SHORT COMMUNICATIONS

RED BLOOD CELL 2,3 DPG IN TRANSFUSION-DEPENDENT E–B THALASSAEMIA

P. LAHIRI, D. ADHIKARY, S. CHANDRA and D. K. BHATTACHARYA
The Society for Research on Haematology and Blood Transfusion, Futnani Chambers, Gate-4, Flat-20F, Corporation Place, Calcutta 700 087, India.

TISSUE oxygen delivery is affected by 2,3 diphosphoglycerate (2,3 DPG) — a glycolytic intermediate, present in red blood cells. The binding of O_2 and 2,3 DPG by the B globin chain of haemoglobin (Hb) is mutually exclusive whereby 2,3 DPG lowers the affinity of Hb for O_2, as it acts to stabilize the deoxy configuration of the molecule[1].

In various anaemic states, decline of Hb concentration is compensated with a corresponding increase of 2,3 DPG which decreases the O_2 affinity of Hb thus ensuring adequate O_2 delivery to tissues[2]. This compensatory mechanism does not operate in B-thalassaemia and 2,3 DPG level is inappropriately low in B-thalassaemics[3,4]. It is not known whether the same compensatory mechanism works in E–B thalassaemia where interacting genes are at advantage since the clinical expression is milder with higher level of HbA than homozygous B-thalassaemia[5].

In the present study, the 2,3 DPG level was evaluated in transfusion-dependent B and E–B thalassaemics maintaining a low Hb concentration during intertransfusion interval.

The study is comprised of B-thalassaemics (8) and E–B thalassaemics (8). The age of the patients varied from 2 to 13 years. All the patients received packed red cell transfusions at intervals of 2–3 weeks. Blood samples were collected just prior to the transfusion when Hb concentration was at its lowest during the intertransfusion interval.

Detailed clinical and haematological investigations for diagnosis of thalassaemia were done including haemoglobin index, red cell morphology, osmotic fragility, alkali-resistant Hb and agarose gel electrophoresis with suitable modifications[6]. 2,3 DPG level was determined by Sigma diagnostic kit (procedure no. 665) and optical density was measured using a spectrophotometer (Bausch and Lomb Spectronic – 2000) at 660 nm.

Table 1 *2,3 DPG level and Hb concentration during intertransfusion state of B and E–B thalassaemia*

Types of thalassaemia	Hb conc. g/dl	2,3 DPG μmol/g Hb
B-thalassaemia $n = 8$	5.09 ± 2.19	14.03 ± 3.86
E–B thalassaemia $n = 8$	5.70 ± 2.64	21.46 ± 3.73

2,3 DPG level shows a significant difference between two groups of patients ($P < 0.01$) in an identical anaemic status.

Normal (N = 5) 2,3 DPG = 13.67 + 0.93/μmol/g Hb

(Haemoglobin range 11.2–14.5 g/dl).

Statistical analysis was done using Student's *t* test.

Values of 2,3 DPG and Hb level of B and E–B thalassaemics are shown in table 1. 2,3 DPG level was found to be significantly higher in E–B thalassaemics ($P < 0.01$) in identical anaemic status as shown by their Hb concentration.

It is well-known that the level of 2,3 DPG is critical in determining the O_2 affinity of Hb[2]. There is an inverse relationship between the O_2 affinity of Hb and 2,3 DPG as observed during storage of blood when O_2 affinity of Hb increases as there is a depletion of red cell 2,3 DPG level. But 2,3 DPG level was shown to revert back to normal after transfusion, thereby decreasing O_2 affinity of Hb[7]. The increase in production of 2,3 DPG as observed in anaemia causes a decrease in O_2 affinity of Hb and permitting the O_2 supply to the tissue. Recently Correra *et al*[4] studied 2,3 DPG level in multitransfused B-thalassaemia and found that 2,3 DPG level of the red cell was inappropriately low and the adaptive compensatory mechanism to counter anaemia had failed to operate in those patients.

The data suggest that the degree of functional anaemia in B-thalassaemia may be more severe than the E–B thalassaemia since comparatively low 2,3 DPG level in B-thalassaemia hinders an efficient tissue oxygen delivery system precipitating a state of tissue hypoxia. The observed high 2,3 DPG level in multitransfused E–B thalassaemia put them in a state of distinct clinical advantage and made them less transfusion-dependent.

Perhaps, there may be a different mechanism operating in E–B thalassaemics which enables them to increase the 2,3 DPG level appreciably to combat functional anaemia. Further studies are needed for elucidation of this unique phenomenon in E–B thalassaemia.

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ENTROPY MINIMIZING LANDSLIDE SYSTEMS

MARTIN J. HAIGH†, J. S. RAWAT* and S. K. BARTARYA**

Geography Unit, Faculty of Environment, Oxford Polytechnic, Headington, Oxford OX3 OBP, England.
**Department of Geography, Kumaun University, Almora 263 601, India.*
***Department of Geology, Kumaun University, Nainital 263 002*, India.

LANDSLIDES are complex dissipative systems which self-create on hillslopes provided with excess relief energy. This excess energy may be generated by processes which increase stress in, or which decrease the strength of, the hillslope. The result is the same. The hillside is transformed by the emergence of a landslide structure.

Conventional theory considers landslides as systems which dissipate energy. It may be better to examine landslides in terms of entropy dissipation and self-organization[1].

Dynamic systems exist in one of three conditions with respect to the creation of entropy. (i) They may accumulate entropy through their own operations and so rundown or decay. The behaviour of such "entropy maximizing" systems follows the second law of thermodynamics. (ii) Dynamic systems may balance entropy production during their operation by importing energy from beyond the system boundaries. This energy maintains the system and so, effectively, dissipates entropy back into the environment, (iii) A system may import so much energy that it dissipates more entropy to the environment than it creates. Entropy minimizing systems grow, reproduce, organize and evolve.

Most landslide systems accumulate entropy during their operations. Few are discrete events but their activities tend to diminish from year to year. However, some landslides do not diminish, but expand in successive seasons. The end product of each landslide event is a hillslope system which has more excess energy than before. Road engineers in the Himalaya name these features "chronic" landslides[2]. In sum, there are two fundamental attractors in road-construction-induced landslide systems: extinction and infinite size within the limits of the environment.

In 1978, field measurements were made of the volumes of all landslide outfalls deposited along two new reaches of Himalayan hillroad. There were 257 outfalls including 6630 m^3 of debris on a 6 km reach of the Mussoorie-Tehri road and 63 outfalls totalling 1880 m^3 of debris on the newly completed Mussoorie Bypass[3,4]. If measured landslide outfalls are arrayed as a ranked series it is possible to describe the relation between rank and log-normal volume as a statistically significant linear relationship. The landslide outfalls can be called self-similar (fractal dimension: about 1.6)[5]. This is consistent with the existence of a single, maximum entropy, system attractor in the landslide system.

However, this appearance is an artifact of statistical generalization. Indicative is the fact that, at Landour, higher landslide outfall volumes per kilometre are recorded on the older road-bed (1,105 m^3/km) than on the newly created Mussoorie Bypass (940 m^3/km), despite a similar geology and the Bypass crossing a steeper hillside. Total landslide outfall volume on the two roads is heavily influenced by a few very large landslides. Figure 1 shows the largest outfalls deviate systematically above the rank-size regression line[5]. The conclusion:

†For Correspondence.