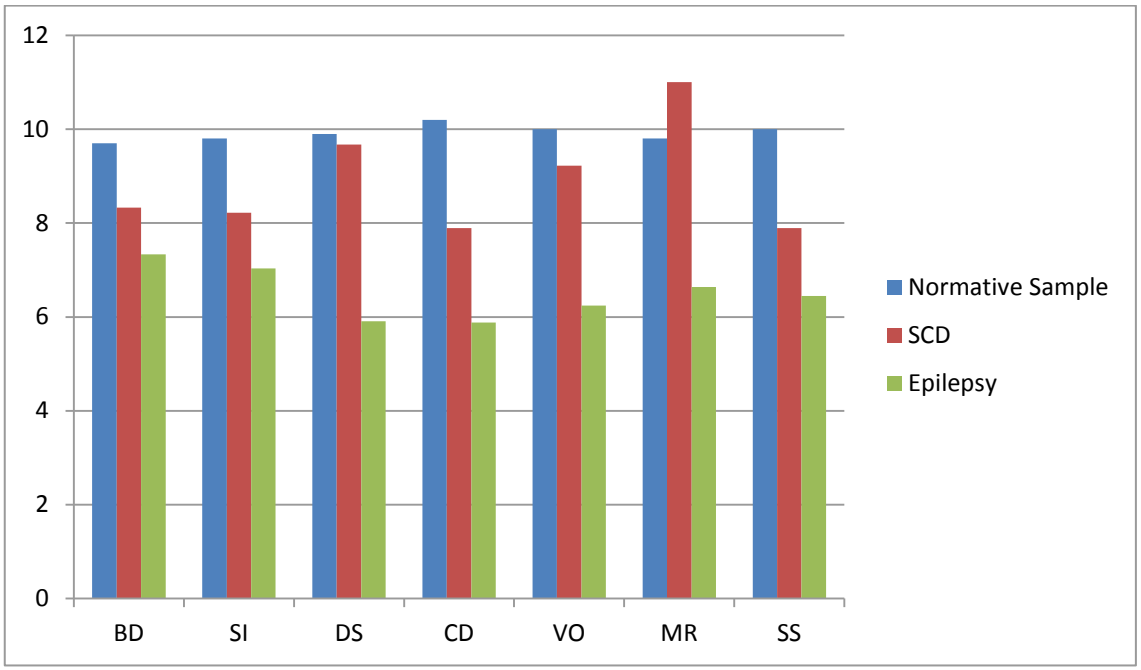

Figure 2: Clustered Column of the Normative, SCD and Epilepsy sample on each subtest.

WISC-IV Profiles of 'High', 'Moderate' and 'Low' Scoring Participants:

Participants in both the SCD and epilepsy groups were categorised into 'high', 'medium' and 'low' in relation to the scores they achieved on the FSIQ. Children within one standard deviation (within 15pts of 100) were classified as 'high' scoring (within the average range), those between one and two standard deviation (within 30pts of 100) lower (low average range) were classed as 'moderate' and those who were greater than two standard deviations lower (within the borderline and impaired range) were placed in the 'low' scoring group.

SCD Profiles:

There were six participants in the SCD group who were in the 'high' scoring group and three who were in the 'moderate' group. There were no participants who met the criteria for the 'low' scoring group. Children in the 'moderate risk' group on average scored lower on all subtests (Table 4) compared to the 'high' group. The 'high' scoring group scored within one standard deviation (within 3pts of 10) on all subtests and 'moderate risk' group achieved this on the subtests Vocabulary (VO) (Mean = 8.33); Matrix Reasoning (MR) (Mean = 8.33); and Symbol Search (SS) (Mean = 7.67). The 'moderate' group, however, scored more than one standard deviation below on subtests Block Design (BD) (Mean = 6.33); Similarities (SI) (Mean = 4.67); Digit Span (DS) (Mean = 6.67); and Coding (CD) (Mean = 6).

Table 4: Mean Scaled Scores of High and Moderate Scoring SCD Group for each WISC-IV Subtests.

	BD	SI	DS	CD	VO	MR	SS
High	9.33	10	11.17	8.83	9.67	12.33	8.00
Moderate	6.33	4.67	6.67	6.00	8.33	8.33	7.67

Epilepsy Profiles:

There were nine participants with epilepsy in the 'high' scoring group, twelve in the 'moderate' group and twelve in the 'low' scoring group. Participants in the 'moderate' group scored lower on all subtests compared to the 'high' scoring group (Table 5). The 'high' group scored within one standard deviation (within 3pts of 10) on all subtests, The 'moderate' scoring group scored within one standard deviation on the subtests BD (Mean = 7.33); MR (Mean = 7.5); and SS (Mean = 7.25), and between one and two standard deviations below on the subtests SI (Mean = 6.25); DS (Mean = 6,08); CD

(Mean = 6.08); and VO (Mean = 6). The 'low' scoring group scored less than two standard deviations on all subtests

.

Table 5: Mean Scaled Scores of High, Moderate and Low Scoring Epilepsy Group for each WISC-IV Subtests.

	BD	SI	DS	CD	VO	MR	SS
High	10.00	10.44	8.66	7.11	8.56	8.23	8.23
Moderate	7.33	6.25	6.08	6.08	6.00	7.50	7.25
Low	5.33	5.25	3.67	4.75	4.75	4.58	4.33

*p<0.0005

Predictors of Word Reading

A stepwise regression identified predictor variables which significantly contributed to the variance of Word Reading to be the subtests 'Vocabulary' and 'Digit Span'. The model was significant ($F(2,21) = 17.63$, $p>0.01$) and accounted for 59.1% of the variance of the Word Reading scores (Adjusted $R^2 = 0.59$). See Table 6 for the unstandardised and standardised regression coefficients for each predictor variable included in the model. Cronbach's alpha was reported as 0.66 suggesting that internal consistency was slightly low.

Table 6: The unstandardised and standardised regression coefficients for the variables included in the model.

Variable	B	SE B	β
Digit Span	2.252	0.802	0.450*
Vocabulary	2.327	0.832	0.448*

*p = 0.011

SDQ and Tea-Ch

There were ten children with epilepsy and three with SCD with completed data for the TEA-Ch and the SDQ. A 2x2 cross-tabular analysis with Fisher's exact test was used to examine for association of scores that were obtained on the TEA-Ch and the parent-completed SDQ. The analysis showed that the association between scores on the SDQ and scores on the TEA-Ch was not significant ($p = 1.00$). The SDQ and TEA-Ch agreed on presence of child difficulties on seven occasions (54%) and disagreed with one another six times (46%). Table 7 displays the frequency of attentional difficulties highlighted by the TEA-Ch and those highlighted by the SDQ.

Table 7: Frequencies of attentional difficulties reported in SDQ and TEA-Ch.

	SDQ Yes	SDQ NO	Total
TEA-Ch Yes	5	5	**10**
TEA-Ch No	1	2	**3**
Total	**6**	**7**	**13**

There were four children with a diagnosis of epilepsy who were rated as 'high risk' on the SDQ. Of these children, all scored within the abnormal range on the 'Emotion Scale', on the 'Hyperactivity Scale' 75% fell within the abnormal range and the remaining scoring as borderline, and 75% fell within the abnormal range on the 'Peer Scale'.

There were two children with epilepsy who were rated as 'borderline' risk on the SDQ. One of these participants fell within the abnormal range on the 'Emotional Scale' whereas the other scored within the abnormal range on the 'Hyperactivity Scale'.

All of the children with SCD were rated within the 'normal' range on the SDQ.

An independent sample t-test found that children who were rated as 'borderline' or 'high risk' on the SDQ scored significantly lower on the subtest 'Digit Span' compared to those who were rated as 'normal' on the SDQ ($t(11) = 3.194$, $p<0.01$). The effect size

was (d = 1.77). There were no other significant differences on the other subtests between the two groups.

Discussion.

Study aims, methods and findings:

The current study aimed to identify an effective and parsimonious screening tool for cognitive difficulties in children with sickle cell disease (SCD) and epilepsy. This was achieved through data obtained in a single Paediatric Neuropsychology service who, as part as routine clinical practice, conducted a comprehensive battery of neuropsychological assessments to these paediatric populations. Parents also completed questionnaires rating various aspects of functioning and adjustment, included in which was the Strengths and Difficulties Questionnaire (SDQ).

A multiple linear regression was carried out using a 'stepwise' method of data entry to identify which subtests of the Wechsler Intelligence Scale for Children – 4th UK Edition (WISC-IV) could be used to form a shorter screening to predict academic functioning (Word Reading subtest on the Wechsler Individual Achievement Test – 2nd UK Editions (WIAT-II)). One sample t-tests were used to identify which subtests of the WISC-IV were significantly different in children with epilepsy and SCD in comparison to published normative data. Profiles of children in each group were identified for children who scored 'low', 'moderate' and 'high' on general intellectual functioning by scrutinising and comparing the mean scores obtained on each subtest for each group.

To investigate whether a parent completed SDQ was sufficient in identifying attention difficulties in children with SCD and epilepsy, a 2x2 cross-tabular analysis was used.

This demonstrated whether or not attention problems on the SDQ were consistent with lower scores obtained on the TEA-Ch assessment of attention and concentration.

In total there were neuropsychological data scores obtained from forty-two children in the current study. Seventy-nine per cent of participants had epilepsy and there were an equal number of males and females. The majority of the children were considered to be within the average range of the ability with ten the participants scoring below the average range. All participants completed the WISC-IV, which included FSIQ, but only twenty-four completed the Word Reading subtest of the WIAT-II. Of those who completed this subtest, seventy-one per cent had a diagnosis of epilepsy and seventy-one per cent were male.

Although females tended to score higher than males on overall general intelligence (FSIQ) and academic performance (Word Reading), the difference was not significant. Similarly, general intellectual ability and academic ability appeared to be poorer in older children compared to younger, but again the difference was not significant.

There were significant differences between FSIQ and Word Reading scores between the conditions with children with SCD scoring significantly higher than those with epilepsy. A possible explanation for this finding may be considering the effects of medication. It is common for children with epilepsy to be prescribed antiepileptic drugs (AEDs) which are designed to help control the frequency and intensity of seizures. As well as reducing neuronal activity, AEDs decrease normal neuronal excitability which may affect cognitive activity (Lezak *et al,* 2012) and areas which may be adversely affected include psychomotor speed and memory (Loring, Marino & Meador, 2007). As the FSIQ comprises tasks relying on psychomotor speeds and memory, it would seem likely that difficulties in these areas would have an influence on the scores obtained.

In comparison with the normative population, children with epilepsy scored significantly lower on all subtests. Children with SCD tended to score lower on all subtests, with the exception of 'matrix reasoning', although only the subtest 'coding' was significantly lower than the normative population. Although the performance on the subtest 'matrix reasoning' was on average higher in children with SCD than the normal population, the difference was not statistically significant. A possible explanation of this finding may be due to there being no timing restrictions imposed. Children with SCD often experience slower processing speed, slower task completion and difficulties in coping with time pressures compared to their peers (Wills, Nelson & Hennessay *et al, 2010).* Therefore with the timing element absent from this subtest, they may have been able to spend longer on this task, without the pressure of having to rush, which may have led to more accurate responses. However, the range of scores on this sub-test across individuals was not normally distributed and over interpretation of this finding is to be avoided.

With regards to the main purpose of the study, the approach does appear to have met with success, that discrete test elements can be utilised to predict general intellectual functioning and academic attainment. The main findings suggested that subtests of 'digit span', 'block design', 'similarities' and 'coding' could be used to predict the general intellectual functioning in children with SCD and the subtests of 'digit span', 'block design', 'coding' and 'vocabulary' in children with epilepsy. These particular subtests show the greatest discrepancies between those children whose general intellectual functioning fell within the average range with those who were performing below this in each health related condition. When compared to the normative population, children with SCD and epilepsy tend to score lower on each subtest. However, the use of the subtests named above would assist in identifying those children

who may be having greater difficulties than other children with the same health condition. The use of these specific subtests to predict intellectual functioning has been supported previously in the literature.

The subtest 'digit span' is used for measuring span of immediate verbal recall which involves auditory attention and short-term retention capacity. Frontal lobes play a critical role in the attention and working memory process (Mesulam, 2000 cited in Lezak *et al.,* 2012; Strauss *et al*, 2006), an area of the brain in both children with SCD and epilepsy that is most commonly affected. 'Block design' relies on visuospatial organisation skills. Research has suggested that lower performance in this subtest is indicative of the presence of any type of brain impairment (Lezak *et al*, 2012). This is consistent with the conditions examined in this study given both are not simply localised in effects but can affect any part of the brain. The subtest 'coding' relies on good processing speed with slowed processing speed often underlying attentional difficulties (Lezak *et al,* 2012*)*. 'Vocabulary' and 'Similarities' are measures of verbal knowledge and reasoning. Much of the literature again implicates the frontal lobes or temporal lobes in these skills, which we know are vulnerable in SCD and epilepsy (Whitefield 2010; King *et al*, 2008; Kral, 2001) but also acknowledges that executive functions are sensitive to damage in other parts of the brain (Lezak *et al*, 2012)

The findings of the current research suggested that the subtests 'digit span' and 'vocabulary' were the best predictors of 'Word Reading'. This supports previous research in children with epilepsy which suggested that poor academic achievement was related to lower levels of verbal skills, auditory attention and working memory (Seidenberg *et al*, 1988; Fastenau *et al*, 2004).

Finally, the current research found that there were no significant associations with problems in attention and concentration scores obtained on the TEA-Ch and difficulties highlighted on the parent completed SDQ. Parents appeared to under-report difficulties which may be explained by parents being 'in denial' and not wanting to face the difficulties that their child experiences. It may also be that the parents do not actually witness the difficulties at home that are identified in the TEA-Ch. The findings of this are consistent with previous research where neurocognitive assessments have been shown to be able to identify difficulties more accurately than parent completed questionnaires (Krull *et al*, 2008).

Strengths and Limitations:

The current study used children who had either SCD or epilepsy who were assessed as part of clinical practice in a Paediatric Neuropsychology Service, the research being given impetus by clear service level requirements. One of the main advantages of this approach to data collection is that it has strong ecological validity, using routine data sets; it is representative of the real clinical practice rather than the more rarefied sampling of highly selected populations. Although it might have been preferable to focus solely on one condition, the inclusion of both SCD and epilepsy reflects not only neurological and cognitive similarities, but the clinical reality of the commonest conditions conferring neurological vulnerabilities for those delivering neuropsychological services. However, there are limitations in combining the findings of these two populations. Firstly, there were almost four times as many children with epilepsy than with SCD and therefore the findings are likely to be biased to that diagnosis. There were differences found between the two groups in the measures used for general intelligence and academic achievement. Children with SCD scored significantly higher than children with epilepsy on these measures. It is therefore

possible that, although the screening assessment suggested by the research findings is effective in predicting general intelligence and academic performance in this combined population, there may be a more effective screening assessment for each discrete group. Future research, having been informed of the feasibility of this approach, would benefit from assessing screening assessments tailored to specific neurological conditions.

Since the research utilised service-collected data there were some limitations to extensive biomedical details, notably history of infarct, SCD genotype, type of epilepsy, medication, evidence/presence of neurological damage. This could have permitted more nuanced analysis of data, however was not sought out given the primary focus of the study was to pilot feasibility of finding discrete predictive tests.

In the current study, the WIAT-II subtest 'Word Reading' was used as a measure of academic performance. The test requires children to correctly pronounce written words and has the assumption that familiar words will be pronounced correctly and therefore familiarity is a reflection of vocabulary. The test assumes that reading vocabulary is a valid measure of reading ability (Lezak *et al,* 2012). However, the test does not measure the child's ability to demonstrate whether they understand the meaning of the word, which is different from recognising the word. Without this semantic element, this test only approximates academic achievement (Strauss *et al*, 2006) and may not fully reflect school performance. Information about performance obtained from the school may have improved the validity of this measure. Correlational studies have raised issues with using WIAT-II scores to predict school achievement as specific subtests and composites, including Reading, were not always the best predictors of grades awarded in subjects in similar domains (Strauss *et al*, 2006).

The parent-completed SDQ was used to explore whether parents were able to identify attention and concentration difficulties in children with SCD and epilepsy. However, only one of the five indices measures attention and concentration (Hyperactivity Index) which makes up only three of the twenty-five statements. A parent completed questionnaire which specifically measures attention and concentration would improve the current study and may have suggested more favourable findings for parent completed questionnaires. It was not possible to make this improvement for the current study as data was restricted to that used by the service. Although other questionnaires were used, they were not completed frequently enough to be included in the data analysis.

A final limitation of the study is the small sample size, in particular, children with SCD. The SCD sample may have been biased and only representative of those who are able to attend neuropsychological appointments. The children in this sample were all performing within the low average to high average range. Therefore the screening tool suggested may not be applicable in identifying children with SCD who's general intellectual functioning falls below the average range and likely to be experiencing difficulties. Future research would benefit from larger sample sizes and in particular, data from children who's intellectual functioning is below the average range.

Clinical Implications:

The current study identified a brief neurocognitive screen to identify children with SCD and epilepsy who may be at risk of cognitive and academic difficulties. It would be ideal for all children to receive comprehensive neuropsychological assessment in order to identify any difficulties they may be experiencing and allow for early support and intervention to be put in place to help reduce future risk. Unfortunately, due to the high

cost in both time and resources required for this to be provided, it is not a feasible option. The brief screen would be able to overcome these practical barriers and allow for more children to be seen. However, the screen may also help to overcome some of the difficulties characteristic of the two populations which may prevent them from attending or even being invited to be seen by the neuropsychology service.

It is the Gold Standard of care for every child with SCD to be reviewed annually which includes Transdoppler Imaging and comprehensive neuropsychological assessment. Regularly reviewing children allows for early identification of children at risk of stroke and allows for medical intervention to be carried out sooner. Although there are clearly health related benefits for the child to attending regular reviews, engagement with the Paediatric Neuropsychology services is often problematic (Kaslow *et al*, 2000). Although there may be many cultural aspects that may affect engagement, the medical and physical consequences of the illness may result in families having to attend numerous professional appointments. This may be very time consuming and disruptive in the day to day lives of these families. It is also important to note that neuropsychological assessment may not be considered a high priority when faced with pressing and overwhelming physical/medical complications of the condition. Therefore a brief screening may help improve engagement with families and children with SCD as it would not be such a demanding experience placed on them as a full comprehensive neuropsychological assessment would be. It would allow for children to be screened at school, or even in their homes so that they do not have miss time at school or face practical difficulties in attending a clinic.

Epilepsy is considered to be the most prevalent chronic neurological condition experienced by children and therefore such high volume of patients are not possible for Paediatric Neuropsychology services to accommodate. The services will only tend to

accept referrals for the most severely affected children. These will usually include children who are prescribed multiple medications and need to be closely monitored or children with known neurological abnormalities identified by MRI scans. It has been well documented that other children with epilepsy also experience a variety of psychosocial and cognitive difficulties (Roberts, 2003) but due to the existing resource demands on the service, they are unlikely to be seen. The use of a short screening tool would allow more children who are less severely affected to be routinely assessed and given support within the school environment to maximise their learning potential.

Although a full neuropsychological assessment would provide a more thorough investigation of cognitive difficulties that children with these conditions may be experiencing, the use of the screening assessment would allow valuable recommendations to be made to support the child in their academic performance. Children with SCD and epilepsy are not usually identified for further support as they do not display hyperactive/behavioural problems which would disrupt the rest of the class. Recommendations may include allowing extra time in exams as the child may have difficulties in their speed of processing information. The screening may also allow for teachers to be educated in the individual child's needs and impact that the illness may be having on their school achievement. Children with epilepsy may experience frequent absences which may get misinterpreted as 'daydreaming', the child being lazy or not being motivated to do their work. Contributing to these erroneous beliefs about the child is that the child will often underperform in comparison to what would be expected from their levels of intelligence. Educating teachers on the underlying cause of the child appearing that they are not 'trying hard' may lead to a better child-teacher relationship, better quality of school experience and more support given to the child.

The parent completed questionnaire was not sensitive in identifying difficulties in attention and concentration. Although parents can provide valuable information on their child, relying solely on parental feedback may mean that children who are experiencing difficulties are not being identified or experience delays in identification. Previous research has suggested that early identification and intervention lead to better quality of life leading into adulthood.

Future Research:

The current research was successful in identifying a screening tool to identify overall intellectual and academic attainment in children with SCD and epilepsy. Although it was considered appropriate to combine these populations due to the similar cognitive difficulties experienced and areas of the brain affected, there were significant differences found between the two. Therefore future research would benefit from collecting and analysing data from the two populations independently. The screening tool should be assessed in other paediatric samples as it may provide the service with a standard screening tool which could help identify all children they see for cognitive/academic difficulties even if they aren't considered to be an 'at risk' group.

Future research would benefit from investigating the association of a variety of parent completed questionnaires with academic and cognitive difficulties.

Conclusion:

The findings of the current study have supported the feasibility and validity of a short neuropsychological screening tool to predict and give early indication of difficulties in general intelligence and academic abilities in children with SCD and epilepsy. The use of the subtests 'block design', 'coding', 'digit span' and 'vocabulary'(for epilepsy) or

‘similarities’ (for SCD) is evidenced to be a useful screening for overall general intelligence. The use of ‘digit span’ and ‘vocabulary’ would also be recommended to screen for school related difficulties. Therefore the entire screening test would consist of four subtests for epilepsy (block design, coding, digit span and vocabulary) with the addition of ‘similarities’ for SCD and would be easily administered in approximately 15-25 minutes.. This is significantly shorter than the current battery of neuropsychological assessments which can take a number of hours to administer and to score up. The use of this screening tool could reduce demand on service resources and allow for more children to be screened for cognitive difficulties which may impact upon their school performance.

Replication of the current study would be beneficial to strengthen the support for the use of the cognitive screening tool in children with SCD and epilepsy. Future research would also benefit from assessing the use of this screening tool in different paediatric populations who may be at risk of under-performing in the school environment.

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Critical Appraisal.

The following appraisal is based on my own reflections throughout the process of conducting and writing up the current research as part of the Doctorate in Clinical Psychology.

When I was first accepted onto the course, the prospect of conducting a doctoral level piece of research was a very daunting task. I had completed two research dissertations previously to obtain an undergraduate degree in Psychology and a Master's degree in Psychological Research Methods, both of which differed tremendously. I knew that I was capable of carrying out research, but the preconceptions that I had before the process began, made me doubt on occasions whether the current study would ever be achieved!

During the first few weeks of starting the course, the cohort was presented with a research fair, presentations and information on particular areas of research. We were required to submit a choice of three potential research ideas or proposed projects to which we were interested in. I had already decided in advance that I would like to conduct my research in the neuropsychological field, and as a result my three choices were heavily neuro-psychologically orientated.

I had recently started my first clinical placement which in part involved working with families of people with Huntington's disease. I had started to become fascinated by the strength of the carers I was working with and as a result had begun to research the disease extensively to understand the genetic s and neurological consequences of the illness. Not surprisingly, I was drawn to conducting research in this area so explored the feasibility of potential qualitative research within this area.

Coinciding with my growing passion in Huntington's disease, a local paediatric neuropsychologist gave a presentation on potential research regarding the neuropsychological screening of children with sickle cell disease. I knew little of the medical condition and had never encountered anyone who had SCD, but the prospect of conducting research which was clinically relevant, had been clearly thought out and would be supported by the local neuropsychological service was too appealing to resist.

Later in the year, I had been advised by the university that I had been appointed to conduct the research of screening for silent infarcts in children with SCD. Initially I was extremely disappointed that I would not be conducting research in Huntington's disease. I felt that I had invested a lot of time in generating and exploring the feasibility of various research projects with the help of my placement supervisor.

Eventually I started to orientate myself towards the idea of SCD. I must admit, I felt at a complete loss. I felt that I was immediately behind as my first year literature review had been geared towards Huntington's disease (which I had begun to feel like an 'expert in the making'!). I became increasingly concerned that the project idea was not my own, I had never worked with people with SCD and would not be collecting the data as this was done or in the process of being carried out as part of the service. I felt extremely disconnected from what I envisioned would be the next 3 years of my life. Through

meetings with my field supervisor and my academic supervisor, we explored how we could alleviate my anxieties and finally came to the conclusion that I would use my research days allocated in the second year of the course in order to become familiar with the paediatric team, gain knowledge and understanding of SCD and to conduct some of the neuropsychological assessments with patients of the service. Immediately I felt relieved and allowed myself to feel part of the research process…and to feel excited about it too!

Soon after this the next hurdle of the research proposal took place. I had started to read up about SCD, feeling completely overwhelmed by the medical aspects of the illness. I started to feel confident in my knowledge of silent infarcts and the implications that they have on children. I was encouraged by my supervisors to put as much detail in the first draft of the proposal as it would save a lot of time later on. They were right. My proposal had been accepted at the peer review process. It was also agreed that I would not need to seek REC approval as data was collected as part of routine practice. I would only need to gain approval from the University Ethics Committee and R & D. After witnessing the great amount of stress my cohort endured for months to gain REC approval, I felt eternally grateful that I had been appointed this particular piece of research.

The next step of gaining approval for the study was time consuming, but thankfully the work that I had put into the research proposal paid off. Firstly I submitted to the University Ethics. After about a month, approval had been granted. I then started the process of gaining R & D approval. Trying to gain a signature for the SSI form was difficulty as everyone who I approached referred me to someone else, which felt very frustrating as it was holding up the approval process. Thankfully, there was only one additional small problem encountered during this process and as a result I have learned

that once you have electronic signatures on your application, you should never try to correct any minor punctuation errors you happen to see!

I received my R & D approval. However, I had recently attended a research meeting where my supervisors were concerned that there may not be as many participants with SCD as we had planned for. It was proposed that the sample could include children with epilepsy. It took a while for me to fully grasp the similarities of neuropsychological consequences of the two but I secretly hoped that I would not need to utilise this new paediatric population. Epilepsy was again a medical illness which I knew little to nothing about and felt that I would be out of my depth if this were to be included in the research. I feared that my newly acquired approval would be revoked, but fortunately a few emails to the R & D manager confirmed that it would be acceptable to use participants with epilepsy in the research should the need present itself.

Data collection:

Starting in the summer of the second year until early into the third year, I was able to be part of the service through changes made to my existing placement contract and through the use of my study and research days. During this time I was able to gain a great deal of knowledge about the service and SCD. I enthusiastically arranged my diary so that I would be able to assess a child every fortnight, allowing time between each assessment for scoring and producing a neuropsychological report for the child's medical file. My optimism soon dwindled as I came to experience first-hand how frequently patients with SCD do not attend the appointments arranged. I would often receive cancellation with too short notice to book in anyone else. Unfortunately there were many times where I would not receive such cancellations. To ease my frustration, I began to understand

some of the challenges that families with childhood chronic illnesses face, including the vast amount of medical appointments they were often expected to attend.

At the end of my time at the paediatric neuropsychology services I had successfully obtained no more than one complete and one partial assessment, and observed two. However, my experiences were extremely valuable as I felt more confident in my ability to conduct and write the thesis now that I had met some children with SCD and their families.

Inputting the neuroassessment scores into SPSS took a great deal longer than I had anticipated. I had not accounted time for locating individual medical files, converting raw scores to scaled scores where they had been overlooked and scoring up the SDQ. It was clear at this point that the use of SCD only in the research would result in it being very underpowered. Therefore I was given details of completed assessments of children with epilepsy and began the long process of data entry process again.

The inclusion of participants with epilepsy meant that I was required to change stance in the aims of the research. Originally the aim was to screen for cognitive decline which may be indicative of silent infarcts. Silent infarct is a very big risk to children with SCD, but not to children with epilepsy. After meeting with my supervisors, I began to understand the implications that cognitive effects of the illnesses have on school performance and achievement. Once again, I felt more at ease with the purpose of my research once this information had been obtained.

Data Analysis:

This part of the research presented little problems. I felt confident in the choice of analysis and being able to perform this. I managed to access some very good statistic

books, with the use of information I had kept as part of my Masters degree to facilitate this process. However, I had moments of questioning whether the analysis was enough when talking to my peers about the content of their qualitative result sections. I soon managed to feel reassured that my results section would be adequate through reading other cognitive screening research.

Write-up:

I felt very confident in the research by the time I began the write-up. I was fortunate that all my data had been collected and inputted into SPSS. I was grateful to have avoided the uncertainty around participants that many of my cohort were experiencing. However, I had once again underestimated the sheer length of time this process would take. Naively I was under the illusion that I would have completed the entire write-up during two weeks I had booked off in February. Needless to say, this didn't happen. Although the process did not appear to cause a great deal of stress, I soon began to resent the thesis as it annihilated every spare second of my personal time (this statement reflects how strongly I felt). I was unable to visit my family for over a month, which I had previously done on a weekly basis, and seeing friends was non-existent! I was able to retain my sanity through phone calls and making sure I took time out for myself, little that it was, to try and relax. There were occasions where I had spent so long reading and trying to write up, that it felt like I had lost the ability to think clearly.

Limitations of the study:

As commented on in the discussion section, I believe the research would have been improved if it had been focused primarily on one childhood chronic illness. Increasing the number of participants, in particular those with SCD would have enhanced the validity of the study and allowed for more reliable comparisons to made between the

two conditions. Unfortunately due to the constraints of conducting research as part of the doctoral course, this was not a viable option.

Overall Learning points.

There has been many things that I have learned throughout the research project. First and foremost, work-life balance should be a priority. Thankfully, I did not feel overwhelmed with stress throughout the process, but I realised that taking time out from the thesis, especially during the write-up stage, actually facilitates performance!

The use of supervision has been essential. It helped to reassure my anxieties early in the process that what I erroneously believed I was doing was not what I considered to be of standard for a doctoral level piece of research. Having supervisors who were genuinely interested and invested in the research was paramount and I believe I avoided many difficulties due to this.

Time management was an area which I felt had been a false sense of security. I had grossly underestimated the amount of time each process would take, in part because I knew that the majority of the data had already been collected. I had underestimated the amount of time I needed to spend just to input the data into SPSS.

Appendices have been removed from this e-thesis due to confidentiality and copyright purposes.