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Efficacy of Cupping in the Treatment of Hypertension Disease Using Graph Colouring

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Abstract. Cupping therapy also well known as Hijama is an ancient and holistic method for treatment variety of infirmities particularly cardiovascular diseases such as hypertension. In this method, suction mechanism used to create partial vacuum inside the cup that mobilizes the blood flow and promotes effective healing at the specific point. As practise, the selection of the points based is on patient's complaints. The aim of this study is to identify the least number yet the most effectiveness point at minimal cost to treat hypertension disease. The graph colouring method is applied, besides C# language is used to validate the result. The finding of this research indicates that the optimum number of hypertension medical cupping points is two.

1. Introduction

Cupping (Hijama in Arabic) is an historical, holistic method for the treatment of variety diseases. In spite of the fact that the precise origin of cupping treatment is a matter of controversy, its utilize has been documented in early Egyptian and Chinese medical practices. The historical descriptions of cupping therapy were discovered in ancient human civilizations of the Eastern and Western world. [1, 2]. Cupping is a physical treatment used by acupuncturists or other therapists that uses a plastic, bamboo or glass to create suction on the skin over an acupuncture point or painful area. Basically, there are two types of cupping; dry cupping and wet cupping. In dry cupping, which pulls the skin into the cup without drawing blood, negative pressure acts on the skin and irritates subcutaneous muscles. In wet cupping, the skin is lacerated so that stagnant blood is drawn into the cup [1, 3]. It has been claimed that cupping (both dry and wet) drains excess fluids and toxins, loosens adhesions and lifts connective tissue, brings blood flow to stagnant skin and muscles, and stimulates the peripheral nervous system. In addition, cupping is also said to reduce pain and blood pressure and modulate neurohormone and immune systems. Cupping is used to improve subcutaneous blood flow circulation and to stimulate the autonomic nervous system [4].

Hypertension is one of the most prevalent chronic diseases that can lead to severe health issues like headache, high blood pressure, kidney failure, stroke and blood vessel problems [4]. One of the most dangerous aspects of hypertension is that it has no recognizable symptoms which make it difficult



to diagnosed. Factors such as obesity, too much alcohol consumption or excessive smoking increases the risk of cardiovascular diseases. With the current growth rate, the prevalence of cardiovascular diseases is expected to be more than one billion people in 2025 [5]. Worldwide, higher blood pressure is estimated to cause 7.5 million deaths, about 12.8% of the total of all deaths. Hypertension is responsible for at least 45% of the deaths from cardiovascular disease and 51% of the deaths from stroke [6]. As reported in [7] estimated 46% of the world population suffers from active headache disorder. In Malaysia, there was a rising trend in the prevalence of hypertension in adults 18 years old and above. There was a general increasing trend in prevalence with age, from 6.7% in the 18-19 years age group. The prevalence peaked at 75.4.1% among the 70-74 years age group [7, 17]. A healthy lifestyle, regular monitoring, antihypertensive medicines and plentiful natural remedies helps to lower down the blood pressure more effectively. The side effect of antihypertensive drug therapy and costly remedies can sometimes cause patients to turn away towards an alternative therapy method.

In clinical practice, cupping is often used to lower blood pressure and relieve symptoms of hypertension [5, 9], headaches and anxiety [7, 10]. Various web sources also illustrate the benefits of cupping for lowering blood pressure and treating hypertension [9]. Cupping is one of the most frequently used by patients with hypertension diseases as mentioned in [3-6] and [8-10]. Although cupping remains a popular treatment modality worldwide, its efficacy for most diseases, including hypertension, has not been scientifically evaluated. This study found a large gap between the prevalence, the awareness, the treatment, and the adequate control of hypertension in central Asian. Therefore, it seems pertinent to evaluate the effectiveness of cupping for treating hypertension. Hence, the objective of this study is to develop a systematic algorithm and to obtain the optimum number of cupping points for treating hypertension.

2. Methods

Hypertension is a chronic human disorder. Effective management of hypertension treatment helps cupping practices justify treatment systematically according to its type of disease and provide effective and efficient treatment to the patient. By utilizing graph colouring method, the optimal number of cupping points can be achieved. Even there exists other related methods to be studied, lack of data collection causes graph colouring to be appointed as the main approach.

Graph colouring is to assign colours to certain elements of a graph subject to certain constraints. In its simplest form, it is a way of colouring the vertices of a graph such that no two adjacent vertices are of the same colour; this is called a vertex colouring. Similarly, an edge colouring assigns a colour to each edge so that no two adjacent edges are of the same colour, and a face colouring of a planar graph assigns a colour to each face or region so that no two faces that share a boundary have the same colour [11]. In general, graph theory has a wide range of applications in diverse fields such as, an optimal assignment of employees to jobs, an acquaintance network, geographical model or map colouring, assigning broadcasting frequencies, roadways between states, register allocation and food web ecosystem [13]. Graph colouring is an extremely useful tool in solving combinatorial problems in different areas including geometry, topology, operations research, optimization, computer science, engineering [14] and physical, biological [15], medical image [15, 16] and social systems. As there is no study of medicinal cupping through graph colouring, this paper will study on finding the optimum number of medicinal cupping via graph colouring.

As a preliminary, the definition of chromatic number is present.

Definition 1[11]: Chromatic Number

The chromatic number of a graph G is the least number of colours needed for a colouring of this graph. The chromatic number of a graph G is denoted by $\chi(G)$.

Once all the vertices coloured, the chromatic number is presented by the total colour used. In this case, the least element from the chromatic number will be considered as the best solution.

3. Results and Discussion

3.1. Graph Colouring

Figure 1 shows a human figure with 19 points that are used by practitioner to perform cupping therapy for hypertension disease. In order to create coloured graph using the points, the figure is then extracted and labeled as shown in **Figure 2**.

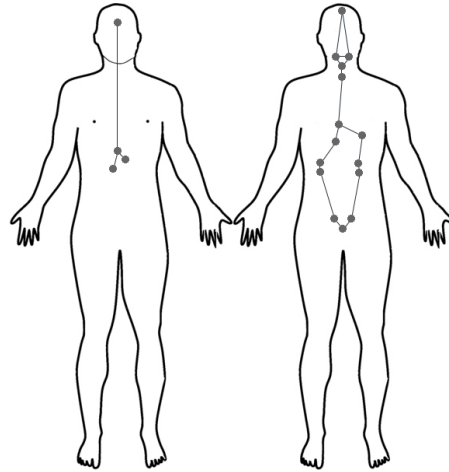


Figure 1: Medical cupping points for hypertension disease.

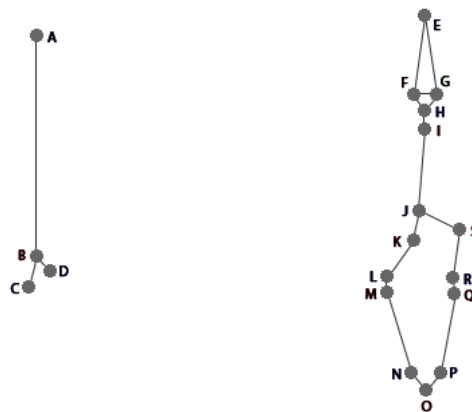


Figure 2: Labeled cupping points to use for plotting matrices

In **Figure 2**, the edges represent the nerves connection in human system while the vertices represent the medicinal cupping points for hypertension disease. **Figure 3** shows the step for using graph colouring method onto the extracted figure.

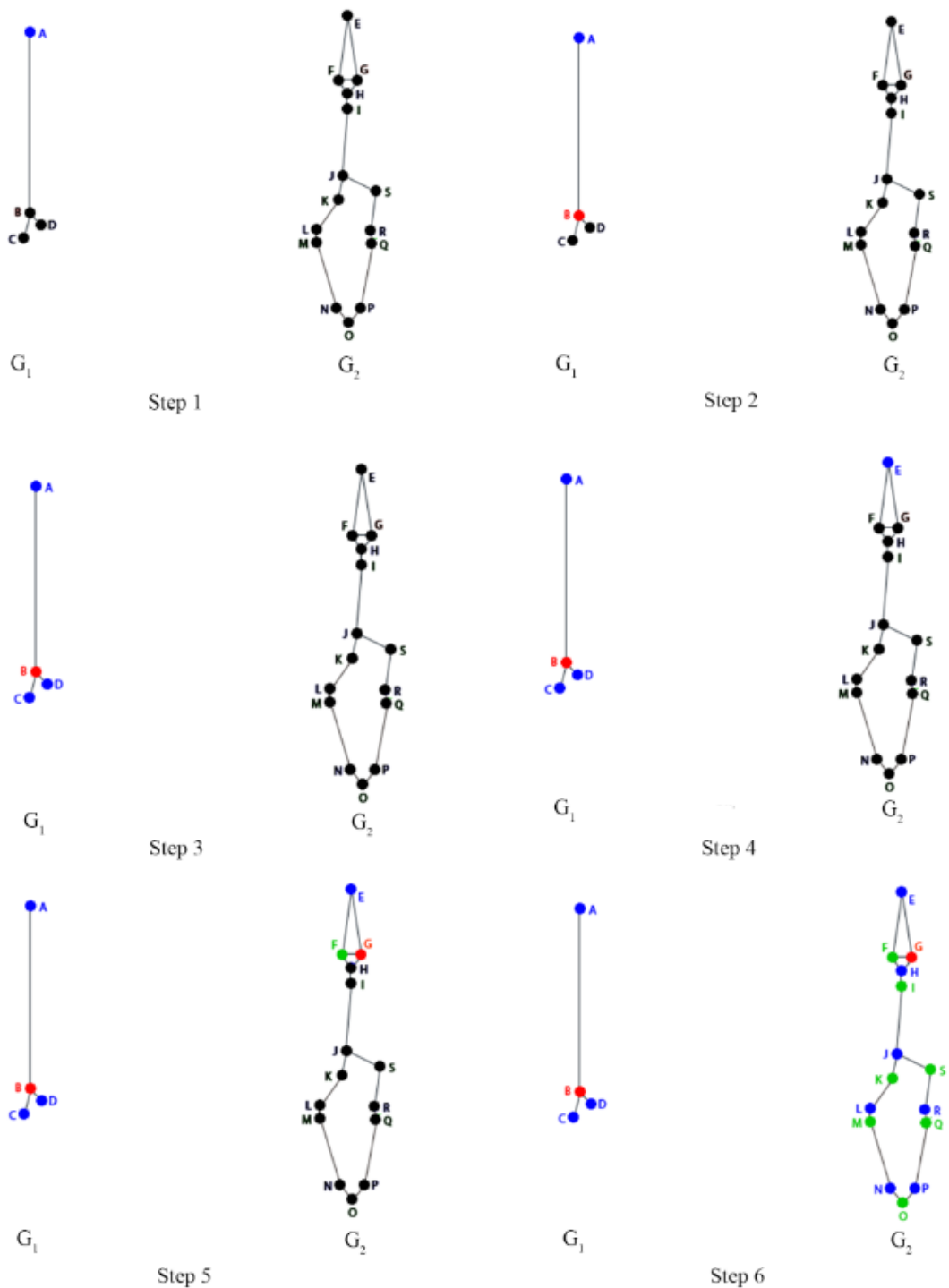


Figure 3: Steps of using graph colouring methods to colour the extracted figure

The process begin by selecting a random point and assign a colour to it. As an example, vertex A is assigned with blue colour (Step 1). From vertex A, the adjacent vertex is found (in this case is vertex B) and coloured with a distinct colour (Step 2). Similar action is done for other vertices that are adjacent with B. It is highly suggested to reuse the colour in which the graph colouring properties hold as shown

in (Step 3 & 4). New color may be used if a vertex is adjacent with two vertices of different colours as in Step 5. This process will be done continuously until all vertices are coloured (Step 6).

In order to get the exact result, trial and error method is used during step 1 to step 6. Below are the possible results obtained.

Table 1: Results of graph colouring for simple graph G

Colour	Result 1	Result 2
Blue	10	10
Green	8	7
Red	1	2

Two possible results are given as shown in **Table 1**. Results 1 is the best solution since it reaches the maximum possible for colour blue and the least element is one vertex (shown by red). However, since there is no nerves connection between G_1 and G_2 , result 2 is the best, in which $x(G) = 3$ with the least points to be cupped are two (B & G). The details are as follows

Result 2: $\chi(G) = 3$

- : 10 medicinal cupping points, {A, C, D, E, H, J, L, N, P, R}
- : 7 medicinal cupping points, {F, I, K, M, O, Q, S}
- : 2 medicinal cupping points, {B, G}

3.2. Pseudocode

Using the extracted and labeled graph, two types of zero-one matrices with the size of 4×4 and 15×15 are plotted. Pair vertices that are adjacent to each other are given the value of "1", and if not then "0" as shown in **Figure 4**. Below are designed pseudocode for graph colouring method that are used to determine the chromatic number and the optimum number of medicinal cupping points. The details code is run on C# platform.

Pseudocode on Finding Element of $x(G)$ in Hypertension Disease

Begin

```

1  Read matrices from .txt file, A = NxN ( $a_{[x,y]}$ ), B = MxM ( $b_{[x,y]}$ )
2  For all node pairs  $[x,y] \in NxN \ \& \ MxM$  do
3      if  $a_{[x,y]} = 1$ , then colour  $i \neq j$ ; Colour 1, Colour 2, ... Colour  $n$ 
4      if  $a_{[x,y]} = 0$ , then colour  $i = j$ ;
5      if  $b_{[x,y]} = 1$ , then colour  $i \neq j$ ; Colour 1, Colour 2, ... Colour  $n$ 
6      if  $b_{[x,y]} = 0$ , then colour  $i = j$ ;
7   $x(G) = \sum$  Colour
8  Display  $\sum$  Colour 1,  $\sum$  Colour 2, ...  $\sum$  Colour  $n$ 
End
```

In line 1, the pseudocode read a text file of a zero-one matrices of size 4×4 and 15×15 . The matrices contain the information of adjacent vertices, which represent adjacent nerves. Line 2 will check all node pairs inside the matrices, and for each node pair, if the value is 1 (Line 3 or 5) it means that the node pair adjacent to each other. This mean that the node pair cannot have similar color. Afterward, the algorithm will determine the colour. If the value is 0 (Line 4 or 6), then the pair node is not adjacent to each other, and the nodes can have a unique colour. This process will continue until the last cupping points are check and assigned colour, as shown in **Figure 5**.

For example, vertex A and B are adjacent to each other, which mean the node pair $a_{[A, B]}$ has a value of 1. This mean that vertex A and B cannot have similar colour. Since point A already has the colour blue assigned to it, point B need to have a different colour that is available, which is red for this case. If the points are not adjacent to each other, as an example node pair $a_{[A, C]}$ for point A and C that has the value of 0, it will have colour that is similar to each other. After finish assigning colour, the total chromatic number are then counted. The $x(G)$ is resented by the number of colours exist in the matrix, while the optimum number of medical cupping points is given by the least number of coloured vertices.

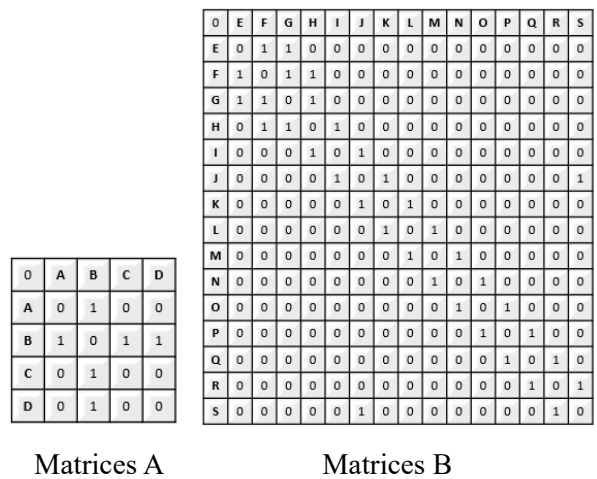


Figure 4: Matrix A with size 4x4 and Matrix B with size 15x15

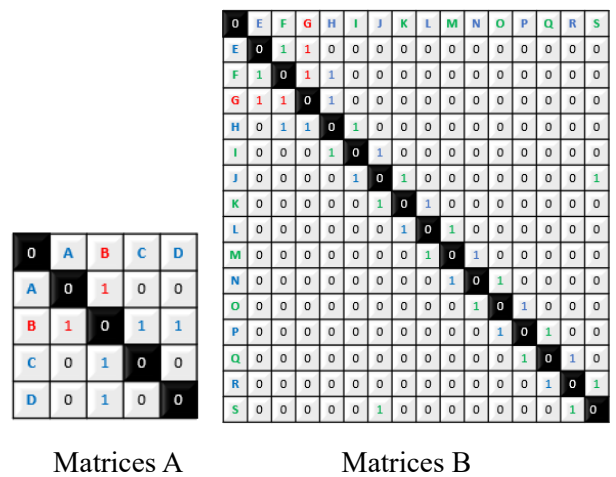


Figure 5: Coloured matrices obtained by using the pseudocode

Details calculations are summarized as follows:

$x(G) = 3$; Colour 1, Colour 2, Colour3.

- $a_{[A,A]} = 0$, Colour A = Colour 1
- $a_{[A,B]} = 1$, Colour A = Colour 1, Colour B = Colour 2
- $a_{[A,C]} = 0$, Colour A = Colour 1, Colour C = Colour 1

$$a_{[A,D]} = 0, \text{ Colour A} = \text{Colour 1}, \text{ Colour D} = \text{Colour 1}$$

.

.

.

$$a_{[D,D]} = 0, \text{ Colour D} = \text{Colour 1}$$

.

.

.

$$b_{[E,E]} = 0, \text{ Colour E} = \text{Colour 1}$$

$$b_{[E,F]} = 1, \text{ Colour E} = \text{Colour 1}, \text{ Colour F} = \text{Colour 2}$$

$$b_{[E,G]} = 1, \text{ Colour E} = \text{Colour 1}, \text{ Colour G} = \text{Colour 3}$$

.


.


.

$$b_{[S,S]} = 0, \text{ Colour S} = \text{Colour 2}$$

Based on the calculation, the $x(G) = 3$ and the least elements for each colour satisfied the graph colouring results:

 Colour 1 = 10

 Colour 2 = 7

 Colour 3 = 2

4. Conclusion

As current practise, 19 vertices are the possible number of cupping points to be cupped for hypertension disease. In this paper, the optimum number of cupping points is two (as shown in the graphical model and algorithm constructed) which benefited to medical cupping practitioners or researchers. However, a deep study need to be done in verifying the effectiveness of this result in reals.

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