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Intellectual disability in cerebral palsy: a population-based retrospective study

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ABBREVIATION

RRR Relative risk ratio

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AIM A population-based observational study design was used to describe the epidemiology of intellectual disability in cerebral palsy (CP) in terms of clinical and neuroimaging associations, and to report the impact of intellectual disability on utilization of health services and length of survival.

METHOD Population CP registry data were used to retrospectively assess the frequency of intellectual disability and strength of associations between intellectual disability and mobility, epilepsy, vision, hearing, communication, and neuroimaging patterns (*n*=1141). Data linkage was undertaken to assess usage of hospital inpatient and emergency department services. Survival analysis was performed in a 30-year birth cohort (*n*=3248).

RESULTS Intellectual disability, present in 45% of the cohort, was associated with non-ambulation (47% vs 8%), later walking (mean 2y 7mo vs 1y 9mo), hypotonic (8% vs 1%) or dyskinetic (9% vs 5%) CP, a quadriplegic pattern of motor impairment (42% vs 5%), epilepsy (52% vs 12%), more emergency and multi-day hospital admissions, and reduced 35-year survival (96% vs 71%). Grey matter injuries (13% vs 6%), malformations (18% vs 6%), and miscellaneous neuroimaging patterns (12% vs 4%) were more common in people with intellectual disability.

INTERPRETATION Intellectual disability adds substantially to the overall medical complexity in CP and may increase health and mortality disparities.

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What this study adds

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- Cerebral maldevelopments and grey matter injuries are associated with higher intellectual disability rates.
- Health care is more 'crisis-driven' and 'reactive' in children with co-occurring intellectual disability.
- Length of survival is reduced in individuals with CP and co-occurring intellectual disability.

[Main text]

Cerebral palsy (CP) is an umbrella term used to describe individuals who, as a consequence of early disturbance to the developing brain, have ongoing problems with movements and/or postures that limit their ability to perform activities of daily living.[1] Intellectual disability is an important and relatively common accompanying impairment in CP that has the potential to further affect daily activities, burden of care, quality of life, effectiveness of interventions, and longevity. Intellectual disability may also exacerbate existing health care disparities because of an increased reliance on carers to identify illnesses and health care concerns, challenging behaviours associated with intellectual disability, and lower rates of participation in preventive care and health promoting practices.[2]

Intellectual disability in CP has not been well studied. This research gap can be partly explained by the substantial challenges posed by the use of standard measures of intelligence for assessing children with CP.[3] Studies from Iceland and Australia estimated that one-third of children with CP were unable to complete all tasks on such measures because of inadequate pointing and verbal ability and, even among those who completed the tasks, summary scores were likely to misrepresent the child's actual level of functioning by the inclusion of tasks that required speed or fine motor responses.[4,5] It is therefore not surprising that estimates of the frequency of intellectual disability in CP have varied between 38% and 52%, despite arising from population samples and being based on the same cut-off of a tested IQ less than 70.[4,6–11] The frequency of intellectual disability has been reported to be relatively increased in association with quadriplegia,[3,7] poor gross motor function,[7] and epilepsy.[12] We know of only one previous publication relating the prevalence of intellectual disability to cerebral pathology. On the basis of classification of patterns of injury on brain magnetic resonance imaging (MRI),[13] the highest rate of intellectual disability was seen in individuals with cerebral malformations (>70%) and the lowest in those with a predominantly white matter injury pattern (<30%).[8]

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The objectives of this study were to describe the epidemiology of intellectual disability in CP in terms of clinical and neuroimaging associations, and to report the impact of intellectual disability on utilization of health services and longevity. We aimed to emphasize the importance of taking intellectual function into account when designing and evaluating intervention studies or considering important issues such as participation, quality of life, patterns of usage of health services, and risk of early death. We also hoped that insights into how intellectual disability influences the characteristics of health care encounters and longevity among children with CP would provide a basis for future decision-making around health care delivery for this group.

METHOD

Research setting and ethics

This population-based, retrospective epidemiological study was undertaken at the Murdoch Children's Research Institute within the Melbourne Children's campus, Victoria, Australia. The protocol was approved by the Human Research Ethics Committee of the Royal Children's Hospital, Melbourne. Data linkage with the National Death Index received ethics approval from the Australian Institute of Health and Welfare.

CP cohorts

Three population-based CP cohorts were identified from the Victorian CP Register. The Register was established in 1986 to capture data on individuals born or receiving medical services in the Australian state of Victoria who conform to one of the recognized definitions of CP at 5 years of age. Children with known postneonatally acquired CP and those born outside the state were excluded from all cohorts.

To assess the frequency of intellectual disability and the strength of associations between intellectual disability, clinical variables, and neuroimaging classifications, cross-sectional data were used for a 1999 to 2008 birth cohort (n=1141), the cohort used for previous neuroimaging studies.

A 1995 to 2009 birth cohort (n=1748) was used to investigate the use of hospital inpatient and emergency department services in young people with CP, and to assess how use differs between those with and without intellectual disability. Routinely collected data on hospital admissions and emergency department presentations were obtained by linking data from the Victorian CP Register to the Victorian Admitted Episodes Dataset and the Victorian

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Emergency Minimum Dataset, which hold data on Victorian public hospital admissions and emergency department presentations respectively.

Survival analysis was performed in a 1981 to 2010 longitudinal birth cohort (*n*=3248). Deaths were ascertained through clinical notifications and previous linkage with the Victorian and Australian National Death Indexes, the latest performed in October 2017.

Data linkage

Data linkage and provision of data pertaining to health service use was undertaken by the Victorian Data Linkages Unit, situated within the Victorian Department of Health and Human Services. Linkage between the Victorian CP Register and the Victorian Admitted Episodes Dataset and Victorian Emergency Minimum Dataset was undertaken using a stepwise deterministic approach. Deterministic linkage, as distinct from probabilistic linkage, requires an exact match between linkage variables, in this case hospital unit record number, date of birth, and sex.

Data management and definitions

CP data were extracted from the Victorian CP Register. Birth gestation in completed weeks was grouped into one term and three preterm categories: less than 28, 28–31, 32–36, and more than 37. Gross motor function was classified according to the Gross Motor Function Classification System (GMFCS).[14] GMFCS levels I and II refer to children who are independently ambulant, level III to children ambulant with walking aids, and levels IV and V to those predominantly using wheeled mobility.

Intellectual disability was defined as a tested IQ of less than 70 and was typically measured at approximately 5 years of age. Clinical judgement was used in some cases as standardized IQ testing was either not feasible or may have misrepresented the child's true IQ because of motor, sensory, and communication difficulties. Epilepsy was defined as a history of two or more afebrile, unprovoked seizures after the neonatal period or a clinical diagnosis of epilepsy. Functional blindness referred to uncorrected visual acuity of 6/60 or worse in the better eye on formal testing or inability to use vision in a functional way, and bilateral deafness to unaided hearing loss of more than 70db in the better ear on audiological testing, or inability to hear a shouted human voice. Lack of verbal communication described the absence of more than a few words of recognizable speech. Birth defects were classified as cerebral, other major birth defects, or minor defects excluding those categorized as insignificant.[15] The neuroimaging classification was based on a previously published

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classification system comprising four abnormal patterns, namely predominant white matter injuries, predominant grey matter injuries, focal vascular insults, and cerebral maldevelopments, as well as normal and miscellaneous findings.[16,17]

Victorian Admitted Episodes Dataset data variables for each admission included admission date, length of stay, admission type (elective vs emergency), intended duration of stay (same-day vs multi-day), diagnosis, and procedure codes. The primary discharge diagnosis was used to describe the primary reason for each admission. Discharge diagnoses were classified according to the International Statistical Classification of Diseases and Related Health Problems 10th Revision standard grouping of diseases.[18] For each emergency department presentation, Victorian Emergency Minimum Dataset data variables included date and time of presentation, triage level, presenting complaint, discharge diagnoses, and departure disposition. Each emergency department presentation was triaged using the five-level Australian Triage Scale.[19] For this study, presentations triaged as 1, 2, or 3 according to the Triage Scale were categorized as higher urgency presentations, and category 4 and 5 presentations as lower urgency.

Statistical methods

The frequency of intellectual disability was calculated for the entire 1999 to 2008 cohort and for children stratified on sex, birth gestation, ambulation status, predominant motor type, topographical pattern of spasticity, epilepsy, vision, hearing, communication, birth defects, and neuroimaging classification. For each clinical variable, the relative risk for intellectual disability was estimated from a univariable generalized linear model assuming binomially distributed data and, using a log link, relative to a designated referent subgroup. In the 1995 to 2009 cohort, for each hospital admission and emergency department presentation, the relative risk of intellectual disability was estimated by fitting a generalized linear model for binomially distributed data using a log link, adjusted for GMFCS level (GMFCS I–III and GMFCS IV–V), as GMFCS level is known to be related to hospital admissions and emergency department presentations. The 95% confidence intervals and *p* values were presented for each estimate. Logistic regression was not limited by the number of events.[20,21]

To assess length of survival based on intellectual status, lifetimes were computed in days from birth until death or the chosen censoring date of October 1st, 2017. For each birth year, the effective number at risk and the proportion who died was determined, and the probability of survival with its standard error was estimated and graphed using the Kaplan–Meier method. Using Cox proportional hazards regression, the relative risk of mortality

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(hazard ratio) associated with intellectual disability and no intellectual disability was estimated, along with 95% confidence interval (CI) and *p* value. Proportionality of hazards between the two groups was assessed visually using log–log plots and by comparing the observed survival function with the survival function predicted from the proportional hazards model. Both survival curves remained parallel and showed that the hazard ratio was an appropriate summary statistic for survival. The same methods were used for the prespecified subgroup of the cohort that was predominantly non-ambulant.

For the 1999 to 2008 birth cohort, 55% of the records contained missing values. For the 1995 to 2009 birth cohort used in the health services data analysis, 14% of the records contained missing values for intellectual disability and GMFCS level. Missing data were imputed using multiple imputation by chained equations with 20 imputations, including all analysed variables. For the 1983 to 2010 longitudinal birth cohort, the proportion of records containing missing values was small (<10%) and therefore no imputation was performed. No changes to the conclusions resulted from imputing the missing data.

Statistical analysis was performed with Stata 14.1 (StataCorp 2015, College Station, TX, USA).

RESULTS

Frequency of intellectual disability in CP

The 1999 to 2008 CP birth cohort comprised 1141 children, of whom 12% had missing data on intellectual status. Of the remaining 1005 children, 45% were recorded as having intellectual disability. The severity of impairment was unknown for nearly half the group with intellectual disability. Overall, there was little evidence for a difference in the frequency of intellectual disability according to birth gestation, although there was some evidence for a lower rate of intellectual disability in children born between 28 and 31 weeks' gestation relative to those born at term (35% vs 48%; relative risk ratio [RRR]=0.8 [0.6, 1.0]; p=0.030).

Clinical associations with intellectual disability

Relative to independently ambulant children (GMFCS levels I–II), where the rate of intellectual disability was 30%, children requiring ambulation aids (GMFCS level III) were more likely to have intellectual disability (48%; RRR=1.6 [1.2, 2.0]; p<0.001), and predominantly non-ambulant children (GMFCS levels IV–V) were nearly three times more likely to have intellectual disability (83%; RRR=2.8 [2.4, 3.2]; p<0.001; Table I). Among the group of children who achieved independent walking, those with intellectual disability

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walked at a mean age of 2 years 7 months compared with 1 year 9 months for children without intellectual disability.

Compared with the frequency of intellectual disability in children with a spastic motor type (42%), dyskinesia was associated with a 50% higher rate (61%; RRR=1.5 [1.2, 1.8]; p<0.001) and hypotonia with more than double the rate of intellectual disability (90%; RRR=2.1 [1.9, 2.4]; p<0.001; Table I). Children with ataxia had a similar rate of intellectual disability to those with spasticity. Among the group with a predominantly spastic motor type and relative to an intellectual disability rate of 26% for children with hemiplegia, the rates of intellectual disability were 36% (RRR=1.4 [1.1, 1.8]; p=0.004) and 85% (RRR=3.3 [2.8, 4.0]; p<0.001) for children with diplegia and quadriplegia respectively (Table I).

Concomitant epilepsy was associated with a higher frequency of intellectual disability (79%; RRR=2.4 [2.2, 2.8]; p<0001), as was functional blindness (97%; RRR=2.2 [2.0, 2.4]; p<0.001), bilateral deafness (86%, RRR=2.0 [1.7, 2.5]; p<0.001), and lack of verbal communication (91%; RRR=3.2 [2.8, 3.6]; p<0.001; Table I). All categories of congenital anomaly were associated with a higher risk of intellectual disability, particularly cerebral defects (75%; RRR=1.8 [1.6, 2.1]; p<0.001; Table I).

MRI patterns associated with intellectual disability

Children with cerebral maldevelopments, miscellaneous MRI findings, or predominant bilateral grey matter injury patterns were nearly twice as likely to have intellectual disability as those with normal MRI findings (all RRR=1.9; p<0.002; Table I). On the other hand, there was little evidence for an increased relative risk of intellectual disability in children with predominant white matter injury patterns and focal vascular insults.

Impact of intellectual disability on health service utilization

The CP cohort (n=1748) had a total of 10 924 hospital admissions and 7042 emergency department presentations over a 7-year period. GMFCS level and intellectual status were known for 9430 hospital admissions and 6050 emergency department presentations.

After accounting for GMFCS level, children with intellectual disability had a greater risk of having had at least one emergency department presentation (RRR=1.2 [1.1, 1.4]; p<0.001) over the study period. There was no evidence for an association between same-day hospital admission and intellectual disability. However, there was strong evidence that the risk of having at least one multi-day hospital admission was increased among children with intellectual disability (RRR=1.1 [1.1, 1.2]; p=0.001; Table II).

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Relative to children without intellectual disability, those with it had higher risks of hospital admissions that were classified as emergencies (compared with elective; RRR=1.4 [1.3, 1.5]; p<0.001), multi-day (compared with same-day) (RRR=1.2 [1.1, 1.2]; p<0.001), and for respiratory conditions (compared with other diagnoses; RRR=1.3 [1.1, 1.5]; p=0.002). Relative to children without intellectual disability, those with it had higher risks of emergency department presentations that were of higher urgency (RRR=1.1 [1.0, 1.1]; p<0.001) and required admission to hospital (RRR=1.2 [1.1, 1.3]; p<0.001; Table III).

Impact of intellectual disability on length of survival

Length of survival differed between groups stratified on intellectual status (hazard ratio=9.8 [6.7, 14.3]; p<0.001; Fig. 1). Thirty-five-year survival was 96% for those with no intellectual disability compared with 71% for those having it. A difference in survival was preserved when the analysis was confined to the subgroup who were predominantly non-ambulant (hazard ratio=4.7 [2.6, 8.4]; p<0.001; Fig. 2). Thirty-five-year survival was 84% for non-ambulant individuals without intellectual disability compared with 44% for those with intellectual disability.

DISCUSSION

Children with neurodisability are typically given a diagnosis that describes one component of their disability, although not always the predominant one. With some exceptions, children with motor impairment of cerebral origin fit under the CP umbrella, even though motor impairment may not be the sole contributor to activity limitations, reduced opportunities for participation, or decreased quality of life. This study shows the important contribution of intellectual function in children with CP in terms of its frequency and the impact of intellectual disability on function, utilization of health services, and length of survival. The main findings were that (1) the frequency of intellectual disability in the population CP cohort was 45%; (2) poor gross motor function, non-spastic motor types, epilepsy, deafness, blindness and non-verbal status, as well as cerebral maldevelopments and grey matter injury patterns on MRI, were associated with a higher frequency of intellectual disability; (3) children with intellectual disability had comparatively more hospital admissions that were unplanned and multi-day, and more emergency department presentations that were urgent and resulted in a hospital admission; and (4) length of survival was reduced in association with concomitant intellectual disability. A strength of the study was its unbiased, large population base; however, we were limited in our ability to make comparisons across different levels of

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intellectual disability because of the difficulties involved in accurately measuring it in children with motor and sometimes sensory impairments, and often having to rely on clinical judgement.

The frequency of intellectual disability of 45% in our Victorian CP cohort fell midway between the frequencies of 38% to 52% reported from other population cohorts where the same definition of intellectual disability was used: that is, IQ less than 70.[4,6,9,11,22,23] Our findings support previous research showing an association between intellectual disability and severity of gross motor function, and between intellectual disability and epilepsy and non-motor impairments. The impact is likely to be cumulative and bi-directional. Severe motor or sensory disability or uncontrolled seizure activity is likely to negatively impact on an individual's opportunities for exploration and learning, whereas severe intellectual disability is likely to affect an individual's ability to acquire motor skills and achieve daily living skills such as toileting, dressing, and independent eating and drinking. Our study shows that for the subgroup of children who were able to achieve independent ambulation, this skill was achieved later in those with intellectual disability.

The co-occurrence of intellectual disability with other motor and non-motor impairments can, to some extent, be explained by the pattern, extent, and location of brain abnormality. Extensive cortical and subcortical brain abnormality is likely to affect more than just motor pathways. In our Victorian cohort, intellectual disability was seen most often in association with brain maldevelopment (73%); a similar association was reported in a Swedish cohort (74%).[8] In comparison, the lowest prevalence of intellectual disability was 23% in children with vascular insults that were more focal.

The finding that children with intellectual disability had more hospital admissions that were classified as emergency and multi-day, and more emergency department presentations that were classified as higher urgency and required an admission to hospital, suggests that their patterns of health care use may be more 'crisis-driven' and 'reactive' than those of other children. This may be a result of delayed identification of illness in children with intellectual disability because of cognitive challenges in understanding, recognizing, and communicating their health problems or symptoms. In addition, the presence of intellectual disability may exacerbate existing health issues in this population, including the ability to effectively cough and clear secretions, leading to an increased risk of pulmonary aspiration and acute respiratory illness.[24,25]

Longevity was comparatively reduced for individuals with intellectual disability across all GMFCS levels. In previous studies, the effect of intellectual disability on survival

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has been shown to be independent of other factors,[26–28] and severity of intellectual disability has been directly related to length of survival.[24,29] A cumulative effect of poor motor function, intellectual disability, epilepsy, and sensory and communication impairments has been noted in Australian studies.[24,30] An over-representation of respiratory causes of death has been reported in cohorts with CP and intellectual disability,[27,31] including pneumonia and aspiration pneumonia, as well as sudden deaths associated with seizures. A recent study of adults with intellectual disability showed that a third of deaths, for example those caused by respiratory or urinary tract infection, were amenable to health care intervention.[27] Although the observed differences might be partly explained by increased exposure to tobacco and alcohol, or with non-adherence to current guidelines, the authors suggested that the observed high risk of deaths amenable to health intervention in their study probably reflected difficulty accessing health care, delays in diagnosis, and poorer management experienced by people with intellectual disability.[27,32] These conclusions were informed by the results of a national confidential enquiry into premature deaths among people with intellectual disability in the UK.[32]

CONCLUSION

This study highlights the importance of considering intellectual function as an important aspect of the clinical heterogeneity of CP. It suggests that additional strategies are needed to improve access to, and quality of, health care among people with CP and concomitant intellectual disability. Early identification of problems and provision of appropriate care in the primary care setting may help prevent health problems escalating to the need for urgent care. The degree to which the health and mortality disparities experienced by individuals with intellectual disability are addressed by health care systems is potentially an important indicator of their equity and effectiveness.[27]

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Table I: Comparison of rates of intellectual disability by birth gestation and clinical variables in a 1999–2008 cerebral palsy birth cohort

	No intellectual impairment		Intellectual impairment		Relative risk ratio (95% CI)	*p*
	n	(Row %)	*n*	(Row %)		
Sex						
Male	310	(53.0)	275	(47.0)	Referent	
Female	239	(56.9)	181	(43.1)	0.9 (0.8, 1.0)	0.212
Unknown	0		0			
Birth gestation						
37+ wks	296	(51.7)	277	(48.3)	Referent	
32–36wks	83	(55.0)	68	(45.0)	0.9 (0.8, 1.1)	0.605
28–31wks	89	(64.5)	49	(35.5)	0.8 (0.6, 1.0)	0.030
<28wks	65	(57.0)	49	(43.0)	0.9 (0.8, 1.2)	0.652
Unknown	16		13			
Ambulation status						
Independent	450	(70.1)	192	(29.9)	Referent	
Ambulant with aids	52	(52.0)	48	(48.0)	1.6 (1.2, 2.0)	<0.001

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Predominantly non-ambulant	44	(17.0)	215	(83.0)	2.8 (2.4, 3.2)	<0.001
Unknown	3		1			
Predominant motor type						
Spastic	498	(58.2)	358	(41.8)	Referent	
Ataxic	20	(54.0)	17	(46.0)	1.1 (0.7, 1.5)	0.700
Dyskinetic	25	(39.1)	39	(60.9)	1.5 (1.2, 1.8)	<0.001
Hypotonic	4	(9.5)	38	(90.5)	2.1 (1.9, 2.4)	<0.001
Unknown	2		4			
Pattern of spasticity						
Hemiplegia	263	(74.5)	90	(25.5)	Referent	
Diplegia	209	(64.3)	116	(35.7)	1.4 (1.1, 1.8)	0.004
Quadriplegia	26	(14.6)	152	(85.4)	3.3 (2.8, 4.0)	<0.001
Unknown	0		0			
Epilepsy						
No epilepsy	481	(68.8)	218	(31.2)	Referent	
Epilepsy	64	(21.4)	235	(78.6)	2.4 (2.2, 2.8)	<0.001
Unknown	4		3			
Vision						
Not blind	524	(57.3)	391	(42.7)	Referent	
Functionally blind	1	(2.8)	35	(97.2)	2.2 (2.0, 2.4)	<0.001
Unknown	24		30			
Hearing						
Not deaf	526	(57.5)	389	(42.5)	Referent	
Deaf bilaterally	5	(13.5)	32	(86.5)	2.0 (1.7, 2.5)	<0.001
Unknown	18		35			
Communication						
Verbal	506	(72.3)	194	(27.7)	Referent	
Non-verbal	24	(9.2)	238	(90.8)	3.2 (2.8, 3.6)	<0.001
Unknown	19		24			
Birth defects						
None	468	(61.7)	290	(38.3)	Referent	
Cerebral +/- other	32	(25.0)	96	(75.0)	1.8 (1.6, 2.1)	<0.001
Other major	21	(46.7)	24	(53.3)	1.3 (1.0, 1.8)	0.041

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Minor excluding insignificant	23	(41.1)	33	(58.9)	1.5 (1.2, 1.9)	0.001
Dysmorphia only	4	(26.7)	11	(73.3)	1.8 (1.3, 2.5)	0.001
Unknown	1		2			
Neuroimaging classification						
Normal	59	62.1	36	37.9	Referent	
Maldevelopment	23	27.4	61	72.6	1.9 (1.4, 2.6)	<0.001
Predominant white matter injury	194	58.1	140	41.9	1.1 (0.8, 1.5)	0.394
Predominant grey matter injury	22	33.8	43	66.2	1.9 (1.3, 2.6)	<0.001
Focal vascular insult	52	76.5	16	23.5	0.8 (0.4, 1.3)	0.325
Miscellaneous	16	28.1	41	71.9	1.9 (1.3, 2.8)	0.002
Unknown	183		119			

CI, confidence interval.

Table II: Comparison of the increase in the risk of having at least one emergency department presentation or same-day hospital admission or multi-day admission associated with having an intellectual disability (compared with not having an intellectual disability)

	At least one emergency department presentation		At least one admission		At least one multi-day admission	
	Relative risk ratio (95% CI)	*p*	Relative risk ratio (95% CI)	*p*	Relative risk ratio (95% CI)	*p*
Intellectual disability (accounting for risk associated with patient's GMFCS level)						
No	Referent		Referent		Referent	
Yes	1.2 (1.1, 1.4)	<0.001	1.0 (0.9, 1.1)	0.668	1.1 (1.1, 1.2)	0.001

Victorian hospital data. Source: Victorian Admitted Episodes Dataset and Victorian Emergency Minimum Dataset. CI, confidence interval; GMFCS, Gross Motor Function Classification System.

Table III: Comparison of the risks of having more complex hospital admissions and emergency department presentations for children with intellectual disability (compared with children with no intellectual disability)

	Hospital admissions					
	Emergency admission (compared with elective)		Multi-day admission (compared with same-day)		Respiratory admission (compared with other diagnoses)	
	Relative risk	*p*	Relative risk	*p*	Relative risk ratio	*p*

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	ratio (95% CI)		ratio (95% CI)		(95% CI)	
Intellectual disability (accounting for risk associated with patient's GMFCS level)						
No	Referent		Referent		Referent	
Yes	1.4 (1.3, 1.5)	<0.001	1.2 (1.1, 1.2)	<0.001	1.3 (1.1, 1.5)	0.002

Emergency department presentations				
	Higher urgency (compared with lower urgency)		Admitted to hospital ward (compared with discharge)	
	Relative risk ratio (95% CI)	*p*	Relative risk ratio (95% CI)	*p*
Intellectual disability (accounting for risk associated with patient's GMFCS level)				
No	Referent		Referent	
Yes	1.1 (1.0, 1.1)	<0.001	1.2 (1.1, 1.3)	<0.001

CI, confidence interval; GMFCS, Gross Motor Function Classification System. Victorian hospital data. Source: Victorian Admitted Episodes Dataset and Victorian Emergency Minimum Dataset.

Figure 1: Kaplan–Meier survival curves by intellectual status, with pointwise 95% confidence intervals, for a population cohort of children with cerebral palsy born in Victoria, Australia, between 1981 and 2010. ID, intellectual disability.

Figure 2: Kaplan–Meier survival curves by intellectual status, with pointwise 95% confidence intervals, for non-ambulant children with cerebral palsy born in Victoria, Australia, between 1981 and 2010. ID, intellectual disability.

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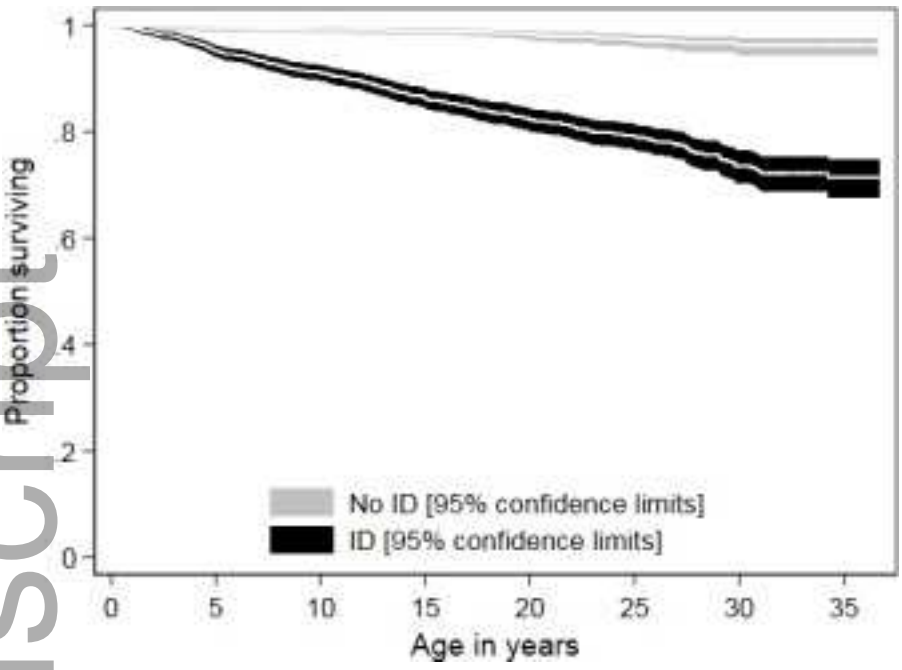

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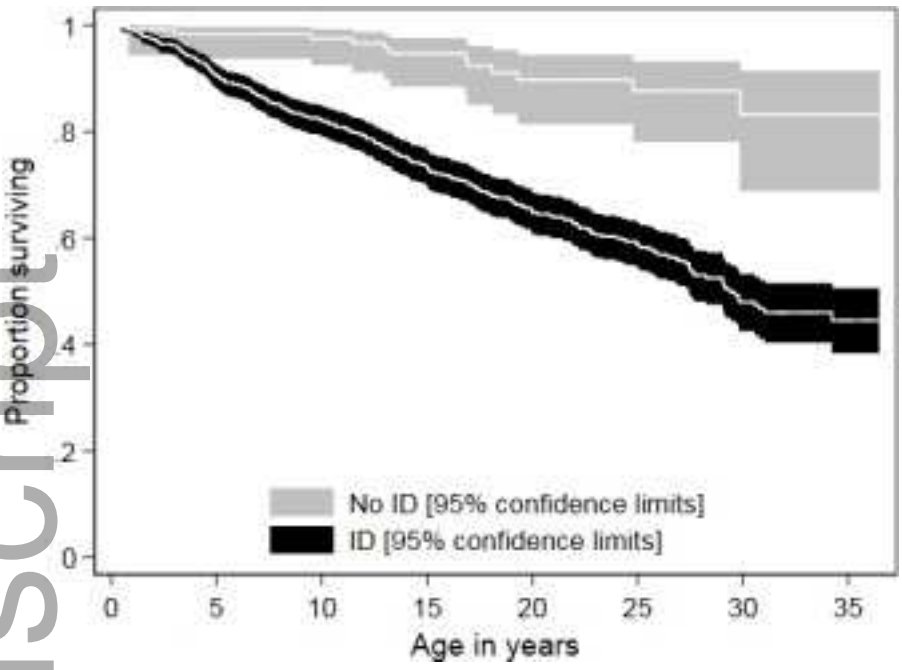

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