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Optimal medicinal cupping points selection for asthma disease via graph colouring: a preliminary study

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Abstract. Medicinal cupping is a traditional therapy which used by applying a cup on acu-points or cupping points and the pressure inside the cup is reduced so that the skin and superficial muscle layer is drawn into and held in the cup. Since all diseases and pains have their specific area to be cupped, most cupping practitioners usually recognize the cupping points based upon the disease and the patient's complaints. Hence, they will randomly choose the points upon request due to the money constraint. However, there is no mathematical approach on guaranteeing the handy method is optimized. Thus, in this paper, a graph model is proposed on finding the optimal number of cupping points for asthma disease via graph colouring approach. This mathematical model will further benefit to the biomathematics and medical fields, especially to the industrial cupping practitioners

1. Introduction

Cupping in Chinese medicine refers to a therapy in which heated glass cups are applied to the skin along the meridians of the body, creating suction and believed to stimulate the flow of energy. People get it for many purposes, including helping with pain, inflammation, blood flow, relaxation and well-being, and as a type of deep-tissue massage [1]. Cupping therapy can be viewed in two different perspectives, Islamic [2-4] and Chinese practitioner views [5-6]. In [2] and [5], the papers highlight the definition, advantages and types of the cupping therapy from two different perspectives; Islamic and Chinese practitioner, respectively by using Randomized Controlled Trials (RCTs) in assessing and reporting the data. Both papers conclude that cupping treatment has a potential effect and [2] suggests this cupping treatment should be practiced only by qualified medical professionals. While in [3] and [4], one of Islamic type cupping treatments (Al-Hijama) is deeply discussed in terms of advantages and implemented on certain diseases. In [3], this paper notes there is not much regulation of Hijama and suggests on providing a reference for cupping based on Evidence-Based Practice. In 4] argues on the effectiveness of Hijama due to the insufficient evidence and bias, besides suggest to conduct a

deep research on cupping. Meanwhile, the relations between area of wet cupping therapy and acupuncture meridians are presented in [6]. Thus, in this paper medicinal cupping is an interest area to be studied.

An asthma disease is chosen as selected diseases to be modelled mathematically in this paper, since it is rated as one of the major illness faced by the people presently [7]. In [8] and [9], these two papers claim that cupping treatment is the very effective treatment for pain relief. Besides, paper [9] found that Bekam therapy is a worth therapy, which helps patients experience less pain and reduce some amounts of analgesic medications.

In modern medication, the drug is applied as one of the asthma treatments, which is costly. As an alternative, medicinal cupping treatment can be used. However, there is no mathematical approach to prove the practical method on selecting the medicinal cupping point is optimized. Motivated by the problem, in this paper, a mathematical model is proposed to be developed on finding the optimal number of cupping points for asthma disease since up to the best of authors' knowledge; there is no research that focuses on this factor.

2. Methods

In this paper, there is a need to overcome the issue. Graph model can be used as a tool in promoting effective knowledge on catered for this problem. In this regards, a valid simulation model via graph colouring offers a better alternative, whereby the cupping practitioners can determine and display the correct and minimum number of cupping points. Even multi criteria decision making and multi objective function also can be one of the tools, limitation of data collection cause graph colouring is selected as the approach.

As the preliminaries, three related definitions will first be reviewed.

Definition 1[10]: Graph

A graph $G=(V,E)$ consist of V a non-empty set of vertices (or nodes) and E, a set of edges. Each edge has either one or two vertices associated with it, called endpoints. An edge is said to connect its endpoints.

A graph G in which each edge connects two different vertices and no two edges connect the same vertices is called a simple graph. In this paper, the cupping points and nerves will represent the vertices and edges, respectively. Next, the definition of the approach method is present.

Definition 2[10]: Graph Colouring

A colouring of a simple graph, G is the assignment of a colour to each vertex of the graph so that no two adjacent vertices are assigned the same colour.

Since the result of the optimum number of asthma medicinal cupping points is based on the least elements from the chromatic number, hence the definition of chromatic number is present.

Definition 3[10]: Chromatic Number

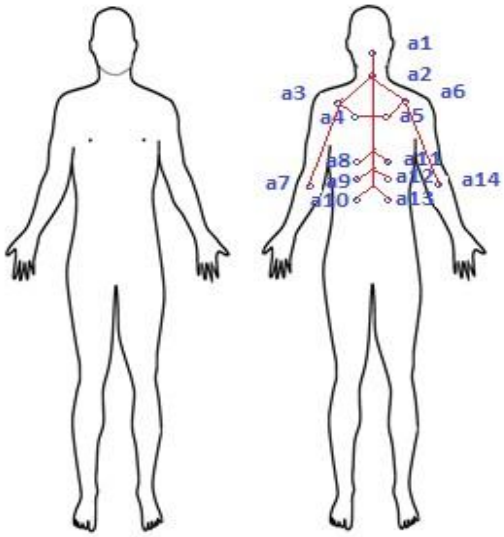
The chromatic number of a graph G is the least number of colours needed for a colouring of this graph. The chromatic number of a graph G is denoted by $\chi(G)$.

Graph colouring served in many practical applications as well as theoretical challenges. It has even reached popularity with the general applications such as Sudoku and placement of Closed-Circuit Television (CCTV); and it stills a very active field of research [1, 11]. The current applications most involved solving a problem on computing [12], network [13] and scheduling problems [14].

Thus, in this paper, the concept of graph colouring is tried to be implemented on the analysis decision of asthma medicinal cupping points since it has not been used for this type of medical problem

3. Results and Discussion

Figure 1 shows the 14 nodes that indicate the asthma cupping points which implemented by medicinal cupping practitioners. These 14 nodes of asthma cupping points are renamed as vertices ai, $1 \leq i \leq 14$, of a simple graph G, while the edge of the graph in **Figure 1**(b) indicates the nerves connection between the cupping points. **Figure 1**(b) can be illustrated as a simple graph depicted as in Figure 2.



(a) (b)

Figure 1. Medicinal cuppingpointsforasthma disease

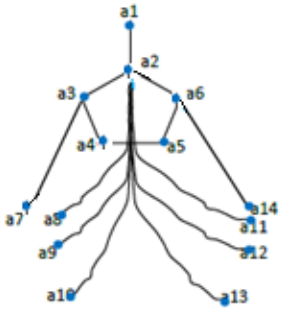


Figure 2. Simple graphmodel, *G*of medicinal cuppingpointsforasthma disease

To find the optimum number of asthma medicinal cupping points, all the vertices of ai, $1 \leq i \leq 14$ need to be coloured by implementing the graph colouring concept as stated in Definition 2 i.e. no adjacent vertices will have the same colour; and the first colour will be put as maximum in the constructed simple graph before the second colour is chosen.

As an example, the vertex a1 is coloured with blue. Automatically, the vertices a3, a6, a8, a9, a10, a11, a12 and a13 also will be coloured with blue since all those vertices are non-adjacent with a1. The vertices will be coloured with blue up to the maximum before the different colour is chosen in Step 2. Once the conditions fail, the second colour (as an example red) is chosen. This process will be done continuously until all the vertices are coloured; which the chromatic number, $\chi(\mathbf{G})$ is present.

To get the exact solution, the try and error method is implemented during the graph colouring step. **Table 1** below shows all the possible solution before reached to the end results.

Table 1: Try and error results

Colour	Results	
	Results 1	**Results 2**
Blue	9	10
Red	4	3
Green	1	1
X(G)	3	3

Table 1 clearly shown both results give χ(G)=3. Even the minimum number of medicinal cupping points of asthma disease for both results is 1, but Results 2 is considered as the best solution regarding to Definition 2 and 3. The cupping point that need to be cupped (which is a6) is depicted as in **Figure 3**. The details description is prescribed next.

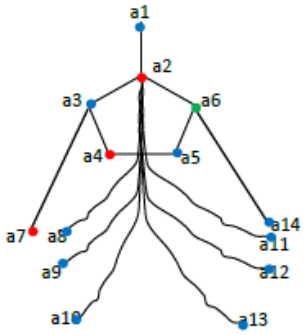


Figure 3. Graph colouring forasthma medicinal cuppingpoints

Details of Results 2:
X(G)=3;

- ●: 1medicinal cuppingpoint,{a6}
- ●: 3 medicinal cuppingpoints,{a2, a4,a7}
- ●: 10medicinal cuppingpoints,{a1, a3,a5,a8,a9,a10,a11,a12,a13,a14}

Based on results of **Figure** 3, only one vertex is found (enough) as the most number of cupping points that can be cupped in the first treatment; compare to the original which is 14 since the green point give the optimum solution. If the patients need to re-do a medicinal cupping treatment, the points marked with red colour will be chosen first compare to the one that marked in blue due to the least number of vertices that need to be cupped.

This model is an origin model that constructed in determines the optimal solution for cupping points of asthma disease, which more accurate compare to the traditional approach implemented. This show the reduction of the vertices (cupping points) can optimize cost and time due to the number of less cupping points, which traditionally is only satisfied for customer demands. Besides, the selection of vertices (cupping points) of the constructed model are based on the edges

(nerves connection), which impact the accuracy and benefit factors (accurate and rigid), in contrast with traditional approach in fulfilled customer satisfactory.

Currently, the approach model is practically under trial process by industrial collaborator (PusatBekam Al-Yakin), since some samples are needed for verification process. Henceforth, in order to validate the results, the following algorithm in Figure 4 is constructed via C# language.

```
begin

read matrices from .txt files, A = NxN ([aᵢ,aⱼ]),
for all vertices pairs [i,j] ϵ NxN do
   if [aᵢ][aⱼ]=1, then colour i≠j;
                       colour 1, colour 2...colour n;
   if [aᵢ][aⱼ]=0, then colour i=j.

   X(G)=Σcolour;
   display colour1, colour 2,...colour n;

end;
```

Figure 4. Algorithm on finding asthma medicinal cuppingpoints

The algorithm starts by reading an adjacency matrix A from a .txt file. Since this study involved with 14 vertices, the elements of the matrix A consist of a[i,j], $1 \le i, j \le 14$. Through the algorithm, vertices $[a_i][a_j] = 1$ means i and j are connected, while 0 represent for not connected. As a result, the chromatic number 3 is obtained and the optimum number of asthma medicinal cupping points are represented as output shown in **Figure 5.**

	a1	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	a14
a1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
a2	1	0	1	0	0	1	0	1	1	1	1	1	1	0
a3	0	1	0	1	0	0	1	0	0	0	0	0	0	0
a4	0	0	1	0	1	0	0	0	0	0	0	0	0	0
a5	0	0	0	1	0	1	0	0	0	0	0	0	0	0
a6	0	1	0	0	1	0	0	0	0	0	0	0	0	1
a7	0	0	1	0	0	0	0	0	0	0	0	0	0	0
a8	0	1	0	0	0	0	0	0	0	0	0	0	0	0
a9	0	1	0	0	0	0	0	0	0	0	0	0	0	0
a10	0	1	0	0	0	0	0	0	0	0	0	0	0	0
a11	0	1	0	0	0	0	0	0	0	0	0	0	0	0
a12	0	1	0	0	0	0	0	0	0	0	0	0	0	0
a13	0	1	0	0	0	0	0	0	0	0	0	0	0	0
a14	0	0	0	0	0	1	0	0	0	0	0	0	0	0

Figure 5. Simulation result from algorithm constructed

It is clearly shown from the output, 1 vertex (a6) is the optimum number of medicinal cuppingpoint of asthma disease, presented in green colour. While red and blue gives three and nine vertices. This output validates the obtaining results by graph colouring and chromatic number concepts previously.

4. Summary

This research has a high impact on the society, economy and nation. The newly developed mathematical model is expected to find the optimal numbers of asthma cupping points; which impact

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