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Early predictors of psychosocial functioning five years after paediatric stroke

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ABBREVIATIONS

PSOM	Pediatric Stroke Outcome Measure
RRQ	Recurrence and Recovery Questionnaire
SDQ	Strengths and Difficulties Questionnaire
SSIS	Social Skills Improvement System Rating Sales
VABS-II	Vineland Adaptive Behavior Scale, 2nd edition

AIM Little is known about psychological and social outcomes after paediatric stroke. This study aimed to evaluate psychosocial outcomes in children 5 years after paediatric stroke and explore the contribution of early presenting factors.

METHOD Thirty-one children with arterial ischemic stroke were involved in this prospective, longitudinal study. Children underwent intellectual assessment at 12 months poststroke and parents completed questionnaires rating their own mental health and their child's functioning at 12 months and 5 years poststroke.

RESULTS At 5-year follow-up, psychological and social function were significantly poorer than normative expectations. Exploration of early predictive factors showed poorer cognitive and psychological function at 12 months poststroke and older age at stroke onset was associated with poorer psychosocial function at 5 years. Larger lesion size was also associated with poorer psychological function at 5 years poststroke.

INTERPRETATION These early predictors of poorer psychosocial outcome suggest that screening children within the first year after stroke may identify children most at risk of later problems and facilitate early intervention.

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What this paper adds

- Psychosocial function is impaired in children 5 years poststroke.
- Children with neonatal onset stroke have better psychosocial outcomes at 5 years poststroke than later onset.
- Poorer psychological and cognitive function at 12 months poststroke is associated the poorer psychological function at 5 years.

[main text]

Stroke can occur at any stage in development, with the rate of childhood stroke (29d–18y) reported to be 1.3 to 13 per 100,000, and approximately 1 per 4000 live births in the neonatal (birth–28d) population.[1] Contrary to commonly held views, children do not recover better than adults[2] and morbidity rates are high, with the majority suffering long-term impairments including motor, cognitive, and language deficits.

The literature on social functioning after paediatric stroke is limited. In available studies, sample sizes are often small and measurement largely consists of social domain scores from broader measures (e.g. adaptive function, quality of life) and non-standardized tools. Yet there is evidence that, after paediatric stroke, children experience changes in friendships with peers,[3] reduced social acceptance and social support from peers,[4] impairments in social function and peer relationships,[5–7] and poorer social adjustment and social participation.[8] A variety of psychological problems have also been described in the paediatric stroke literature.[9] One study reported 59 per cent of children with stroke developed psychiatric disorders compared with only 14 per cent of chronic illness controls.[10] Other studies have also reported elevated levels of attention-deficit–hyperactivity symptoms

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(learning difficulties, attention problems, anxiety, impulsivity) (50%),[4] externalizing problems (44%),[3] and emotional problems (25%).[6,7] Further, the literature suggests that there is wide variation in the severity of these psychosocial impairments, with some children showing little or no difficulties.

Theoretical models focusing on psychosocial outcomes in the context of childhood brain insult[11,12] emphasize the links between brain and psychosocial function, also acknowledging the importance of functional domains (e.g. cognition) and environmental factors (socioeconomic status, family function) to psychosocial outcome. The evidence for factors associated with psychosocial functioning after paediatric stroke is limited and findings are inconsistent. Some studies exploring timing have found no association between age at stroke,[4,6] while others have reported higher rates of psychopathology in children with neonatal stroke.[13] Evidence from other early brain disorders suggests that children may have elevated risk of social impairment regardless of age of insult.[14,15] Few studies have explored child related factors, though cognitive impairment has been reported to be associated with poorer social adjustment,[16] social participation, and friendship quality.[17] Family environmental factors are known to play a key role in the well-being of typically developing children.[18] Within the child traumatic brain injury literature, health outcomes have been linked to family factors such as socioeconomic status, parent mental health, and family functioning.[19] The impact of environmental factors has not been addressed extensively in the stroke literature, though recent findings suggest that family function and parent mental health are associated with psychosocial functioning.[8,17]

Psychosocial problems are some of the most distressing and enduring symptoms reported by families after childhood brain injury.[20] Problems in these domains are difficult to identify and often emerge in later stages of recovery, thus they are not routinely addressed by rehabilitation services. This study aimed to evaluate psychosocial function 5 years after paediatric stroke and explore the contribution of early presenting factors. This is the first prospective, longitudinal study to explore early predictors of psychosocial outcome 5 years after paediatric stroke. The identification of factors that contribute to psychosocial impairment postpediatric stroke will enable health providers to identify children most at risk and provide early intervention and support to families. We hypothesized that (1) children with stroke would show poorer psychosocial function compared to normative data, and (2) poorer psychosocial function would be associated with association with early functional impairment and environmental factors.

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METHODS

Participants

The data presented represents a subset of a larger prospective, longitudinal study[21] which recruited children from newborn to 16 years of age, presenting to The Royal Children's Hospital Melbourne with focal arterial ischemic stroke from December 2007 to January 2012. Specific inclusion/exclusion criteria are detailed in Gordon et al.[21] An earlier paper from our group reporting on the original study examined psychosocial outcomes in the first 12 months after stroke.[22] While some participants from the 12-month study continued into the 5-year cohort, the sample in the current study is different. The 12-month paper reported on childhood stroke participants only, excluding neonatal onset, as psychosocial function was underdeveloped at this stage. This paper included (1) a broader age at stroke range (both neonatal and older stroke onset), and (2) only those who were 4 to 6 years poststroke at the time of the follow-up study.

The first 41 families who were consecutively recruited to the initial study were approached to participate in a 5-year follow-up (i.e. all participants who had reached 4–6y poststroke). Three declined with no reason given and four were untraceable. One participant was excluded because of unexplained developmental regression unrelated to the stroke, one had substantial missing data, and one was 20 years of age at follow-up and did not have all measures administered. Therefore, 31 children were included in analysis.

Measures

Psychosocial function (5y poststroke)

Psychological function was measured using: (1) Strengths and Difficulties Questionnaire (SDQ),[23] a parent-rated questionnaire. Five subscales are calculated: Emotional Symptoms, Conduct Problems, Hyperactivity-Inattention, Peer Problems, and Prosocial Behaviours. Total Difficulties score is obtained by combining the scores for all but Prosocial Behaviour. SDQ data are compared to US normative data *(n*=10,367) provided on the SDQ website (www.sdqinfo.com). US norms were selected because of the age range (4–17y) comparing more closely to the study sample than Australian normative data (7–17y); (2) Problem Behaviours subscale, Social Skills Improvement System Rating Sales (SSIS),[24] parent report of externalizing, bullying, hyperactivity/inattention, and internalizing behaviours. Scores are calculated as standard scores (M=100, SD 15), with higher scores reflecting greater problems.

Social competence was measured using: (1) Socialization subscale, Vineland Adaptive Behavior Scale, 2nd edition (VABS-II),[25] parent-report of social function in terms

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of interpersonal relationships, play and leisure, and coping skills; (2) Social Skills subscale from the SSIS. Parent ratings of social skills in terms of communication, cooperation, reasonability, empathy, engagement, and self-control. For both measures, scores are calculated as standard scores (M=100, SD 15), with lower scores reflecting greater problems.

Predictors of outcome (acute–12mo poststroke)

Social risk was measure using the Social Risk Index[26] rates socioeconomic status using family factors. Scores range from 1 to 10 with higher scores indicating higher social risk.

Stroke severity. Lesion size was used as a marker of stroke severity. Lesion size was determined by the vascular territory affected; where a major vessel was affected the lesion was coded large, where a branch was affected it was coded medium and where a perforator was affected it was small.

Neurological impairment. Neurological function was assessed using: (1) Pediatric Stroke Outcome Measure (PSOM),[27] a detailed neurological examination with outcome scored in terms of degree of impairment in each of language, cognition, and sensorimotor; (2) Recurrence and Recovery Questionnaire (RRQ),[28] an abbreviated version of the PSOM administered as an interview with parents and based on the same functional categories and severity rating scale as the PSOM. Good agreement has been reported between PSOM and RRQ.[28] Total impairment scores (out of a maximum of 10) were collapsed into good/poor, 0 or 0·5 representing good and poor 1 or greater, consistent with the approach taken previously.[29]

Early cognition. Cognition was assessed using one of the following: (1) Cognition subscale, Bayley Scales of Infant Development III[30] (age ≤3.5y); (2) IQ composite from the Kaufman Brief Intelligence Test 2[31] (age ≥4y). Scores for all measures are calculated as standard scores (M=100, SD 15).

Early psychological function. Psychological function was measured using one of the following: (1): Social-Emotional scale, Bayley Scales of Infant Development III (age ≤3y) (M=100, SD 15); (2) Total Difficulties subscale, SDQ (age ≥3y). SDQ raw scores were converted to standard scores (M=100, SD 15) using US normative data.

Early social competence. Socialization subscale, VABS-II, was used. See above for details.

Parent mental health. The mental health summary (M=50, SD 10) from the SF-36v2 was used to measure parent mental health. Australian norms were employed.[32]

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Procedure

The study was approved by the Human Research Ethics Committee of The Royal Children's Hospital Melbourne (HREC# 27114). Participants were identified by acute care clinicians and referred to the study. Written consent was obtained from parents for their participation and that of their children. Lesion characteristics were determined by review of acute standard clinical protocol magnetic resonance imaging. Infarct laterality, lesion location, and vascular territory affected were rated by two neuroradiologists (MD, LC) and based on visual inspection of imaging obtained at the time of diagnosis, as described by Gordon et al.[21] Twelve-month cognitive assessment of the child was administered individually by one of the investigators (MG, ALG). Twelve-month neurological function was evaluated using the PSOM, rated by a trained paediatric occupational therapist (ALG) for 19 participants, and the RRQ was administered via parent interview for the remaining 12 participants, where a trained PSOM rater was not available. Parents completed questionnaires at 12 months (VABS-II, Bayley Scales of Infant Development III: Social-Emotional scale/SDQ, SF-36v2) and 5 years (SDQ, VABS-II, SSIS) poststroke.

Statistical analysis

For hypothesis 1, analysis was undertaken dividing the cohort into neonatal (<28d at diagnosis) and older (>29d at time of diagnosis). One-sample *t*-tests were conducted to compare 5-year measures of psychological function (SDQ, SSIS: Problem Behaviours) and social competence (VABS-II: Socialization, SSIS: Social Skills) ratings to normative data. Independent samples *t*-tests were also conducted to compare measure of social function and functional performance between the two age-at-stroke onset groups. To explore rates of impairment on the SDQ, scores were banded into 'normal', 'elevated', or 'clinically significant', where 80 per cent are expected to be 'normal', 10 per cent 'elevated', and 10 per cent 'clinically significant'. Rates of impairment for the SSIS and VBAS-II were explored by categorizing participant's ratings on each measure into 'normal', 'elevated', or 'clinically significant'. Scores were considered elevated if they were 1 standard deviation from the mean and clinically significant scores were those more than 2 standard deviations from the mean. Based on normal distribution, 84 per cent would be expected to be within the normal range, 14 per cent elevated, and 2 per cent in the clinically significant range.

For hypothesis 2, multiple regression models were conducted for all predictor variables, with bootstrapped confidence intervals (1000 replications).[33] Likelihood ratio tests determined model improvement with predictor; where non-significant improvement was

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made, predictors were excluded. The most parsimonious models were presented, illustrating the contribution of impairment to social function. One participant was missing psychological functioning at 12 months and was excluded from regression analysis.

RESULTS

Sample characteristics

Sample demographics, clinical characteristics, and predictors are presented for neonatal and later age at stroke onset in Table I. Thirteen children had neonatal (<28d) and 18 older (>29d) stroke onset. A greater proportion of the neonatal group had large sized (neonatal 31%; older 11%) and left sided (neonatal 28%; older 0%) lesions. The older group had a greater proportion of discrete cortical lesions (neonatal 8%; older 72%) and infarcts involving the vertebrobasilar artery (neonatal 0%; older 28%). None of the 31 children had epilepsy or were taking seizure medication at either 12 months or 5 years poststroke.

Psychosocial function 5 years poststroke

For 5-year measures of psychological function, on the SDQ, compared to normative data, the sample demonstrated significantly higher mean Emotional Symptoms (p=0.016); Hyperactivity (p=0.001); and Total Difficulties (p=0.007) (Table II). They also showed significantly poorer mean Prosocial Behaviour (p=0.001). No significant differences were found for Conduct Problems (p=0.309); or Peer Problems (p=0.868). The older age at stroke group showed poorer means scores on most of the SDQ subscales, but were not statistically significant. Histograms of psychological and social outcomes can be found in Appendix S1 (online supporting information).

The sample showed significantly poorer means scores on SSIS: Problem Behaviours (p=0.017) compared to normative expectations. There was a significant difference between age at stroke groups for this measure with the older group showing poorer mean scores than the neonatal group.

For measures of social competence, the sample had poorer mean scores than expected on VABS-II: Socialization (p=0.029) and close to normative expectations on SSIS: Social Skills (p=0.542). The older age at stroke group showed poorer mean scores on both measures compared to the neonatal group. This difference was statistically significant on SSIS: Social Skills, but not VABS-II: Socialization.

Psychosocial impairment rates

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To better convey the clinical relevance of these findings, 5-year data were characterized in terms of frequency of impairment (Fig. 1). For psychological function, compared to expectations, a higher proportion of participants had elevated or clinically significant scores on Emotional Symptoms (36%), Conduct Problems (29%), Hyperactivity (36%), and Total Difficulties (32%) on the SDQ. Peer Problems (13%) and Prosocial Behaviour (10%) were within expectations. For SSIS: Problem Behaviours, 26 per cent were classified as elevated or clinically significant. For social function, for VABS-II: Socialization, 26 per cent were classified as elevated and for SSIS: Social Skills, 13 per cent were classified as elevated.

Predictors of psychosocial outcome

Bootstrapped multiple regression models were conducted on psychological function outcomes. Model parsimony was determined by likelihood ratio tests with incremental predictor inclusion, and final parsimonious models are presented (Table III). Analyses showed that neurological function and social competence (both at 12mo) did not make a significant contribution to any model, and were excluded.

For SDQ: Total Difficulties (Wald $\chi^2(2)=11.98$, $p=0.003$, $R^2=0.32$), poorer cognitive function at 12 months (standardized beta coefficient [β]=-0.39, $p=0.025$) and poorer psychological function (β=-0.53, $p=0.007$) at 12 months poststroke significantly predicted poorer psychological function at 5 years. Poorer psychological function (β=-0.46, $p=0.005$) at 12 months poststroke and larger lesion size (β=-0.43, $p<0.001$) significantly predicted poorer 5-year function for SSIS: Problem Behaviours (Wald $\chi^2(3)=27.06$, $p<0.001$, $R^2=0.54$). Conversely, older age at stroke significantly predicted better functioning in the SSIS: Problem Behaviours model (β=0.55, $p=0.001$).

For SSIS: Social Skills (Wald $\chi^2(3)=30.29$, $p<0.001$, $R^2=0.41$) older age at stroke onset (β=-0.51, $p<0.001$) significantly predicted poorer social function, while poorer cognitive function (β=0.46, $p=0.009$ and poorer psychological function (β=0.41, $p=0.027$) at 12 months poststroke significantly predicted poorer social skills. Older age at stroke onset (β=-0.47, $p=0.005$) alone significantly predicted for VABS-II: socialization (Wald $\chi^2(5)=23.44$, $p<0.001$, $R^2=0.44$).

DISCUSSION

This study investigated psychosocial functioning in children 5 years poststroke and explored early presenting factors that may predict outcome. The findings were generally in keeping

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with study expectations. Firstly, mean group performances were significantly poorer than normative data on many of the psychological measures. Mean performance was significantly poorer than normative data on one measure of social competence (VABS-II: Socialization), while there was no significant difference for the other (SSIS: Social Skills). Pooper cognitive and psychological function at 12 months and older age at stroke onset was predictive of poor psychosocial function at 5 years. Larger lesion size was also predictive of poorer psychological function. Neurological impairment, social function at 12 months, and early family environmental factors were not associated with outcome.

It is important to note that while we found significant differences in group means, they were within the normal range and thus impairment rates were also examined to convey clinical relevance. For SDQ, 20 per cent of children would be expected to fall within the elevated or clinically significant range and for VABS-II and SSIS, based on the normal bell curve 15 per cent would be expected to be within these ranges. We found much higher rates in our sample for psychological outcomes, with 29 to 36 per cent in the elevated or clinically significant range on SDQ subscales of Emotional Symptoms, Conduct Problems and Hyperactivity-Inattention. Twenty-six per cent also fell into this range on SSIS: Problem Behaviours. These results are consistent with findings from previous studies.[3,4,6,7,10] We found similar rates of psychological impairment in our 12-month study,[22] with the exception of Peer Problems. In the earlier study, 29 per cent of children were rated as having elevated or clinically significant symptoms in this domain and only 15 per cent in the current study. Differences across samples limit direct comparisons, however our findings indicate a reduction in peer interaction difficulties over time. While on some of these scales only a small proportion of children were rated in the clinically significant range, elevated scores represent a deviation from normal functioning and may have a significant impact on the child and their family.

Rates of social impairment differed between the two measures used, with 26 per cent of children found to be impaired on the VABS-II and 13 per cent on the SSIS. This discrepancy may reflect differences in the social domains being measured by these questionnaires. The VABS-II measures adaptive function and the Socialization subscale comprises questions pertaining to interpersonal relationships, how the child spends play and leisure time, as well as coping skills. Thus, this measure may be capturing more of the functional aspects of social skills and degree to which the child engages in social activities. In contrast, the SSIS has a greater focus on skills required for social competence, including communication, cooperation, empathy and self-control.

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Compared to the neonatal group, the older age at stroke group demonstrated poorer mean scores across most measures, although the difference was only statistically significant on the SSIS measures. Furthermore, age at stroke was found to predict both psychological and social function, with children who suffered a stroke during the neonatal period showing better outcome. Other studies have reported no association between age at stroke and social function,[4,6] yet these studies did not include children with neonatal onset stroke. Results from our 12-month study,[22] which did not include neonatal onset stroke, also showed better social function in children who were younger at stroke onset, suggesting there may be an age effect. This finding may be associated with the young age of the children in these studies, with social problems difficult to recognize. Alternatively, it may suggest that brain plasticity in children who are very young at the time of stroke may enable compensation for damaged brain regions, allowing for relatively normal social development. The debate between early plasticity versus early vulnerability is frequently discussed in the childhood acquired brain injury literature, but this usually relates to cognitive skills and has not been confirmed for psychosocial function.

Greater stroke severity (lesion size) was found to predict psychological, but not social function. Previous studies have generally found no association between lesion size and outcome,[8,29,34] although a recent study from our group showed larger infarcts predicted poorer social participation[16] and Ganesan et al. reported greater disability in children when infarcts were more than 10 per cent of intracranial volume.[35] Neurological function at 12 months poststroke was not found to predict psychosocial outcomes at 5 years. These findings are inconsistent with those of our 12-month study, where we found acute neurological impairment was associated with poorer social function at 12 months; however, in a recent retrospective, cross-sectional study we reported a significant relationship between neurological deficits and poorer social adjustment and participation.[16] As noted in Table I, there was considerable change in the number of children classified as neurologically impairment at 12 months compared to 5 years, particularly in the older age at stroke group. Taken together, results from these studies suggest that the impact of neurological function is subject to change over time and may not predict later psychosocial development.

Cognition at 12 months poststroke contributed to both psychological and social function at 5 years poststroke. Our earlier study[22] found no association with cognition at 1 month poststroke and psychosocial function at 12 months. This may be explained by recovery of cognitive function across the first year, with stabilization thought to occur by 12 months poststroke. Other cross-sectional studies of long-term survivors by our team have found

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cognitive impairment to be correlated with poorer social adjustment,[16] social participation, and perceived friendship quality.[17] Psychological function at 12 months poststroke was a significant predictor of psychosocial function at 5 years, suggesting that it is possible to identify children who may be at risk for later impairment at this early stage by screening for psychological problems. Interestingly, social competence at 12 months poststroke did not predict any of the 5-years psychosocial measures used. This may be due to the young ages of the children, with social skills relatively undeveloped at the 12 month timepoint.

Social risk and parent mental health at 12 months were not significant for any outcome measure. In our earlier study,[22] we found that social risk was not associated with psychosocial outcome at 12 months poststroke, but that parent mental health at 12 months was. Few studies have explored the contribution of environmental factors on psychosocial outcomes in paediatric stroke, though recent studies from our team have found family function, parent mental health, and parent education to be associated with internalizing problems and social competence.[8,17] The lack of association in the current study between child psychosocial function and earlier environmental factors may reflect the changing relationship between these factors over the poststroke period.

There are several limitations to this study. The small sample size limited analysis and reduced power to detect differences. This is a common issue within the paediatric stroke literature and highlights the benefits of multicentre studies. Poststroke epilepsy has been reported in 15 to 20 per cent of children, and is associated with poorer cognitive outcomes and quality of life.[5] Since none of the children in this study had epilepsy at either 12 months or 5 years poststroke, our results may underestimate the outcomes of children with more severe neurological impairments. Another limitation is the young age of these children, with the majority pre-adolescent. It is possible that in such young children, particularly with many of them preschool or early school age, psychosocial impairments have not yet emerged or the full extent is not apparent. Impairments may emerge over time as children commence school and are compared to same-age peers. While the initial study was open to children up to 18 years of age, there were low numbers of children over 10 years of age recruited because of the higher rates of paediatric stroke in younger children. A longer follow-up period, as these children enter adolescence (when the reliance on peer networks is greater) may identify more impaired outcomes. Finally, the reliance on parent ratings of psychosocial function may not capture the child's functioning across contexts. The addition of teacher and self-ratings may provide a more complete evaluation; though self-report is difficult in such young children.

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CONCLUSIONS

Despite these limitations, this study is the first to prospectively follow a group of children with paediatric stroke to explore early presenting factors that may contribute to psychosocial impairment 5 years poststroke. These results show that children are at greater risk of psychosocial impairment after stroke, and older age at stroke onset appears to place children at greater vulnerability. We found a relationship between cognitive and psychological function at 12 months poststroke and psychological function at 5 years poststroke. This association with earlier function suggests that screening children for psychological problems within the first year after stroke may identify children most at risk of later difficulties, providing an opportunity for early intervention.

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SUPPORTING INFORMATION

The following additional material may be found online.

Appendix S1: Histograms of psychological and social outcomes.

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[figure legend]

Figure 1: (a) Percentage of participants categorized as normal, elevated, and clinically significant for SDQ subscales, compared to normative expectations. (b) Percentage of participants categorized as normal, elevated, and clinically significant for SSIS and VABS-II subscales, compared to normative expectations. SDQ, Strengths and Difficulties

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Questionnaire; ES, Emotional Symptoms; CP, Conduct Problems; HYP, Hyperactivity/Inattention; PP, Peer Problems; PB, Prosocial Behaviours; TD, Total Difficulties; SSIS, Social Skills Improvement System; VABS-II, Vineland Adaptive Behavior Scales.

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Table I: Sample demographics, clinical characteristics, and predictors

	Neonatal (*n*=13)			Older (*n*=18)		
Age (y) at stroke onset, M (SD), range	0.0	(0.0)	0.0–0.0	4.2	(2.8)	0.2–9.3
Age (y) at assessment, M (SD), range	5.1	(0.8)	3.8–6.5	9.5	(3.0)	5.9–15.4
Time (y) since stroke, M (SD), range	5.1	(0.8)	3.8–5.1	5.3	(0.8)	4.0–6.8
Sex (male) *n* (%)	11	(85)		8	(44)	
Epilepsy at assessment *n* (%)	0	(0)		0	(0)	
Lesion characteristics:						
Lesion size[a]						
Large *n* (%)	4	(31)		2	(11)	
Medium *n* (%)	9	(69)		16	(89)	
Small *n* (%)	0	(0)		0	(0)	
Vascular territory						
Full MCA *n* (%)	1	(8)		0	(0)	
Partial MCA *n* (%)	7	(54)		8	(44)	
PCA *n* (%)	3	(23)		2	(11)	
Vertebrobasilar *n* (%)	0	(0)		5	(28)	
Multiple *n* (%)	2	(15)		3	(17)	
Laterality						
Left *n* (%)	9	(69)		2	(11)	
Right *n* (%)	3	(23)		6	(33)	
Bilateral *n* (%)	1	(8)		5	(28)	
Infratentorial only *n* (%)	0	(0)		5	(28)	
Location						
Discrete subcortical *n* (%)	1	(8)		13	(72)	
Cortical/cortical + subcortical *n* (%)	12	(92)		5	(28)	
Neurological examination						
12mo PSOM/RRQ median, IQR, range	0	0	0.0–2.0	1.0	0	0.0–5.0
12mo PSOM/RRQ[b] *n* (%)	2	(15)		11	(61)	
5y PSOM total median, IQR, range	0	0	0.0–5.0	0.3	0	0.0–4.5

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5y PSOM impaired[b] *n* (%)	5	(38)	5	(28)
Child functioning				
12mo cognition, M (SD), range	99.6	(13.6)	106.7	(21.5)
12mo psychological function, M (SD), range	110.8	(9.3)	98.5	(17.3)
12mo social competence, M (SD), range	98.4	(16.2)	98.2	(11.4)
Environmental factors				
Acute SRI, M (SD), range	1.9	(1.7)	1.5	(1.7)
12mo parent mental health, M(SD), range	44.1	(11.6)	37.3	(13.6)

[a]Lesion size – vascular territory affected: large-major vessel; medium-branch; small-perforator. [b] Impaired PSOM were total scores 1 or greater. MCA, middle cerebral artery; PCA, posterior cerebral artery; PSOM, Pediatric Stroke Outcome Measure; RRQ, Recurrence and Recovery Questionnaire; IQR, interquartile range; SRI, Social Risk Index.

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Table II: Psychosocial function: comparison to published normative data

	Comparison value		Whole Sample				Neonatal				Older				Difference between groups	
	M	SD	M	SD	t	d	M	SD	t	d	M	SD	t	d	t	d
Psychological Function																
SDQ: Emotional Symptoms	1.6	(1.8)	**2.7**	**(2.4)**	**2.544**	**0.52**	2.3	(2.1)	1.217	0.36	**2.9**	**(2.6)**	**2.233**	**0.58**	-.736	0.25
SDQ: Conduct Problems	1.3	(1.6)	1.6	(1.3)	1.034	0.21	1.2	(1.3)	-.411	0.07	1.8	(1.3)	1.689	0.34	-1.419	0.46
SDQ: Hyperactivity	2.8	(2.5)	**4.8**	**(3.0)**	**3.718**	**0.72**	4.3	(3.4)	1.542	0.50	**5.2**	**(2.8)**	**3.729**	**0.90**	-.904	0.29
SDQ: Peer Problems	1.4	(1.5)	1.4	(1.5)	-0.168	0.00	1.2	(1.7)	-.530	0.12	1.5	(1.4)	.307	0.07	-.629	0.19
SDQ: Prosocial Behaviour	8.6	(1.8)	**7.5**	**(1.7)**	**-3.570**	**0.63**	**7.5**	**(1.7)**	**-2.300**	**0.63**	**7.5**	**(1.8)**	**-2.656**	**0.61**	.061	0.00
SDQ: Total Difficulties	7.1	(5.7)	**10.4**	**(6.3)**	**2.907**	**0.55**	8.9	(7.0)	.903	0.28	**11.5**	**(5.7)**	**3.275**	**0.77**	-1.165	0.41
SSIS: Problem Behaviours	100	(15)	**106**	**(13.3)**	**2.522**	**0.42**	99.3	(13.7)	-.183	0.05	**110.9**	**(11.0)**	**4.187**	**0.83**	**-2.610**	**0.93**
Social Competence																
VABS-II: Socialization	100	(15)	**95.3**	**(11.5)**	**-2.291**	**0.35**	99.23	(11.2)	-0.248	0.06	**92.4**	**(11.2)**	**-2.882**	**0.57**	1.680	0.61
SSIS: Social Skills	100	(15)	98.6	(12.8)	-0.617	0.10	104.4	(11.7)	1.350	0.33	94.4	(12.2)	-1.952	0.41	**2.289**	**0.84**

Boldface indicates $p<.05$. SDQ, Strengths and Difficulties Questionnaire; VABS-II, Vineland Adaptive Behavior Scales; SSIS, Social Skills Improvement System

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Table III: Multiple regression for psychosocial outcomes

	SDQ: Total Difficulties			SSIS: Problem Behaviours			VABS-II: Socialization			SSIS: Social Skills		
Predictor[a]	B	SE	*p*	B	SE	*p*	B	SE	*p*	B	SE	*p*
Age at stroke (neonate vs older)				**0.55**	**0.16**	**0.001**	**-0.47**	**0.18**	**0.005**	**-0.51**	**0.14**	**<0.001**
Lesion size (small/medium vs large)				**-0.43**	**0.12**	**<0.001**						
Cognition (12mo)	**-0.39**	**0.18**	**0.025**				0.34	0.20	0.093	**0.46**	**0.18**	**0.009**
Psychological function (12mo)	**-0.53**	**0.20**	**0.007**	**-0.46**	**0.16**	**0.005**	0.45	0.25	0.072	**0.41**	**0.18**	**0.027**
Social risk (time of diagnosis)							-0.30	0.20	0.087			
Parent mental health (12mo)							-0.30	0.16	0.137			
R^2	**0.32**		**0.003**	**0.54**		**<0.001**	**0.44**		**<0.001**	**0.41**		**<0.001**

Boldface indicates $p<0.05$. [a]Neurological function – good vs poor (12mo) and social competence (12mo) did not contribute to any model. B, standardized beta coefficient; SDQ, Strengths and Difficulties Questionnaire; SSIS, Social Skills Improvement System; VABS-II, Vineland Adaptive Behaviour Scales.

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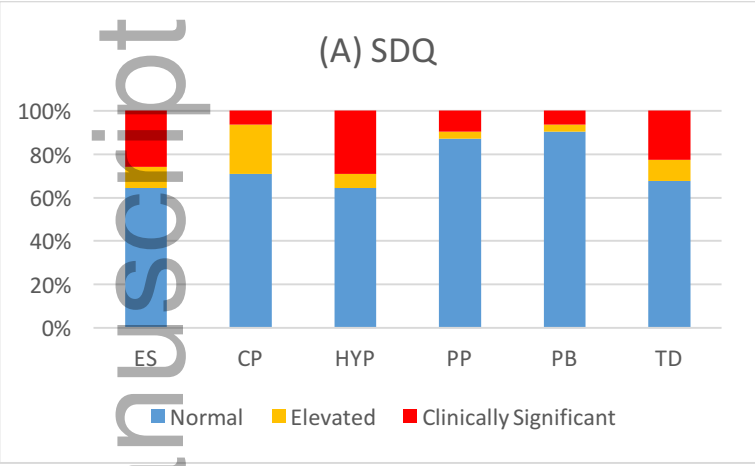

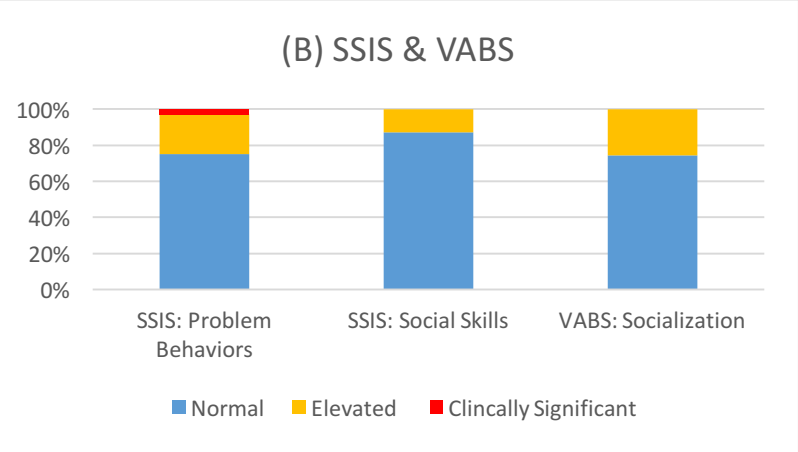

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