Limb distribution, motor impairment, and functional classification of cerebral palsy

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This study explored the relationships between the Gross Motor Function Classification System (GMFCS), limb distribution, and type of motor impairment. Data used were collected in the Ontario Motor Growth study, a longitudinal cohort study with a population-based sample of children with cerebral palsy (CP) in Canada (n=657; age 1 to 13 years at study onset). The majority (87.8%) of children with hemiplegia were classified as level I. Children with a bilateral syndrome were represented in all GMFCS levels, with most in levels III, IV, and V. Classifications by GMFCS and 'limb distribution' or by GMFCS and 'type of motor impairment' were statistically significantly associated (Pearson's χ^2 p<0.001), though the correlation for limb distribution (two categories) by GMFCS was low (tau-b=0.43). An analysis of function (GMFCS) by impairment (limb distribution) indicates that the latter clinical characteristic does not add prognostic value over GMFCS. Although classification of CP by impairment level is useful for clinical and epidemiological purposes, the value of these subgroups as an indicator of mobility is limited in comparison with the classification of severity with the GMFCS.

See last page for list of abbreviations.

The term 'cerebral palsy' or CP (more appropriately the 'cerebral palsies') refers to a group of disorders in the development of postural control and mobility secondary to non-progressive impairments of the developing central nervous system (Bax 1964, Mutch et al. 1992, Stanley et al. 2000). It is recognized that many developmental disorders, notably a number of syndromes including mental retardation* or developmental delay, include motor impairment but can at times be described and classified more usefully as disease entities in other ways (Badawi et al. 1998). Nonetheless, the idea of CP as a group of developmental disorders of motor control is thought to be important and useful as both a clinical and an epidemiological concept.

The history of approaches to classification of CP has been presented by Ingram (1984). Both there and in subsequent work (Stanley et al. 2000) the traditional systems of descriptive classification based on impairments have been well outlined. These systems include an account of the 'topography' of CP (what parts of the body are affected), the 'types' of motor impairment (describing the predominant characteristics of the motor findings), and the 'severity' of motor impairments (Balf and Ingram 1955). Others have tried to classify cerebral palsies on the basis of pathological findings (as outlined by Ingram 1984) and more recently by cerebral imaging techniques (Pinto-Martin et al. 1995). The recent modification of the World Health Organization's (2001) conceptual framework about health conditions and functioning, the *International Classification of Functioning, Disability and Health*, provides another useful way of considering CP and its consequences, from the perspectives of biological factors ('impairments'), functional impacts ('activity limitations'), and the social consequences of the condition ('participation restrictions').

To understand the clinical picture of CP we need to know the value of characteristics at the impairment level, such as the limb distribution of the clinical 'syndromes' (the number of limbs with impaired motor control) or the type of motor disorder, and its severity at the function level. The primary purpose of this report was to describe how limb distribution and type of motor impairment (spastic, dyskinetic, ataxic, or other) relate to functional abilities described by the Gross Motor Function Classification System (GMFCS). The second purpose was to explore to what extent patterns of motor development of children with CP can be explained by the limb distribution of CP and by type of motor impairment, in contrast to observations made using the GMFCS alone.

BACKGROUND ISSUES

One of the continuing challenges in the field of the cerebral palsies concerns what aspects of these conditions to classify, and how to do so. Classification can serve one or more of several purposes (Alberman 1984), and the system(s) used should be specific to those aims. Epidemiologists want to track the incidence, prevalence, and features of these conditions over time to ascertain whether and how these indices are changing (see Krägeloh-Mann et al. 1993, Blair and Stanley 1997, Hagberg et al. 2001). This requires clinical descriptions at the impairment level of both primary features, such as limb distribution and type of motor impairment, as well as associated features of the conditions (such as epilepsy). Parents and families wish to have an account of the severity of the condition and to understand the prognosis of their child's mobility, for

*UK usage: learning disability.

which functional and prognostic classification are necessary (Palisano et al. 2000, Wood and Rosenbaum 2000, Rosenbaum et al. 2002). Clinical service providers and planners have to be able to describe their populations in ways that can be used for service planning (e.g. for creation of a spasticity management clinic) for which descriptions of both functional status and comorbidity are important. Such information also informs individual children's and families' needs for issues such as caregiver assistance, equipment, and services.

Very little evidence is available about the *reliability* of existing classifications of children with CP, and what has been published suggests that classification of the clinical features of CP is difficult and of relatively poor reliability (Table I). In one of the rare studies to explore this challenge, Blair and Stanley (1985) reported that even among a group of six experienced neurodevelopmental clinicians assessing children with known CP, it was difficult to reach as high as 60% agreement on severity of the disability, and lower rates of agreement were observed regarding type of motor impairment (40%) and body location (50%). To our knowledge (E Blair, personal communication; MA Johnson, personal communication) no other work than that described in Table I has been published to assess inter-observer agreement about the classification of CP according to 'type' of motor impairment and the degree of limb involvement. Palisano et al. (1997) and Wood and Rosenbaum (2000) have both reported good to excellent interrater reliability for 'severity' of gross motor function limitations in children with CP using the GMFCS. One might add that if a system cannot be used reliably it is not possible for it to be valid (i.e. to reflect what it is meant to reflect) because of uncertainty about the accuracy of the categorizations.

The *validity* of a classification system rests essentially on the usefulness of its categories. In other words, do they enable people to make meaningful distinctions between the subgroups? In the field of CP one of the challenges has been the need to strike a balance between the varied nature of the clinical entities that constitute the CP spectrum and the complexity of systems to classify these multivariable conditions (Jarvis and Hey 1984). Several reports from CP registries (Krägeloh-Mann et al. 1993, Pharoah et al. 1998, Stanley et al. 2000, Beckung and Hagberg 2002) have illustrated the correlations between motor 'severity' and other aspects of neurodevelopmental impairment, such as epilepsy, mental retardation, and sensory impairments. These findings suggest that 'severity' is a useful marker of at least some aspects of the clinical picture. However Kennes et al. (2002) found that, apart from 'ambulation' (tau-b=0.82) and 'dexterity' (tau-b=0.58), the correlations between a valid marker of motor 'severity' (GMFCS level) and other dimensions of functional status (e.g. speech or sensory function) were at best modest (tau-b=0.46 and 0.36 respectively) and often statistically non-significant.

The prognostic validity of the GMFCS has been reported with the use of both cross-sectional (Palisano et al. 2000) and longitudinal (Rosenbaum et al. 2002) observations of the gross motor development of children with CP followed over several years in the Ontario Motor Growth study. Serial assessments of motor function of 657 children with CP were made with a reliable and valid measure: the Gross Motor Function Measure (GMFM; Russell et al. 1989). At the same time a clinical description of each child's CP was obtained, including both the limb distribution of the CP and the predominant type of motor impairment. This provided the opportunity to explore relationships between the various clinical descriptions of children with CP.

Methods

Details of the Ontario Motor Growth study have been reported elsewhere (Rosenbaum et al. 2002) and are presented only briefly here. This study was made possible through a partnership between the *CanChild* Centre for Childhood Disability Research at McMaster University and the 19 publicly-funded regional ambulatory children's rehabilitation programs in Ontario, Canada. Each program serves the majority of eligible children in their area.

The ethics review boards of Hamilton Health Sciences Corporation, the Bloorview MacMillan Children's Centre

Table I: Summary of literature on reliability and validity of classification systems in cerebral palsy

Classification	*References*	*ICF level*	*Reliability*	*Validity*
Type of motor impairment[a]	Blair and Stanley (1985)	Impairment	±	–
	Surveillance of Cerebral Palsy in Europe (2000)	Impairment	±	±
Limb distribution[b]	Blair and Stanley (1985)	Impairment	±	–
	Krägeloh-Mann et al. (1993)	Impairment	±	±
	Surveillance of Cerebral Palsy in Europe (2000)	Impairment	±	±
Severity				
Mild/moderate/severe	Balf and Ingram (1955)	Impairment/activity	–	–
Mild/moderate/severe	Blair and Stanley (1985)	Not explicitly described	±	–
Four functional gradings[c]	Krägeloh-Mann et al. (1993)	Impairment/activity	–	±
GMFCS (five levels)	Palisano et al. (1997); Wood and Rosenbaum (2000)	Activity	+	+
ICIDH Handicap code[d]	Beckung and Hagberg (2000)	Activity/participation	–	±

[a]For example, spastic, dyskinetic, ataxic, hypotonic, or mixed. [b]For example, hemiplegia, diplegia, triplegia, or quadriplegia.
[c]Derived from the classification system of Hagberg et al. (1975). [d]Dimension mobility, 10 levels.
Scoring: +, classification has been studied systematically and meets criteria of good reliability and/or evidence of validity; ±, reliability/validity has been studied systematically, but has not been fully established; –, classification has not been tested or information is unavailable.
ICF, International Classification of Functioning, Disability and Health; GMFCS, Gross Motor Function Classification System; ICIDH, International Classification of Impairment, Disability and Handicap.

(Toronto, Ontario), and the Thames Valley Children's Centre (London, Ontario) approved the Ontario Motor Growth study (Rosenbaum et al. 2002). All parents of the participants gave their written consent.

The sampling frame was created in early 1996 with 18 of the 19 centres and one hospital-based therapy program in a community without a regional centre. Each centre identified all the children on their case list with a diagnosis of CP born in 1986 or later. In addition, children with neuromotor findings consistent with CP (e.g. spasticity or reflex abnormalities) who had not yet been diagnosed as having 'cerebral palsy' were included. The sampling frame contained 2108 children, of whom 1304 were randomly selected. The goal was to obtain a random sample of eligible children, stratified into four age groups and five GMFCS severity levels. Each age/GMFCS stratum was deliberately over-sampled in the hope of getting at least 15 children in each predefined stratum. In all, 365 children were ineligible or unavailable for various reasons. Of the remaining 939 children, 721 families (77%) consented and, of these, 682 (94.6%) provided data. In total, 657 had fully useable data (369 males [56.2%], 288 females [43.8%]), after the exclusion of children who were subsequently determined not to have CP. The final sample included 183 children in GMFCS level I, 80 in level II, 122 in level III, 137 in level IV, and 135 in level V. Mean age of the children at the start of the study was 6.6 years (SD 2.8); no significant difference was found for age within each GMFCS stratum.

At the first assessment, therapists were asked in a standardized way whether the child had received a formal diagnosis of CP. Therapists were asked to report the limb distribution of the child's CP as it was described in the child's clinic chart by indicating the predominantly affected limbs in a figure with the clinical subtypes of bilateral CP developed by Michaelis and Edebol-Tysk (1989) and also published by Krägeloh-Mann et al. (1993). No specific instructions were given to the clinician to define hemiplegia, diplegia, triplegia, or quadriplegia, nor was a formal algorithm available at the time by which to standardize the therapists' reports.

Therapists were also asked to include whatever terms had been used to describe the diagnosis, including terms about the type of motor impairment (spastic, dyskinetic, ataxic, hypotonic). When no formal diagnosis had yet been given, therapists were asked whether, in their judgement, that child's motor behaviour and patterns 'looked like' CP. Information on the limb distribution of CP was missing for 17 (2.8%) children, and information on the type of motor impairment was missing for 18. For the purposes of the present study, children with three- and four-limb CP were grouped together (n=325). In the Ontario Motor Growth study therapists were asked to report any medical problem in the period 6 months before entry to the study, but apart from a parent-completed report of health status (Kennes et al. 2002) no standardizd information was obtained on cognitive functioning (e.g. IQ), visual impairments (field defects), or comorbidity (e.g. epilepsy).

MEASURES

'Severity' of CP was based solely on gross motor function as judged by therapists using the GMFCS, a reliable and valid five-level pattern recognition classification system that discriminates between children with CP according to their age-specific gross motor activity (Palisano et al. 1997, Wood and Rosenbaum 2000). The GMFCS describes the major functional characteristics of children with CP in each level within several age 'windows': before their second birthday, between age 2 years and the fourth birthday, between age 4 years and the sixth birthday, and between ages 6 and 12 years. Table II outlines the main abilities of children aged 6 to 12 years in each GMFCS level. Use of the GMFCS requires familiarity with the child but requires no formal training.

Motor function was assessed with the 88-item version of the GMFM (Russell et al. 1989) and subsequently analyzed using the Gross Motor Ability Estimator computer scoring program to get an interval-level GMFM-66 score (Russell et al. 2000, 2002). The GMFM is a widely used criterion-referenced clinical observation tool developed for and validated on children with CP. It was not designed to compare the function of children with CP to typically developing children. The GMFM measures gross motor function in lying and rolling, crawling and kneeling, sitting, standing, and walk-run-jump activities and can be used with any child or adolescent with CP. The original 88-item measure has excellent reliability and a demonstrated ability to evaluate meaningful change in gross motor function in children with CP (Russell et al. 1989), as does the newer 66-item GMFM (Russell et al. 2000).

ANALYSIS

Descriptive analyses were done to report the association between the three methods of classification of CP, i.e. (a) by limb distribution (two categories [one-sided vs two-sided involvement], binary/ordinal system, and four categories [hemiplegia, diplegia, triplegia, quadriplegia], nominal system); (b) motor type (four categories, nominal system); and (c) severity by GMFCS (ordinal ranking). To test the statistical significance and, where applicable, to quantify the degree of association between the classification systems, Pearson's χ^2 test and Kendall tau-b were used respectively. A correlation (tau-b) below 0.7 is considered to be poor to modest, because such an association accounts for, at most, about 49% of the explained variance (i.e. tau-b^2).

Non-linear mixed-effects modelling was used to estimate the parameters of motor development as described in Rosenbaum et al. (2002) for children in each stratum by limb distribution

Table II: Summary account of gross motor function by GMFCS level at ages 6 to 12 years (Palisano et al. 1997)

Level	*Description*
I	Walks without restrictions; limitations in more advanced gross motor skills
II	Walks without assistive devices; limitations walking outdoors and in the community
III	Walks with assistive mobility devices; limitations walking outdoors and in the community
IV	Self-mobility with limitations; children are transported or use power mobility outdoors and in the community
V	Self-mobility is severely limited even with the use of assistive technology

(hemiplegia, diplegia, and quadriplegia) and for children in each of the five GMFCS levels. Motor development of children with CP on a group level was expressed as a non-linear change function with parameters that represent the mean rate of change and mean limit of observed GMFM-66 scores. We report the mean GMFM-66 limit scores as a value between 0 and 100. To aid interpretation, the mean rate of gross motor development is expressed as 'age-90', which is the mean age at which children with CP reach 90% of their predicted GMFM-66 limit. Ninety-five percent confidence intervals (CIs) are provided for both quantities. Estimated variances in the limit for each subgroup are used to construct intervals that are expected to encompass 50% of limits in the population; this is expressed as the 50% range of the GMFM-66 limit. Likewise, the variation in age-90 (50% range) is reported as the interval expected to encompass 50% of the age-90 values around the mean age-90.

Within each GMFCS level we compared the differences in GMFM-66 limit scores between subgroups classified by limb distribution, using their 95% CI. Because there were children described as having diplegic CP in each of GMFCS levels I–IV, the diplegic group was used as the 'reference' population against which to compare the patterns of motor development in children with other distributions (using data reported by Rosenbaum et al. 2002). In level V no comparison was possible, because only one child in that level was classified as having diplegic CP to contrast with 126 children having a quadriplegic distribution.

In the analysis, children with any type of motor impairment – both spastic and other types of motor impairment – were included. We refrained from undertaking additional subgroup analysis (e.g. looking at children with spastic CP only, visual impairments, cognitive capacity or comorbidity) within each

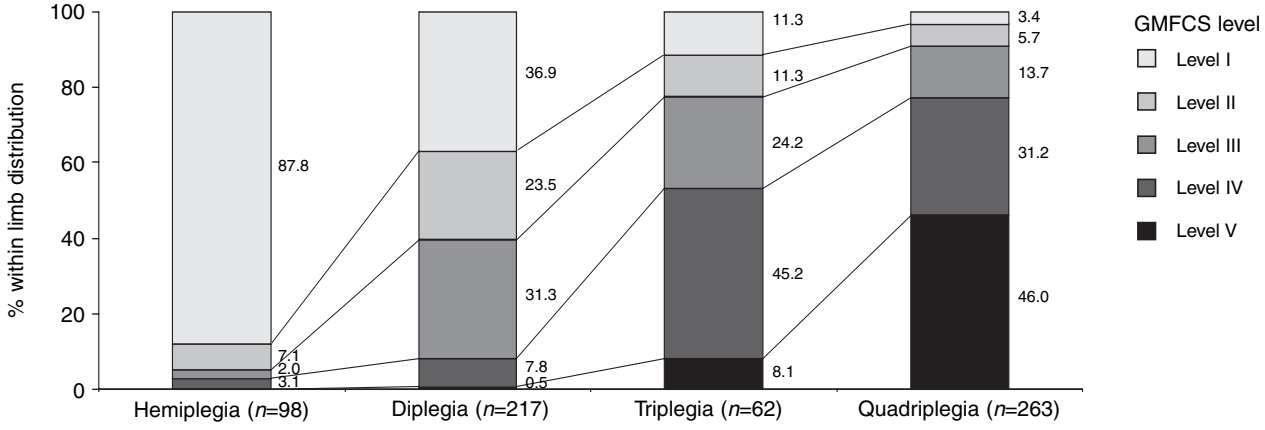

Figure 1: *'Limb distribution' by GMFCS; data from Ontario Motor Growth study (Rosenbaum et al. 2002). Kendall's tau-b (limb involvement in two categories: one-side versus two-side involvement by GMFCS) 0.43, p<0.001; Kendall's tau-b (limb involvement in four categories: hemiplegia, diplegia, triplegia, quadriplegia by GMFCS) 0.13, p=0.001. Pearson's χ^2 test (limb involvement in four categories: hemiplegia, diplegia, triplegia, quadriplegia by GMFCS) p<0.001.*

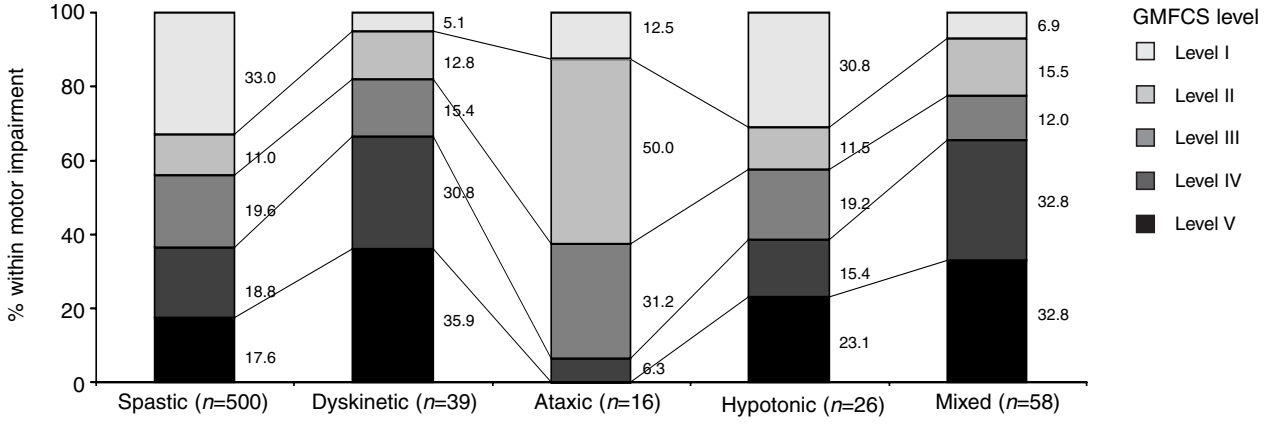

Figure 2: *Distribution of 'type of motor impairment' by GMFCS; data from Ontario Motor Growth study (Rosenbaum et al. 2002). Pearson's χ^2 test (motor impairment by GMFCS) p<0.001.*

GMFCS stratum, because this is possible only for variables recorded at the outset of the study in a systematic and reliable way, issues that were not a focus of the original Ontario Motor Growth study.

Results

Figures 1 and 2 present the functional classification of the sample (by GMFCS) with respect to the four 'limb distribution' groups (hemiplegia, diplegia, three- and four-limb CP) and by the predominant type of motor impairment respectively. There was no significant difference in the mean ages of the children in the four 'limb distribution' groups or by type of motor impairment. According to limb distribution most children with hemiplegia were classified in GMFCS level I (87.8%) but a small number were classified in level II and very few in levels III or IV. Children with a bilateral syndrome were represented in all GMFCS levels, with the majority in levels III, IV and V. The association between limb distribution and GMFCS levels was modest at best, and varied depending on whether one classified using four categories of limb distribution (tau-b=0.13; $p=0.001$) or two categories of limb distribution (tau-b=0.43; $p<0.001$). Both relationships, for limb distribution (four categories) and type of motor impairment, were statistically significantly associated with functional motor ability described using the GMFCS (Pearson's χ^2 $p<0.001$).

For children with presumed spastic CP only ($n=501$) the relationship between limb distribution and gross motor ability (GMFCS) was essentially the same as reported for children with all types of motor impairment (two categories of limb distribution, Kendall tau 0.46, $p<0.001$; four categories of limb distribution, Kendall tau 0.10, $p=0.02$; Pearson's χ^2 $p<0.001$).

Table III presents the GMFM-66 limit and rate (age-90) estimates for the mean gross motor development according to limb distribution and according to functional ability as described by the GMFCS. As reported in Rosenbaum et al. (2002), the estimated limit of development was highest in GMFCS level I and lowest in level V: 87.7 and 22.3 respectively. There were significant differences in the mean limits of motor development by GMFCS strata, with no overlap in the 95% CIs between adjacent levels. Furthermore, the range of values within the 95% CIs was relatively narrow (only in level II did the value reach 5.7 GMFM-66 points). Corresponding values for limits of gross motor development of children classified on the impairment level, namely hemiplegia, diplegia, and quadriplegia, were significantly different from one another, because the 95% CIs did not overlap. Here, however, the width of the 95% CI range was larger: the minimum value was 5.7 GMFM-66 points (diplegia) and the maximum was 15.1 GMFM-66 points for children classified as having quadriplegia. In addition, the 50% ranges of GMFM-66 scores were in most cases larger for the limb distribution groups (three categories) than for the five GMFCS groups, indicating that the estimated rate and limit varied substantially within subgroups of limb distribution.

The rate of gross motor development has similar straightforward clinical interpretations when combined with the children's GMFCS level. Although statistically non-significant, the age by which a child is expected to have reached about 90% of their average limit has a positive correlation with the limit GMFM-66 score for each GMFCS level, but not for each category of limb distribution. Because almost 80% of the children were described as having 'spastic' CP, no analysis of GMFM scores by type of motor impairment has been undertaken.

The mean limit scores of the reference group in each level (diplegic CP in levels I to IV, quadriplegia in level V) with 95% CIs of the estimates are reported in Table IV. In addition, for each subgroup a 50% range interval of the GMFM-66 limit could be calculated. Analysis of function (GMFCS) by impairment (limb distribution) was performed, to contrast patterns of gross motor development in the predominant limb distribution groups for each level. It can be seen that the differences in mean GMFM limit scores between hemiplegia and diplegia in level I and diplegia versus quadriplegia in level II were small (2.3 and 0.4 GMFM-66 points respectively) and not significant. In levels III and IV the children with diplegic CP had small (3.6 or 3.7 GMFM-66 points) but significantly higher GMFM limits than those with three or four

Table III: Parameters of motor development for severity (GMFCS levels I to V) and limb distribution

Category	*n*	*Mean observations per child*	*GMFM-66 Limit*	*95% CI*	*50% range*	*Age-90 (years)*	*95% CI (Age-90)*	*50% range (Age-90)*
GMFCS*								
I	183	4.0	87.7	86.0–89.3	80.1–92.8	4.8	4.4–5.2	4.0–5.8
II	80	4.4	68.4	65.5–71.2	59.6–76.1	4.4	3.8–5.0	3.3–5.8
III	122	4.1	54.3	52.6–55.8	48.5–60.0	3.7	3.2–4.3	32.5–5.5
IV	137	3.9	40.4	39.1–41.7	35.6–45.4	3.5	3.2–4.0	3.5[b]
V	135	3.8	22.3	20.7–24.0	16.6–29.2	2.7	2.0–3.7	2.7[b]
Limb distribution								
Hemiplegia	98	4.2	87.9	82.9–91.7	78.8–93.5	4.6	3.6–5.9	3.5–6.1
Diplegia	217	4.0	72.3	69.3–75.0	57.0–72.3	4.6	4.2–5.1	3.5–6.1
Quadriplegia[a]	325	3.9	38.3	31.0–46.1	24.0–54.9	3.4	2.7–4.3	2.6–4.5

*Data as reported in Rosenbaum et al. (Copyrighted © (2002). American Medical Association. All rights reserved). Parameters of motor development (limit, 95% confidence interval, 50% range) are expressed in GMFM-66 scores. Age-90 is the age at which children are expected to achieve 90% of their potential GMFM-66 score.

[a]For this analysis, data on all children with triplegia and quadriplegia were collapsed into quadriplegia group.

[b]Variation in age-90 was near zero, so 50% range is approximately equal to population mean.

CI, confidence interval; GMFCS, Gross Motor Function Classification System; GMFM, Gross Motor Function Measure.

limbs involved (grouped as 'quadriplegia').

Discussion

The clinical features of CP conventionally used to describe both populations and individual children focus on the impairment level (i.e. limb distribution and type of motor impairment). Until recently, functional limitations were described idiosyncratically, although with the development of the GMFCS a reliable and discriminative system can be applied to this clinical dimension of CP. Of these approaches, only the GMFCS has demonstrated validity and clinical utility. It is possible, in fact likely, that a multidimensional classification that includes functional, topographical (limb distribution), and motor impairment information in combination with associated conditions simultaneously – for example, cognitive capacity, visual impairments, and comorbidity (epilepsy) – would enable parents, service providers, researchers, epidemiologists, and others involved in CP to make more meaningful distinctions about both prognostic and therapeutic issues within this heterogeneous population.

Turning first to the issue of classification by topography (limb distribution), we have been unable to find clear and meaningful descriptions of the distinctions between, for example, 'severe' diplegia and quadriplegia, or between asymmetrical hemisyndromes (with very few signs on the contralateral side) and bilateral CP. For clinical practice even the recent elegant work of the Surveillance of Cerebral Palsy in Europe group (SCPE 2000) leaves open to judgement how to distinguish with precision unilateral from bilateral CP as well as how to distinguish diplegia from quadriplegia.

Perhaps even more challenging from a clinical perspective is how to describe the type of motor impairment found in people with CP. Again, the SCPE group has proposed a hierarchical system for the classification of CP subtypes (SCPE 2000, see figure p 821), but to the best of our knowledge (MA Johnson, personal communication) this algorithm has yet to be field-tested for its reliability and validity. Of all classification systems, only functional status as categorized by the GMFCS has been objectively demonstrated to be both reliable and valid (Palisano et al. 1997, Wood and Rosenbaum 2000).

The availability of a large database of information about motor development in a community-based randomly selected population of children with CP has made it possible to explore the relative usefulness of impairment-level and activity-level methods of classifying CP. In this study we found that the overall association between classification on the impairment level (limb distribution and type of motor impairment) and classification according to function (by GMFCS) is statistically significant but low. The GMFCS seems to provide meaningful distinctions in gross motor development between five functional subgroups (Rosenbaum et al. 2002). In contrast, grouping by limb distribution or type of motor impairment does not provide the clinician additional prognostic information in terms of gross motor abilities. 'Limb distribution' may differentiate children only in levels III and IV, but not in levels I, II, and V. Given the very small differences observed, it is not likely that this information will enable clinicians to distinguish children in ways that families might find useful for prognostic or interventional planning.

In this study, with the exception of the GMFCS data, the clinical descriptions of children with CP were made by clinicians without the benefit of standardized information or a systematic, reliable, and validated classification system. One might question whether, with more accurate ways of categorizing children according to topographical features of CP or types of motor impairment, these classifications could have more clinical utility for prognostic and planning purposes. For this to happen, however, there will need to be clearly formulated descriptions of the clinical characteristics of 'hemiplegia', 'diplegia', 'triplegia', and 'quadriplegia' based on international consensus, with evidence that these clinical subgroups can be identified reliably by people with appropriate training and experience. The same argument applies to the need for the application of the SCPE (2000) distinctions to predominant types of motor impairments, assuming that these can be shown to be reliable in practice. The development of a reference and training manual for clinicians by the SCPE study group is now under way and will contribute in

Table IV: Parameters of motor development for classification of function level (GMFCS) combined with classification of impairment level (limb distribution)

GMFCS level	*Limb distribution*	*n*	*Mean observations per child*	*Limit (GMFM-66)*	*95% CI (GMFM-66)*	*50% range (GMFM-66)*
I	Hemiplegia	86	4.2	Δ +2.3 (*ns*)		82.6–93.7
	Diplegia	80	3.9	87.1	84.6–89.3	79.3–92.3
II	Diplegia	51	4.5	67.9	64.9–70.8	59.9–75.1
	Quadriplegia[a]	15	4.2	Δ +0.4 (*ns*)		61.0–75.9
III	Diplegia	68	4.0	56.0	54.0–57.9	50.4–61.5
	Quadriplegia[a]	51	4.1	Δ –3.6 ($p<0.06$)		46.7–58.0
IV	Diplegia	17	3.8	43.3	41.5–45.2	43.3–43.3[b]
	Quadriplegia[a]	110	3.9	Δ –3.7 ($p<0.001$)		39.6–39.6[b]
V	Quadriplegia[a]	126	3.8	22.3	20.7–24.2	16.6–29.5

Δ, difference in GMFM-66 points between value of reference group (children with diplegia): + is a higher value than reference group; – is a lower value than reference value.

[a]For this analysis, data on all children with triplegia and quadriplegia were collapsed into quadriplegia group.

[b]Figures are rounded to one decimal place. For instance, level IV diplegia 50% range is 43.29 to 43.30. Variance for random effect in the limit parameter is near 0, meaning that there is no evidence for individual differences in limit among these children.

CI, confidence interval; GMFCS, Gross Motor Function Classification System; GMFM, Gross Motor Function Measure; *ns*, not significant.

the coming years to a uniform, reliable, and multidimensional classification of CP (Krägeloh-Man et al. 2003).

In recent years several international collaborations in the field of CP (Krägeloh-Mann et al. 1993, Palisano et al. 1997, SCPE 2000) have brought together the experience and ideas of colleagues from many centres. It will be important for classification systems to be translated into the language(s) of each country so that consistent systems are applied internationally. This has already occurred with systems such as the GMFCS and for a number of clinical measures now in use or being developed around the world. We believe that the time is ripe for further refinement of the clinical details of the CP 'syndromes' in an effort to increase the clarity and consistency with which these children are characterized. Such efforts would make an enormous contribution to the field, to the benefit of everyone for whom CP is important.

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List of abbreviations

GMFCS	Gross Motor Function Classification System
GMFM	Gross Motor Function Measure
SCPE	Surveillance of Cerebral Palsy in Europe