A severity score for intraventricular hemorrhage in preterm neonates

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Intraventricular hemorrhage (IVH) is common among very low-birth-weight infants as many of them survive with the advancements in neonatal care. Severe IVH may lead to significant morbidity and mortality. Traditionally, IVH is graded according to the grading systems of Papile et al[1] or Volpe.[2] Papile et al's grading system is as follows: Grade 1 - germinal matrix hemorrhage. Grade 2 - IVH without ventricular dilatation. Grade 3 - IVH with ventricular dilatation. Grade 4 - IVH extending into adjacent brain parenchyma. Volpe's grading system is as follows: Grade 1 - germinal matrix hemorrhage with no IVH or IVH occupying <10% of the ventricular area on parasagittal view. Grade 2 - IVH occupying 10-50% of the ventricular area on parasagittal view. Grade 3 - IVH occupying >50% of the ventricular area on parasagittal view. Periventricular venous hemorrhagic infarction (PVHI) should be noted separately as this brain parenchymal hemorrhage is a consequence, not a continuum, of IVH. However, some researchers who have adopted Volpe's grading system, including Volpe himself, used the term "grade 4" when referring to PVHI.[3]

Gaps in the traditional IVH grading systems. The overall incidence of all grades of IVH is 20-25% among very low-birth-weight infants, and approximately half of these cases are bilateral.[2,4] Approximately 50-70% of PVHIs are extensive, 25-33% are bilateral, which is characteristically asymmetric, and 50% are associated with a midline shift.[2,5] Two gaps in the traditional grading systems need to be highlighted. First, neither the Papile et al nor the Volpe grading system takes into consideration the severity of the brain parenchymal involvement (grade 4/PVHI). This gap may preclude the further delineation of risk factors or outcomes of IVH. It has been shown that a severity score for PVHI that takes into account bilaterality, brain midline shift, and the extent of brain involvement may help in the further delineation of risk factors and neurological outcomes of IVH.[5] Several severity scores for IVH that are associated with hemorrhagic stroke in adults have been shown to have a very powerful predictive ability for outcomes.[6] Second, neither the Papile et al, nor the Volpe grading system takes into consideration bilateral IVHs. Thus, bilateral IVH has always been collapsed into the unilateral classification in the analysis in most of the studies assessing the risk factors, protective factors, and outcomes associated with IVH. By combining bilateral IVH with unilateral IVH, further delineating or ranking the potential risk and protective factors that may modify the incidence of IVH may be precluded. This practice may also hinder the further delineation of outcomes associated with IVH. In addition to the aforementioned value of the severity score of PVHI, a recent study showed that the neurological outcomes of unilateral PVHI were better than the outcomes in cases of bilateral PVHI.[7]

A severity score for IVH. The primary aim of this work was to develop a severity scoring system for IVH that bridges the gaps in the traditional grading systems mentioned above, and took into account our current knowledge of IVH. Therefore, a severity score for IVH is proposed in this article. It was not the intention to replace the traditional grading systems, but rather the goal was to develop a score based on one of these 2 widely used traditional grading systems. As **Table 1** shows, the proposed severity score is equal to the squared IVH grade of the worse side, plus the IVH grade of the other side, plus 5 for each hemisphere when it has extensive parenchymal involvement (≥ 2 brain territories), and plus 5 when there is a brain midline shift. The PVHI will be graded as a grade 4 IVH to overcome the discrepancy that will occur if the Volpe's grading system is used. Thus, the score will range from 0 (no IVH) to 35 (the most severe). The brain territory is defined using the criteria of Bassan et al.[5] Specifically, the territory is defined as an area ≥5 mm in diameter on the parasagittal view using 3 imaginary lines that border the thalami. Although this severity score ranging from 0-35 was developed arbitrarily, 2 points were considered in its development. First, the IVH grade of the worse side was squared so it would not have a score equal to any

Table 1 - Proposed severity score for intraventricular hemorrhage (IVH).

IVH grade on the worst side	IVH grade on the other side	Score*
4	4	20
4	3	19
4	2	18
4	1	17
4	0	16
3	3	12
3	2	11
3	1	10
3	0	9
2	2	6
2	1	5
2	0	4
1	1	2
1	0	1
0	0	0

*Add 5 to the score for each hemisphere when it has extensive parenchymal involvement (≥2 brain territories). Add 5 to the score when there is a brain midline shift.

set of bilateral IVH. Second, the neurological outcomes of extensive PVHIs and midline shifts are worse than those of bilateral PVHIs.[5] Therefore, extensive PVHI and midline shift were each assigned a score of 5, which is higher than the possible maximum grade of the side that is not squared, even in case of a bilateral PVHI. For instance, the severity score for a bilateral localised PVHI without a midline shift would be 20 (4^2 + 4). A score of 21 (4^2 + 5) would be assigned for both a unilateral extensive PVHI without a midline shift and a unilateral localised PVHI with a midline shift.

Hopefully, this proposed 0-35 severity score will help in further delineating the risk factors, protective factors, and outcomes associated with IVH. Ultimately, it requires validation by either re-analyzing the data from existing studies or by conducting new ones.

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