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ORIGINAL ARTICLE

A simple device (Hemostick®) for the standardized description of macroscopic haematuria: Our initial experience

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Abstract

Objective. To evaluate the clinical use of a simple device (Hemostick) developed to enable a standardized description of the degree of macroscopic haematuria. *Material and methods.* The visual scale (Hemostick) used in this study comprised six colour fields, one yellow (blank; 0) and five with different nuances of red (1–5) selected from a colour scale according to clinical observations of samples obtained from patients with macroscopic haematuria. Urine samples containing blood were examined and given a Hemostick score (HS) of 0–5, based on comparison with the colour fields on the scale. In three experimental series, (A) 63, (B+C) 14 and (D) 60×4 urine samples were examined by observers. The reported HS was compared with the personal descriptions of the degree of haematuria. We also assessed the absorbance at 412 nm, the haemoglobin concentration and the number of erythrocytes. *Results.* In the first two series (A and B+C) comprising 325 observations on 77 urine samples, the HS for the same sample as reported by the observers was in agreement in 75–93% of cases. In Series B+C the coefficient of variation was 0.06 and the mode 2.68, which was almost identical to the observed mean HS value of 2.69. Based on observations on 240 urine samples considered by four observers during four consecutive days (Series D), an acceptable agreement was recorded in 74–94% of cases. In this experiment the mean HS differed from the mode by not more than 0.12–0.19. In terms of absorbance there was very good discrimination between samples with HSs 1, 2, 3 and 4. Measurements of the haemoglobin concentration (g/l) gave us the following approximate ranges for HSs 0, 1, 2, 3 and 4: <0.2, 0.2–1, 1–5, 5–25 and >25, respectively. Samples with HS 5 comprised those with a high concentration of old blood. *Conclusions.* The results of this series of experiments involving scoring of macroscopic haematuria were encouraging. The Hemostick device was easy to use and resulted in a satisfactory consensus regarding the degree of haematuria and one that was superior to that deduced from a personal terminology.

Key Words: *Blood loss, documentation, macroscopic haematuria, patient care, recording, standardized description, urine*

Introduction

Macroscopic haematuria, a very common symptom in patients with diseases of the urinary tract, can occur with varying degrees of severity. Whereas mild haematuria can usually be adequately managed by increasing diuresis, conditions involving pronounced bleeding often require active evacuation of the bladder by means of catheters or endoscopic procedures. Moreover, mild haematuria that persists for a long time can result in significant loss of blood and anaemia. It stands to reason that the appropriate treatment decision for patients with macroscopic haematuria in both the short and long term will be facilitated by a method that describes the degree of haematuria in a standardized way.

The appearance of blood in urine is a dramatic symptom which is noticed when the number of erythrocytes exceeds 5×10^9/l. This corresponds to $\approx$1 ml of blood or $\approx$100–150 mg of haemoglobin per litre of urine [1–3].

Patients presenting with macroscopic haematuria are occasionally seen in many different fields of the medical profession, but this clinical problem is particularly common in a urological unit. In a recent study [4] with the aim of defining the content and sources of after-hours telephone calls from

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outpatients as well as from emergency units and other medical centres, questions related to haematuria were the third commonest problem.

Although a standardized description of the degree of haematuria is highly desirable, the problem has not been addressed in a consistent way to our knowledge. For patients at different levels of the healthcare system, nurses and surgeons/physicians use their own, often very personal, terminology for describing the degree of haematuria. Vague expressions such as "the colour of tea", "the colour of strawberry juice", "the colour of blueberry juice" and "the colour of rosé wine", to mention just a few examples, are thus common.

At a time when the medical and nursing professions are asking for guidelines or standardized recommendations for the management of various clinical problems, it is evident that such a step cannot be taken for patients with macroscopic haematuria without a unifying concept regarding the severity of the bleeding.

In order to improve the correctness of therapeutic decisions in patients with macroscopic haematuria the Hemostick scale was developed using a series of arbitrarily chosen colour fields. The aim was to use this device in routine clinical work as a basis for describing the degree of haematuria in a reasonably standardized way. This article summarizes our initial experience with such a method.

Figure 1. The Hemostick.

Material and methods

Design of the Hemostick device

Based on clinical observations in an unselected group of patients with macroscopic haematuria, five different red colours were chosen from a colour system. The resulting visual colour scale was assigned six fields, representing Hemostick scores (HSs) between 0 and 5. One field was yellow in order to represent normal urine without blood or with a very low concentration of blood in it (HS 0), whereas the fields for HSs 1–5 represented red colours with an increasing degree of colour saturation.

The device used in this study, which is referred to as the Hemostick, is shown in Figure 1. The various colour fields were applied to a piece of cardboard and subsequently embedded in transparent film. Care was taken to design the Hemostick device so that it would easily fit in a pocket.

Clinical use of Hemostick

With the aim of gaining information on the clinical usefulness of the Hemostick device, four clinical studies were carried out: three (Series A, B and D) involving nurses from our urological ward and one (Series C) involving nurses from a gynaecological ward. A protocol and brief written instructions on how to use Hemostick were given to the nurses. In addition to selecting an HS for each sample, the nurses in Series A–C were asked to describe the degree of haematuria in their own words.

Series A. In this first study, two nurses per day were randomly assigned to make observations on 63 different urine samples with haematuria. Independently of each other the nurses had to make their decision within a period of 5 min. In this study, as well as in all other series (see below), it was important that the test persons in no way compared or discussed the results with each other. A total of 126 observations were recorded in this experimental series.

Series B+C. In this experiment, 14 urine samples with haematuria were presented to 27 observers, of whom 24 were nurses, two were urologists and one was a secretary. Five of these samples were examined by 11 nurses from a gynaecological ward. The total number of observations was 199.

Series D. On four consecutive days four nurses observed 60 urine samples with different degrees

of haematuria. Each day the samples were presented in a randomized order. The HS was recorded for each observer, as well as for each urine sample.

In order to study whether the colour of the haematuria changed over a limited period of time we followed the HS value in two urine samples stored in the refrigerator during 4 days. This test was carried out before the observations on the 60 urine samples were started.

Correspondence between the recorded HS and the degree of haematuria

Absorbance. We assessed the absorbance of samples with haematuria in a Lambda 2 spectrophotometer (Perkin Elmer Corporation, Norwalk, CT) in order to establish the most appropriate wavelength. Of the absorbance peaks, 412 nm gave the most apparent absorbance. This wavelength approximately corresponded to one of the absorbance maxima of oxygenated haemoglobin [5].

Thirty samples with HS values of 1–4 were used for absorbance measurements and subsequently for decisions on the corresponding concentrations of haemoglobin.

Erythrocytes. The erythrocytes in the same fresh urine samples as used for the absorbance measurements were allowed to settle, after which the clear urine was decanted. The samples were then diluted with saline to the original volume of urine. This latter step was undertaken to reduce the risk of osmotic destruction of the blood cells.

Counting of erythrocytes was subsequently carried out in grid chambers (KOVA Glasstic® slides 10; Hycor Biomedical GmbH, Kassel, Germany). A Zeiss light microscope with a magnification of × 160 was used and the volume of erythrocytes was counted in five squares corresponding to a volume of 0.055 μl.

Haemoglobin concentration. A rough estimate of the concentration of haemoglobin was made using HemoCue (Ängelholm, Sweden) equipment. The sensitivity of this method is relatively poor for low concentrations of haemoglobin and the samples were therefore concentrated before these measurements. Thereby, 2 ml of urine was centrifuged at 7500 rev/min for 4 min, after which 1 ml of the supernatant was removed. The remaining part of the sample was mixed and the haemoglobin concentration assessed. In order to establish approximate limits of haemoglobin concentration in samples with HSs 1 and 2, we used absorbance values for samples with known concentrations of haemoglobin.

Statistical considerations

For each group of urine samples we calculated the mean (SD) HS. The mode was the HS that was indicated by the majority of observers. The coefficient of variation (CV) was expressed as the quotient SD/mean.

The local Ethics Committee approved all of the studies.

Results

Of the 63 urine samples in Series A there was agreement on the HS in 47 (75%). Moreover, this first attempt to apply the Hemostick device in clinical work showed that it was easy to use after giving only brief, simple instructions.

A unanimous HS was recorded in 8/14 urine samples considered by the 27 observers in Series B+C. These samples were accordingly assigned HS values of 1, 1, 2, 3, 3, 3, 5 and 5, respectively. In the remaining six samples the scores varied between 1 and 2, 1 and 3, 2 and 3, 2 and 3, 2 and 3 and 3 and 5, respectively.

The mean (SD) HS, mode and CV in the 14 samples in Series B+C are shown in Table I. The average CV was 0.06, but in eight samples there was no variation at all. If we assume that the mode represents the "true" score, the expected average score for all samples will be 2.68. This value should be compared with a recorded mean of 2.69.

When 16 nurses were asked to describe, in their own words, the degree of haematuria in the same sample, the report comprised 11 different terms. This lack of a uniform terminology should be considered in view of the fact that HS 2 was assigned to this sample by all nurses. Figure 2 shows the various personal descriptions of haematuria in the

Table I. Mean, SD, mode and CV of HS values in samples from Series B+C.

Sample	Mean	SD	Mode	CV
1	1.00	0	1	0
2	1.00	0	1	0
3	2.00	0	2	0
4	1.88	0.50	2	0.17
5	2.50	0.52	2	0.15
6	2.50	0.52	2.5	0.15
7	3.00	0	3	0
8	4.44	0.63	5	0.12
9	5.00	0	5	0
10[a]	1.18	0.40	1	0.19
11[a]	2.18	0.40	2	0.13
12[a]	3.00	0	3	0
13[a]	3.00	0	3	0
14[a]	5.00	0	5	0

[a]Samples observed by nurses from a gynaecological ward.

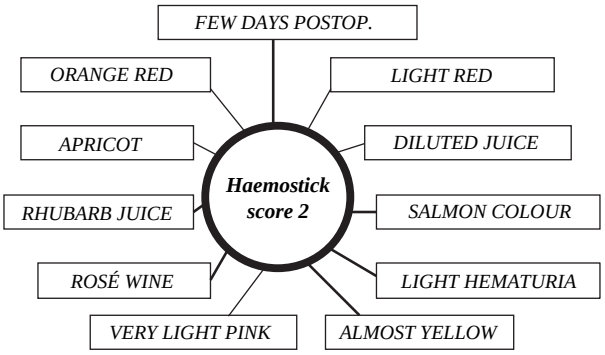

Figure 2. The various personal descriptions of haematuria in the samples from Series B.

samples from Series B. When only the observations made by gynaecological nurses were considered the mean HS was 2.87, a value only slightly above the mode of 2.80.

The main purpose of Series D was to obtain information on the intra- and inter-observer variations. An individual recording with three or four similar HS values was obtained in 51 (84%), 57 (94%), 49 (81%) and 45 (74%) cases on the four days, respectively. The intra-observer variations in a total of 240 samples are shown in Table II. Although complete agreement for the same sample was not obtained the results were reasonably acceptable.

The mode was 1, 2, 3, 4 and 5 in 303, 176, 144, 176 and 160 observations, respectively. The calculated means and the differences from the mode are summarized in Table III. One observation in the group with a mode of 1 was excluded from these calculations because it was obvious that the observer had made a mistake.

Figure 3 shows the absorbance and HS values for 60 samples with haematuria. As is evident, there was good discrimination between samples referred to as HS 1, 2, 3 and 4. Absorbance was assessed in samples with low concentrations of haemoglobin in order to define levels of absorbance that corresponded to low concentrations of haemoglobin. In this way it was possible to give approximate levels of haemoglobin concentrations corresponding to the different HS values. This information, together with direct measurement of the haemoglobin concentration in those samples in which this was possible, was used to derive the haemoglobin concentrations in the urine samples. The result of this procedure is shown in Table IV.

Table II. Intra-observer variation of HS of 4×60 urine samples as reported by the four observers.

No. of samples with the same score ($n = 240$)	Observer No.			
	I	II	III	IV
4	47	22	46	18
3	12	25	4	20
2	1	13	10	22
1	0	0	0	0

Table III. Inter-observer variation expressed as the difference between the mode and mean in samples considered to have HS values of 1–5.

HS (mode)	Mean	Mode–mean
1	0.84	0.16
2	1.85	0.15
3	2.81	0.19
4	4.12	−0.12
5	4.88	0.12

In order to determine the haemoglobin concentration corresponding to the various HS values, we measured the absorbance of appropriately diluted urine samples. We also compared the HS values with those of samples containing known concentrations of haemoglobin. Thereby we were able to establish the following approximate ranges of haemoglobin

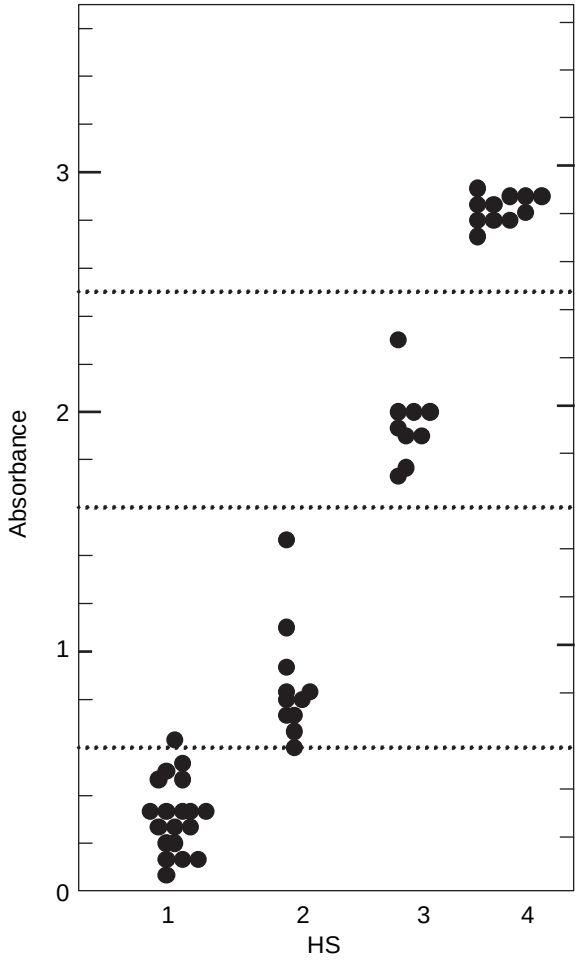

Figure 3. Absorbance and HS values for 60 samples with haematuria.

Table IV. Relationship between HS and approximate haemoglobin concentration.

HS	Haemoglobin (g/l)
0	<0.2
1	0.2–1
2	1–5
3	5–25
4	>25
5	Old haematuria

concentration (g/l): <0.2 in samples with HS 0; 0.2–1 in samples with HS 1; 1–5 in samples with HS 2; and 5–25 in samples with HS 3. The haemoglobin concentration was considered to be >25 g/l in samples with HS 4. HS 5 was found only in samples with old and highly concentrated haematuria and this score was not directly related to a specific concentration of haemoglobin in the way this was measured (Table IV).

The number of erythrocytes in samples with HS 1 varied between 22 and 160/0.055 μl. For HS 2 and 3 the corresponding values were 44–301 and 212-302/0.055 μl. For HS 4 there were 218–447 erythrocytes/0.055 μl and for HS 5 404–781/0.055 μl. The haemoglobin concentrations derived from the number of erythrocytes were much lower than those obtained using the other methods. As might be expected, there is considerable osmotic destruction of erythrocytes excreted in urine and although there was a clear relationship between the number of erythrocytes and the degree of haematuria, it was not possible to estimate the blood loss from the number of erythrocytes remaining in the samples.

Discussion

The colours used in the Hemostick device originated from clinical observations in patients with haematuria seen in the urological ward. At the initial stage of this project we had the feeling that the selected arbitrary nuances of red corresponded to degrees of haematuria for which the management of the patients differed. This has, however, not been studied in the tests carried out so far and might be one of several questions that it will be necessary to address in future studies.

It is important to emphasize that all test persons who participated in our experiment appreciated working with the Hemostick. They found the device easy to use after only brief instruction.

As is evident from the results of our three experimental series, there was very good agreement between observations made by several test persons. In Series A, in which two nurses used the Hemostick to express the degree of haematuria, 75% of 63 samples were given the same score. In Series B, comprising 199 observations, agreement was recorded in 89% of cases. The average CV of 0.06 was acceptable. In Series D we wanted to get some idea of the intra- and inter-observer variations. It was evident that the mean HS differed only slightly from the mode. There is of course no absolute truth regarding the HS of each sample and the mode was our way of categorizing the samples. As shown in Table II, however, the results varied considerably. Two observers reported very consistent results whereas the other two had more pronounced variability in their conclusions.

The observations were made during normal clinical work by persons without previous experience with the device. We did not check the colour vision of the test persons, and neither did we pay any attention to the lighting conditions. All these factors may, however, be of importance to the result.

For HSs 1–4 it was possible to identify a range of absorbance values and to discriminate absorbance levels corresponding to approximate concentrations of haemoglobin. In this way we derived haemoglobin concentrations for those samples that contained < 1–2 g of haemoglobin/l. Although such a method is far from exact it nevertheless gives a rough idea of the haemoglobin content. There was also agreement between the absorbance and the number of erythrocytes, but as many cells may have been destroyed in urine, it was not possible to determine the haemoglobin content by counting the number of erythrocytes.

Samples with HS 5 did not fit into a model of successively increasing concentrations of blood. HS 5, which occurred only infrequently, was seen in samples with old and concentrated haematuria.

We have so far obtained evidence that the Hemostick can be used to describe the degree of haematuria in a more consistent way than previously. Our purpose was not to obtain exact information on the extent of bleeding. The use of the scoring system described will, however, hopefully result in improved communication between providers of healthcare and bring about more stringent and reproducible documentation than is the case today.

In the future we believe that the Hemostick scale as described herein, or in a slightly modified design, might be useful in communication between individual patients and the healthcare system. Many of our patients are either discharged from hospital with various degrees of haematuria or afflicted by haematuria which occurs later as a consequence of the pathology in the urinary tract or as a complication or late effect of surgery. The appropriate management

of these patients would indeed be facilitated by an objective description of the degree of haematuria.

Following this first experience with the Hemostick device we consider it essential to further study its usefulness in sectors of the healthcare system in which patients with macroscopic haematuria are less frequently encountered.

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