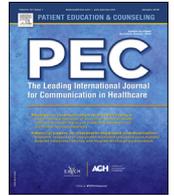




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# The effect of different styles of medical illustration on information comprehension, the perception of educational material and illness beliefs

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## ABSTRACT

**Objective:** To explore how the addition of a medical illustration and its style affected information comprehension, perception of educational material and illness beliefs.

**Methods:** 204 people recruited in a supermarket were randomised to read one of the four leaflets about gout and fill out a questionnaire. Three leaflets had a picture showing gout in the form of a cartoon, an anatomical drawing or a computed tomography scan (CT). The control leaflet did not contain images.

**Results:** Seeing an illustrated leaflet helped correctly identify treatment for gout  $\chi^2(1, N = 204) = 5.51, p = 0.019$ . Out of the three images, only the cartoon was better than text in conveying information about treatment  $\chi^2(1, n = 102) = 8.84, p = 0.018$ . Participants perceived illustrated leaflets as more visually appealing  $t(70) = 3.09, p = 0.003$ , and the anatomical image was seen as more helpful for understanding of the illness than the cartoon. Pictures did not significantly influence lay illness perceptions about gout.

**Conclusion:** Pictures aid the understanding of health information and increase the visual appeal of materials. While simpler illustrations convey information more effectively, people prefer more detailed anatomical images; CT scans offer no benefits over simpler images.

**Practice implications:** The results can help guide the use of images in gout education material.

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## 1. Introduction

A substantial body of research has demonstrated benefits of using visual materials in patient education. Compared to text-only interventions, the addition of visual aids can improve comprehension of medical information, recall and compliance with medical advice [1,2]. Patient education materials employ a variety of illustrations including anatomical drawings of the body, cartoons and other styles of pictures. However, few studies looked at what styles of illustrations are more helpful for conveying health information.

It is thought that simpler images are easier to interpret as there are no distracting details. A research by Moll [3] explored the effect of several illustration types on the communicational value of a health message. His analysis revealed that an educational booklet containing cartoons was the most effective for improving information comprehension, and simple line drawings were

second in effectiveness. A review on the role of pictures in health communication found that the simplification of visual aids was essential for effective communication of health information [4].

On the other hand, previous research has shown that viewing computed tomography (CT) scans can also improve people's understanding of illness and treatment [5–7]. A study in the general population found a better understanding and recall of medical information, as well as greater levels of satisfaction in the way diagnoses were communicated, in those who viewed CT images [8].

Medical scans are complex and highly detailed visualisations of structures of the body and may be difficult for a layperson to interpret. Therefore, it is unclear whether medical images have any educational benefits over simpler visual mediums such as cartoons or simple drawings.

This study investigated firstly how the addition of a medical illustration to an educational text affected information comprehension and people's perception of educational material. It was hypothesised an educational leaflet on gout with an embedded medical illustration of gout would improve people's understanding of the information about the disease and will be more interesting than the same leaflet without images. Secondly, the study compared the impacts of three illustration styles including a

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cartoon, a simple anatomical drawing and a CT scan. A leaflet about gout containing a cartoon was expected to improve understanding of information about gout more so than other illustrations.

## 2. Methods

### 2.1. Study design

The study employed a quasi-experimental design with four arms 1:1 allocation ratio and one measurement immediately after the intervention.

Shoppers at a local supermarket were approached with an invitation to take part in research aiming to explore better ways of presenting information about gout. The participants were asked to read one of the four educational leaflets on gout and fill out a questionnaire. Three leaflets had an embedded image showing the foot of a person with gout depicted in the form of either a cartoon, an anatomical drawing or a 3D computed tomography scan (see Fig. 1). The control leaflet included the same text without an image. All four intervention leaflets included a text explaining what gout was, causes of gout and treatment for it.

The participants were blinded both to the study design and the group allocation. Randomisation was performed by stacking the study booklets according to a randomisation sequence. The sequence was generated by the researchers using an online research randomisation tool (Research Randomizer.org) based on 51 blocks of 4 unique numbers to ensure 1:1 allocation ratio.

### 2.2. Participants

A convenience sample of two hundred and four supermarket shoppers was recruited into the study. To take part they had to be over 18 years old and be able to fill out a questionnaire in English. A power calculation using G\*Power software [9] showed that for a medium effect size ( $f = 0.25$ ), 4 groups (3 image conditions and one no image arm),  $\alpha = 0.05$  and 3 degrees of freedom, one-way ANOVA would require a sample of 201 subjects to reach 85% of power.

### 2.3. Procedure

The study was approved by the University of Auckland Human Participants Ethics Committee (Reference number: 021867). A research stand was arranged in one of the popular supermarkets in Auckland, New Zealand. Shoppers were invited to participate in a study looking at how information about gout could be better presented to improve illness and treatment understanding in the general public and patients. While in the supermarket, the participants were asked to read an educational leaflet about gout and fill-out an anonymous questionnaire. All participants received an NZ\$10 shopping voucher.

### 2.4. Intervention

#### 2.4.1. Text

The intervention leaflets included the same text (see Appendix A in Supplementary material). The information was derived from a widely used patient information booklet on gout available on the New Zealand Ministry of Health website [10]. The Flesch–Kincaid Grade Level was 5.9 which complies with the recommendation of the American Medical Association for patient education materials being written at or below the 6<sup>th</sup> grade [11].

#### 2.4.2. Images

The images embedded in the leaflet showed a foot of a person with gout affected by urate crystals depicted in the form of a cartoon, an anatomical image or a CT scan (see Fig. 1). Urate crystals

were colour coded in green in all three images. The cartoon was a basic shape of the foot with a green area representing urate crystals. The anatomical image showed the foot as well as foot bones and joints with a urate crystal deposit in the big toe. The CT scan was an anonymised dual-energy computed tomography ankle and foot bilateral scan. The scan was rendered in 3D using standard image processing radiology software. This software allows visualise the foot in detail and helps to identify urate crystals by highlighting them in a contrasting colour.

### 2.5. Measures

Demographic information about age, sex, ethnicity and occupation was collected during the study. To determine participants' previous experience with gout, two items of the questionnaire asked whether the participant or any of their family members or friends had ever been diagnosed with gout.

**Perception of the intervention leaflet** was assessed using eight questions. The participants were asked to rate on an 11-point Likert scale (0–10) their worry about gout induced by the leaflet [12,13], the believability and ease of understanding of the information; how interesting, visually appealing and helpful the leaflet was for understanding of gout, and how likely they were to read it, if it was in a clinic. Additionally, participants in the image conditions rated how helpful the image was for the understanding of gout.

**Information comprehension** was measured with four multiple choice questions designed to test understanding of the information about gout provided in the intervention leaflet. The participants were asked to choose only one answer. The questions asked about the causes of gout (What causes gout? a. Too much alcohol; b. Too much seafood; c. High blood urate; d. Diabetes), causes of gout attacks (What inside the joint causes attacks of gout? a. Virus; b. Crystals; c. Bacteria; d. Calcium), best treatment for gout (Which of these is the best treatment for gout? a. A balanced diet and moderate physical activity; b. Short course of urate-lowering medication; c. Long-term urate-lowering medication; d. Painkillers), one question asked whether gout was a form of arthritis. The total number of correct answers was analysed as well as answers to the individual questions.

**Illness perceptions** were measured with the Brief Illness Perceptions Questionnaire [14,15]. Participants were asked to imagine they were diagnosed with gout and answer questions about perceived consequences of gout, personal control over gout, treatment control (how much treatment could help gout), illness identity ("How much would you experience symptoms from gout?"), concerns about gout, emotional response to having gout and understanding of the illness. One item was added to assess the perceived illness severity ("How serious do you think gout is as an illness?") [12,16]. All items were rated on an 11-point Likert scale (0–10).

Gout is often depicted as a self-inflicted condition caused by over-indulgence in food and alcohol [17]. Such public beliefs can induce feelings of embarrassment in people with the condition and discourage from seeking treatment [18]. To assess perceived gout stigma a single-item measure asking to rate on an 11-point Likert scale (0–10) "How embarrassed would you feel if you were diagnosed with gout?" was added to the survey [19].

### 2.6. Statistical analysis

The data was analysed in IBM SPSS Statistics (v 25.0). Statistical significance was determined at  $p \leq 0.05$ . *t*-test for independent samples was used to determine differences between the no image and the medical illustration arms in perception of educational leaflet and illness perceptions. The effects of the illustration style



Fig. 1. Intervention leaflets: a – leaflet with a cartoon illustration, b – anatomical illustration, c – 3D dual-energy computed tomography scan; c – no image arm leaflet.

on illness perceptions and perception of the leaflet were explored with one-way analysis of variance (ANOVA). Multiple comparisons were performed with Sidak's adjustment. Games-Howell test was employed when the assumption of equality of variances was violated. The chi-square test of independence was used for the analysis of the information comprehension section.

### 3. Results

#### 3.1. Demographic characteristics

There were no statistically significant differences between the four groups in demographic characteristics, the number of people

with gout and the number of people whose family or friends were diagnosed with gout (see Table 1). The majority of the sample identified as New Zealand European (46%), 19% as Indian and 10% as Māori. 61% of the participants were females. The age of the sample ranged from 18 to 87 years with an average of 46.9 years (SD = 17.5).

### 3.2. Perception of the intervention leaflet

The leaflet containing a medical illustration was rated as significantly more visually appealing than the no image leaflet  $t(70) = 3.09$ ,  $p = 0.003$ . There were no significant differences between the leaflets in believability  $t(202) = 0.26$ ,  $p = 0.80$  and ease of understanding of information  $t(202) = 0.26$ ,  $p = 0.80$ . Addition of a picture did not make the leaflet more interesting  $t(202) = -0.63$ ,  $p = 0.53$ , more worry provoking  $t(202) = -0.29$ ,  $p = 0.77$  or more helpful for the understanding of gout  $t(202) = -0.94$ ,  $p = 0.35$ . Illustrated and text-only leaflets were similarly likely to be read if they were in a clinic  $t(202) = 0.49$ ,  $p = 0.63$ .

The image style had a significant effect on how visually appealing and helpful the leaflet was for participants' understanding of gout (see Table 2). A post hoc test showed that leaflets with the cartoon and anatomical drawing were more visually appealing than the text without images ( $p = 0.038$  and  $p = 0.011$  respectively). However, the CT scan did not add any visual appeal to the text. Moreover, the leaflet with the CT scan was found less helpful for the understanding of gout than the one with the anatomical picture ( $p = 0.049$ ).

The style of a medical illustration also had a significant impact on the ratings of how helpful the image was for the understanding of gout (see Table 2). The anatomical drawing was reported to be significantly more helpful than the cartoon ( $p = 0.009$ ). There were no significant effects of the image style on other domains of intervention leaflet perception.

### 3.3. Information comprehension

There were no significant differences between the medical illustration and the no image group in the total number of correct answers to comprehension questions Mean difference = 0.24 95% CI [-0.02; 0.49],  $t(202) = -1.81$ ,  $p = 0.07$ . However, participants who saw an illustrated leaflet were significantly more likely to identify urate crystals as the cause of gout attacks and more likely to choose the correct treatment for gout (see Table 3).

There were no differences between the cartoon, anatomical drawing, CT scan and no image conditions in the total number of correct answers  $F(3,200) = 2.07$ ,  $p = 0.11$ . However, the image style had a significant effect on the proportion of correct answers to the question about gout treatment (see Table 4). Multiple comparisons using Chi-square test with Sidak's adjustment indicated that compared to the no image leaflet seeing the cartoon helped participants identify the correct treatment  $X^2(1, n = 102) = 8.84$ ,  $p = 0.018$ . On the other hand, the anatomical drawing or the CT scan did not convey information about gout treatment any better than the text-only material. The differences between the three medical illustration groups were not significant.

### 3.4. Illness perceptions

There were no significant differences between the medical illustration arm and the no image condition in illness perceptions, perceived gout severity or perceived gout stigma (See Appendix B, Table B.1 in Supplementary material). The image style also did not have any significant effects on these variables (See Appendix B, Table B.2 in Supplementary material).

## 4. Discussion and conclusion

### 4.1. Discussion

Although research evidence suggests that the addition of images to patient educational materials can aid understanding of health information, a large proportion of such materials do not contain illustrations. Moreover, what type of illustrations offer the most benefits is still unclear, as it is unclear whether medical scans should be used in patient education. This study contributes to the literature on the role of visual aids and is one of the first modern studies directly comparing various visualisation mediums commonly used in patient education, including medical scans, anatomical images and cartoons.

In line with existing literature [4,20], the results of this study suggest the addition of a medical illustration to the text can improve understanding of health information. On the other hand, pictures had no effects on illness perceptions, illness stigma or perceived illness severity. Out of the three image styles, only the cartoon was better than text without images in conveying information about gout treatment. Those who saw the cartoon were almost two times more likely to correctly respond to the question about treatment for gout, whereas viewing the

**Table 1**  
Demographic characteristics of the sample.

|   | No image (n = 51) | Cartoon (n = 51) | Anatomical image (n = 51) | CT scan (n = 51) | Total sample (n = 204) |
|---|-------------------|------------------|---------------------------|------------------|------------------------|
| Age in years M(SD)                              | 50.2 (18.7)       | 43.9 (15.3)      | 48.8 (17.7)               | 44.7 (17.9)      | 46.9 (17.5)            |
| Gender  |                   |                  |                           |                  |                        |
| Female  | 31 (61%)          | 28 (55%)         | 31 (61%)                  | 34 (67%)         | 124 (61%)              |
| Ethnicity                                       |                   |                  |                           |                  |                        |
| Māori   | 3 (6%)            | 7 (14%)          | 6 (12%)                   | 5 (10%)          | 21 (10%)               |
| NZ European                                     | 25 (49%)          | 27 (53%)         | 23 (45%)                  | 20 (39%)         | 95 (46%)               |
| Other European                                  | 3 (6%)            | 0 (0%)           | 4 (8%)                    | 5 (10%)          | 12 (6%)                |
| Pacific peoples                                 | 3 (6%)            | 3 (6%)           | 0 (0%)                    | 3 (6%)           | 9 (4%)                 |
| Chinese   | 0 (0%)            | 4 (7%)           | 4 (8%)                    | 7 (14%)          | 15 (7%)                |
| Indian  | 13 (25%)          | 7 (14%)          | 11(21%)                   | 7 (14%)          | 38 (19%)               |
| Other   | 4 (8%)            | 3 (6%)           | 3 (6%)                    | 4 (7%)           | 14 (7%)                |
| Education                                       |                   |                  |                           |                  |                        |
| Primary   | 0 (0%)            | 0 (0%)           | 1 (2%)                    | 2 (4%)           | 3 (1%)                 |
| Secondary                                       | 16 (31%)          | 16 (32%)         | 7 (14%)                   | 13 (26%)         | 52 (26%)               |
| Tertiary  | 35 (69%)          | 34 (67%)         | 42 (82%)                  | 36 (71%)         | 147 (72%)              |
| Have been diagnosed with gout                   | 4 (8%)            | 8 (16%)          | 2 (4%)                    | 9 (18%)          | 23 (11%)               |
| Friends or family have been diagnosed with gout | 18 (35%)          | 24 (47%)         | 20 (39%)                  | 27 (53%)         | 89 (44%)               |

**Table 2**  
Effect of the image style on intervention leaflet feedback (One-way ANOVA with post hoc).

|  | No image<br>(n=51) | Cartoon<br>(n=51) | Anatomical<br>Image<br>(n=51) | CT scan<br>(n=51) | Statistic<br>F   | Sig.            | Multiple comparisons, p           |                       |                      |                              |
|--|--------------------|-------------------|-------------------------------|-------------------|------------------|-----------------|-----------------------------------|-----------------------|----------------------|------------------------------|
|  | Mean<br>(SD)       | Mean<br>(SD)      | Mean (SD)                     | Mean<br>(SD)      |                  |                 | Group                             | Cartoon               | Anatomical           | CT                           |
| How visually appealing was the leaflet? (10 - extremely appealing)                                       | 6.3 (2.9)          | 7.7 (2.2)         | 7.9 (2.2)                     | 7.4 (2.1)         | F(3, 200) = 4.62 | <b>0.004</b>    | No image<br>Cartoon<br>Anatomical | <b>0.038</b>          | <b>0.011</b><br>0.95 | 0.14<br>0.90<br>0.62         |
| How helpful was the information leaflet you saw for your understanding of gout? (10 - extremely helpful) | 8.6 (1.5)          | 8.4 (1.6)         | 8.8 (1.3)                     | 8.0 (1.7)         | F(3, 200) = 2.68 | <b>0.048</b>    | No image<br>Cartoon<br>Anatomical | 0.98                  | 1.00<br>0.77         | 0.18<br>0.63<br><b>0.049</b> |
| How helpful was the image for your understanding of gout? (10 - extremely helpful)                       | n/a                | n/a               | 8.0 (2.2)                     | 9.1 (1.2)         | 8.5 (1.7)        | F(2,150) = 4.79 | <b>0.010</b>                      | Cartoon<br>Anatomical |                      | <b>0.009</b><br>0.40<br>0.13 |
| If this information leaflet was in a clinic, how likely were you to read it? (10 - extremely likely)     | 6.6 (2.6)          | 6.8 (2.7)         | 7.2 (2.1)                     | 6.4 (2.9)         | F(3, 200) = 0.83 | 0.48            |                                   |                       |                      |                              |
| How interesting was the leaflet? (10 - extremely interesting)  | 8.0 (1.9)          | 7.9 (1.8)         | 8.1 (1.6)                     | 7.6 (1.5)         | F(3, 200) = 0.86 | 0.46            |                                   |                       |                      |                              |
| How believable is the information in the leaflet? (10 - extremely believable)                            | 8.8 (1.5)          | 8.9 (1.3)         | 9.1 (1.5)                     | 8.7 (1.4)         | F(3, 200) = 0.82 | 0.48            |                                   |                       |                      |                              |
| How easy was it to understand the information in the leaflet? (10 - extremely easy to understand)        | 9.0 (1.8)          | 9.1 (1.2)         | 9.1 (1.3)                     | 8.9 (1.3)         | F(3, 200) = 0.28 | 0.84            |                                   |                       |                      |                              |
| The leaflet made me worry about gout (10 - absolutely true)  | 4.7 (3.3)          | 4.6 (3.0)         | 4.1 (3.4)                     | 4.9 (3.6)         | F(3, 200) = 0.56 | 0.64            |                                   |                       |                      |                              |

**Table 3**  
The proportion of correct answers to the comprehension questions in medical illustration and no image arms (Chi-square test of independence).

| Question                                       | Medical illustration | No image | X <sup>2</sup> (1, N = 204) | Sig.         |
|--|----------------------|----------|-----------------------------|--------------|
| What is the cause of gout?                     | 89%                  | 92%      | 0.44                        | 0.51         |
| What inside the joint does cause gout attacks? | 98%                  | 92%      | 3.99                        | <b>0.046</b> |
| What is the best treatment for gout?           | 52%                  | 33%      | 5.51                        | <b>0.019</b> |
| Is gout a form of arthritis                    | 92%                  | 90%      | 0.19                        | 0.66         |

**Table 4**  
The effect of the style of the medical illustration on the proportion of correct answers to the comprehension questions (Chi-square test of independence).

|  | Cartoon | Anatomical image | CT scan | No image | X <sup>2</sup> (3, N = 204) | Sig.         |
|--|---------|------------------|---------|----------|-----------------------------|--------------|
| What is the cause of gout?                     | 92%     | 90%              | 84%     | 92%      | 2.28                        | 0.52         |
| What inside the joint does cause gout attacks? | 96%     | 100%             | 98%     | 92%      | 5.18                        | 0.159        |
| What is the best treatment for gout?           | 63%     | 45%              | 49%     | 33%      | 9.02                        | <b>0.029</b> |
| Is gout a form of arthritis                    | 96%     | 88%              | 92%     | 90%      | 2.25                        | 0.52         |

anatomical drawing or the CT scan did not improve understanding of gout treatment. This finding corresponds with general recommendations for using simpler visuals in patient education [4]. However, it contradicts with the literature that demonstrated the benefits of using medical scans [8,21]. This discrepancy could be due to differences in research contexts. Commonly medical scans are incorporated into longer face-to-face educational sessions, where scans are explained in detail. In this study, the scan was embedded in an educational leaflet. There was no additional explanation of the scan, and participants read the leaflet without assistance. Therefore, they might have difficulties interpreting such a complex image without the extra information on what CT scans show.

The addition of a medical illustration to the text increased the visual appeal of the material. Moreover, different styles of illustrations had different effects on people's perception of educational leaflets. Both the anatomical image and the cartoon

made the leaflet more visually appealing than the text without images. However, the CT scan did not add visual appeal to the text. The leaflet containing the anatomical image was found more helpful for the understanding of gout than the information with the CT scan. Furthermore, the anatomical drawing itself was rated as more helpful than the cartoon. This preference, however, did not translate into better understanding of information about gout treatment. Further research should explore whether the perception of the educational material can affect people's understanding of the health message, engagement, satisfaction with the material or other important aspects of patient education.

This study has several limitations. Firstly, it did not investigate if positive changes in illness understanding induced by medical images are sustainable over time and if they translate into health behavior. Secondly, the sample was recruited from the general population, and hence the findings may be not generalizable for patient populations. Finally, it is possible that the choice of the images per se determined

the outcomes, and different pictures might have evoked different results. We selected a cartoon, an anatomical drawing and a medical scan to be representative of the illustration styles typically used in patient education materials. However, this list is not exhaustive. More research should look into illustration styles as well as the content of pictures to understand how the benefits of using images can be maximized for patient education purposes.

#### 4.2. Conclusion

Addition of a medical illustration to printed educational material can aid understanding of health information and make it more visually appealing. The style of a medical illustration has an impact on people's perception of the material and can affect information comprehension. Further research is required to identify what images offer consistent benefits for patient education.

#### 4.3. Practice implications

Gout is a chronic form of inflammatory arthritis found in 1–4% of the population in Western Europe and North America [22]. Gout is caused by the deposition of monosodium urate crystals in the joints and soft tissues. Clinically, gout manifests as recurrent attacks of severe joint pain usually self-resolving within 1–2 weeks. An attack of arthritis is followed by a relatively asymptomatic period during which urate crystals can continue to form. Untreated gout can lead to joint damage and disability.

Guidelines of all major professional rheumatology associations recommend the long-term use of urate-lowering therapy to achieve the dissolution of urate crystals and long-term illness control [23–25]. However, adherence to urate-lowering medication has been reported to be suboptimal (10–46% according to a 2014 systematic review) [26].

Despite the substantial evidence of the efficacy of urate-lowering medication for gout management, dietary and lifestyle modifications are often seen as the best treatment both by patients and the general public [19]. While dietary and lifestyle modifications can be beneficial for people with gout, there is no conclusive evidence that these changes can help prevent future gout attacks [27].

In this study, gout was used as an example of a condition where people's knowledge and beliefs about illness management may contradict with medical advice that patients with this form of arthritis may receive. The importance of appropriate patient education explaining gout and treatment for gout has been highlighted in numerous publications in gout education domain [28–30].

The results of the present study suggest that the addition of a simple medical illustration to printed educational material can aid understanding of information about treatment for gout.

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#### Declaration of Competing Interest

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We confirm all personal identifiers have been removed or disguised so the participants described are not identifiable and cannot be identified through the details of the story.

#### Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.pec.2019.09.026>.

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