


Changes in patient perceptions regarding ChatGPT-written explanations on lifestyle modifications for preventing urolithiasis recurrence

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Abstract

Purpose: Artificial Intelligence (AI) imitating human-like language, such as ChatGPT, has impacted lives throughout various multidisciplinary fields. However, despite these innovations, it is unclear how well its implementation will assist patients in clinical situations. We evaluated changes in patient perceptions regarding AI before and after reading a ChatGPT-written explanation.

Materials and methods: In total, 24 South Korean patients receiving urolithiasis treatment were surveyed through questionnaires. The ChatGPT explanatory note was provided between the first and second questionnaires, detailing lifestyle modifications for preventing urolithiasis recurrence. The study questionnaire was the Korean version of the General Attitudes toward Artificial Intelligence Scale, including positive and negative attitude items. Wilcoxon signed-rank tests were accomplished to compare questionnaire scores before and after receiving the explanatory note. A linear regression analysis with stepwise elimination was used to assess variable (demographic data) accuracy in predicting outcomes.

Results: There were significant differences between total negative questionnaire scores pre- and post-surveys of ChatGPT, but not in the positive scores. Among variables, only education level significantly influenced mean score differences in the negative questionnaires.

Conclusions: The negative perception change among urolithiasis patients after receiving the explanatory note provided by the AI chatbot program was observed, evidencing that patients with lower education levels expressed a more negative response. The explanatory note provided by the AI chatbot program could provoke an adverse change in AI perception. Negative human responses must be considered to improve and adapt new technology in health care. Only through changing patient perspectives will upgraded AI technology integrate into medical healthcare.

Keywords

Artificial intelligence, language model, patient knowledge, healthcare, ureterolithiasis

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Introduction

Artificial Intelligence (AI) is a multidisciplinary field combining computer science and linguistics to develop machines that can perform tasks that generally require human intelligence.¹ Large Language Models (LLMs) are an AI breakthrough that enables them to replicate human-like language. They are based on deep learning techniques, such as neural networks, and are trained through extensive data from books, news articles, scientific journals, and other diverse sources. LLMs can generate high-quality text with striking coherence and realism by analyzing and learning patterns or relationships through training data. This process allows them to predict words or phrases likely to appear next in a given context. Understanding and generating language establish LLMs as conducive to various natural language processing fields, such as text classification, chatbots, and sentiment analysis.²

The generative pre-trained transformer (GPT) is an LLM model designed by OpenAI (San Francisco, CA, USA). In November 2022, they launched ChatGPT using GPT-3.5, trained on 175 billion parameter tests.³ Recently, GPT-4 was released with a 170 trillion parameter model size supporting image inputs.³ GPT architecture utilizes a neural network to process natural language and generate responses based on the input's context. ChatGPT's superiority over its GPT-based predecessors lies in its ability to generate refined and highly sophisticated responses in multiple languages based on advanced modeling. In a currently available preprint manuscript, ChatGPT successfully completed all three sections of the United States Medical Licensing Examination.⁴ Despite these impressive results, it is unclear how well ChatGPT will assist patients in clinical situations. Therefore, this study aims to evaluate changes in patient perceptions regarding AI before and after receiving a ChatGPT-written explanatory note.

Patients and methods

Study design

Our institute's ethics committee approved this observational study. Questionnaires were completed through self-survey; the first questionnaire was issued before the explanatory note regarding lifestyle modifications for preventing urolithiasis recurrence, and subsequent questionnaires were provided after receiving the note. ChatGPT wrote the explanatory note (Table 1). The first question was, "Please explain lifestyle modification to prevent urolithiasis recurrence" in English. Each answer from ChatGPT was linked to detailed subsequent questions. All answers were translated into Korean through Google Translate. Our input entailed printing the answers and crafting the explanatory note.

Study population

Participants comprised patients receiving urolithiasis treatment, in which diagnosis was confirmed through computed tomography. All patients were treated with ureterorenoscopy for ureter or renal stone management from April 2023. Inclusion criteria required an age less than 80 but more than 18 years. Exclusion criteria encompassed those unable to understand the explanatory note or check questionnaires.

Data collection

The study questionnaire was the Korean version of the General Attitudes toward Artificial Intelligence Scale (GAAIS-K),⁵ a validated adaptation of the original GAAIS.⁶ After proving their informed consent, patients first completed the GAAIS-K. The explanatory note concerning lifestyle modifications for preventing urolithiasis recurrence was provided upon submission. Then, the second questionnaire was distributed, which surveyed satisfaction regarding the ChatGPT explanatory note.

Statistical analysis

Wilcoxon signed-rank tests were used to compare questionnaire scores before and after supplying the explanatory note. This study's primary outcome measurement was to ascertain score differences in negative questionnaires between pre- and post-explanatory note learning. Sample size calculation was based on the mean difference of negative questionnaires using paired-group sample analysis. The mean difference was 1.29, and the standard deviation was 2.09. We accepted two-sided α -errors of 5% and β -errors of 20% when identifying significant differences. Based on these calculations, this study's post hoc power was 0.825 with a 0.6172249 effect size. A linear regression analysis with stepwise elimination was used to assess predictor variable roles (demographic data included income, education, age, sex, religion, and marriage status) in extrapolating outcome variables (mean differences of positive or negative questionnaire scores). All p values were two-tailed, with $p < 0.05$ considered statistically significant. All statistical analyses were performed using R version 4.2.2 (R Project for Statistical Computing; <http://www.r-project.org/>).

Results

Demographic data and AI questionnaire scores are summarized in Tables 2 and 3. There were significant differences in the summation of negative questionnaire scores between pre- and post-surveys of ChatGPT but not in the positive questionnaire scores. The mean difference of negative questionnaires was increased by 1.3 ± 2.1 , indicating that

Table 1. Questions and ChatGPT responses.

Questions	ChatGPT responses
The first question: What should we do to prevent urinary stones?	<p>To prevent the formation of urinary stones, the following steps can be taken:</p> <ul style="list-style-type: none"> • Drink plenty of water: Staying hydrated helps flush out substances that can contribute to stone formation. Aim for at least 8 glasses of water a day. • Limit salt intake: High salt intake can increase the amount of calcium in the urine, which can lead to stone formation. • Limit animal protein: Consuming a diet high in animal protein can increase the level of uric acid in the urine, which can lead to stone formation. • Limit oxalate-rich foods: High oxalate foods can contribute to the formation of calcium oxalate stones. • Limit high-purine foods: High-purine foods can increase the production of uric acid in the body, leading to stone formation. • Avoid sugar and sugary drinks: Excessive sugar intake can lead to changes in calcium and oxalate metabolism and increase the risk of stone formation. • Maintain a healthy weight: Being overweight or obese can increase the risk of developing stones. • Get enough calcium: A diet high in calcium can help reduce the risk of developing oxalate stones. <p>Consult with a healthcare professional for personalized dietary and lifestyle advice and to ensure proper treatment if a stone is already present.</p>
The second question: To prevent salt intake?	<p>To prevent high salt intake and reduce the risk of urinary stone formation, you can:</p> <ol style="list-style-type: none"> 1. Read food labels: Choose low-sodium options and avoid processed foods that are high in salt. 2. Limit salt at the table: Use herbs, spices, and vinegar to add flavor to food instead of salt. 3. Avoid high-sodium condiments: Soy sauce, Worcestershire sauce, and mustard are often high in salt. 4. Cook at home: Preparing your own meals allows you to control the amount of salt used in cooking. 5. Ask for low-salt options when dining out: Restaurants often use more salt in cooking than necessary. 6. Snack on fruits and vegetables: Processed snack foods are often high in salt. <p>It's important to remember that salt is often hidden in many foods, so be mindful of your overall intake and consider the sodium content of all the foods you eat. Consult with a healthcare professional for personalized dietary advice.</p>
The third question: How can I limit animal protein?	<p>To limit animal protein and reduce the risk of urinary stone formation, you can:</p> <ol style="list-style-type: none"> 1. Choose plant-based protein: Beans, lentils, tofu, and nuts are good plant-based protein sources. 2. Eat fish instead of red meat: Fish is a lower-purine protein source compared to red meat. 3. Limit portion sizes: Eating smaller portions of animal protein can help reduce overall intake. 4. Use low-fat dairy products: Dairy products can be a good source of calcium, but choose low-fat options to reduce the amount of animal protein. 5. Include vegetarian meals in your diet: Incorporating meatless meals into your diet can help reduce overall animal protein intake. <p>It's important to have a balanced and varied diet, including a mix of plant-based and animal-based protein sources. Consult with a healthcare professional for personalized dietary advice.</p>

(continued)

Table 1. Continued.

Questions	ChatGPT responses
<p>The fourth question: How can I limit oxalate-rich foods?</p>	<p>To limit oxalate-rich foods and reduce the risk of urinary stone formation, you can:</p> <ol style="list-style-type: none"> 1. Know which foods are high in oxalates: Foods high in oxalates include spinach, beets, nuts, chocolate, and tea. 2. Vary your diet: Include a variety of foods in your diet and limit foods high in oxalates. 3. Cook foods properly: Boiling, steaming, and baking can reduce the oxalate content of some foods. 4. Choose calcium-rich foods: Eating calcium-rich foods can help reduce the absorption of oxalates in the intestines. 5. Limit processed and packaged foods: Processed and packaged foods often contain high levels of oxalates. <p>It's important to have a balanced and varied diet and to avoid excessive intake of any one type of food, including those high in oxalates. Consult with a healthcare professional for personalized dietary advice.</p>
<p>The fifth question: How can I limit high-purine foods?</p>	<p>To limit high-purine foods and reduce the risk of urinary stone formation, you can:</p> <ol style="list-style-type: none"> 1. Know which foods are high in purines: High-purine foods include red meat, organ meats, and seafood. 2. Limit portion sizes: Eating smaller portions of high-purine foods can help reduce overall intake. 3. Choose low-purine protein sources: Plant-based protein sources such as beans, lentils, tofu, and nuts are low in purines. 4. Include vegetarian meals in your diet: Incorporating meatless meals into your diet can help reduce overall purine intake. 5. Avoid alcohol: Alcohol can increase the risk of urinary stones by increasing the production of uric acid. <p>It's important to have a balanced and varied diet, including a mix of plant-based and animal-based protein sources. Consult with a healthcare professional for personalized dietary advice.</p>
<p>The sixth question: How can I avoid sugar and sugary drinks?</p>	<p>To avoid sugar and sugary drinks and reduce the risk of urinary stone formation, you can:</p> <ol style="list-style-type: none"> 1. Read food labels: Check the sugar content of packaged foods and drinks and choose those with lower sugar levels. 2. Limit processed and packaged foods: Processed and packaged foods often contain added sugars. 3. Drink water: Drink water instead of sugary drinks, including soda, fruit juice, and sports drinks. 4. Eat a balanced diet: Include a variety of fruits, vegetables, whole grains, and lean protein in your diet. 5. Avoid added sugars: Limit added sugars in your diet, such as those found in baked goods, candy, and syrups. <p>It's important to have a balanced and varied diet and to avoid excessive intake of any one type of food, including added sugars. Consult with a healthcare professional for personalized dietary advice.</p>
<p>The seventh question: How can I maintain a healthy weight?</p>	<p>To maintain a healthy weight, you can:</p> <ol style="list-style-type: none"> 1. Eat a balanced diet: Include a variety of fruits, vegetables, whole grains, and lean protein in your diet. 2. Watch portion sizes: Use a food scale or measuring cups to ensure you're eating appropriate portions. 3. Limit processed and packaged foods: Processed and packaged foods often contain added sugars and unhealthy fats.

(continued)

Table 1. Continued.

Questions	ChatGPT responses
	<ol style="list-style-type: none"> 4. Drink water: Drink water instead of sugary drinks, including soda, fruit juice, and sports drinks. 5. Get regular exercise: Aim for at least 30 min of physical activity per day, such as walking, biking, or swimming. 6. Avoid skipping meals: Eating regularly can help regulate hunger and prevent overeating. 7. Get enough sleep: Lack of sleep can disrupt hormones that control hunger and lead to weight gain. <p>It's important to have a balanced and varied diet, as well as engage in regular physical activity and get adequate sleep, for overall health and weight management. Consult with a healthcare professional for personalized advice.</p>
The eighth question: How can I get enough calcium to prevent urinary stone?	<p>To get enough calcium and prevent urinary stone formation, you can:</p> <ol style="list-style-type: none"> 1. Eat calcium-rich foods: Foods high in calcium include dairy products, leafy greens, and fortified foods such as orange juice and tofu. 2. Use calcium supplements: Calcium supplements can be taken to meet your daily calcium needs, but it's important to not exceed the recommended amount. 3. Limit high-oxalate foods: High-oxalate foods, such as spinach, almonds, and sweet potatoes, can interfere with calcium absorption and increase the risk of urinary stone formation. 4. Talk to your doctor: If you have a history of calcium-containing stones, your doctor may recommend a low-oxalate diet and limiting calcium supplements. <p>It's important to have a balanced and varied diet, including calcium-rich foods, and to consult with a healthcare professional for personalized advice on calcium intake and the prevention of urinary stones.</p>

negative emotions, such as worry or wariness relative to the AI, were augmented.

Linear regression was used to identify how demographic factors influenced this mean score difference in the negative questionnaires. However, only education level was deemed significantly influential (Table 4). In this analysis, patients with lower education levels expressed increased negative sentiments after receiving ChatGPT's explanatory note.

In the satisfaction questionnaires (Table 5), approximately 80% of patients replied that the explanatory note helped them understand the disease (agree or strongly agree) and that the sentences were not too awkward (strongly disagree or disagree, 58.3%). However, their confidence in the explanatory note (agree or strongly agree, 66.7%) was lower than the rated helpfulness. There were no correlations between demographic data and satisfaction questionnaire results ($p > 0.05$).

Discussion

After supplying the explanatory note about lifestyle modification to patients who underwent urolithiasis, we surveyed attitude shifts regarding AI. ChatGPT provided detailed advice to improve lifestyle adjustments for preventing urolithiasis. However, negative attitude scores increased among patients, revealing a rising trend in negative perception. This trend was influenced by education level,

establishing that patients with lower education levels will likely express more negative emotions after reading ChatGPT's explanatory note. Nonetheless, patients replied that the explanation note reinforced their understanding of the disease, although they did not harbor enough confidence in this type of explanatory note.

AI development has impacted people's lives in transportation, health, science, finance, and the military.⁷ AI programs employ human-like language to overcome the "uncanny valley" impression, which remains a challenge yet to be resolved.^{8,9} Concerning the medical field and their own health, some humans opposed replacing human doctors with medical AI.¹⁰ Lower education levels correlated to a negative likelihood of AI improving an individual's health,¹¹ potentially due to a lack of technological understanding and fear of job security.¹² Different perceptions between highly and less educated people significantly influence AI program development and adoption. Therefore, AI programs assisting the medical field must consider individuals with lower education levels by implementing a more user-friendly interface and providing clear information.¹³

Urolithiasis recurrence rates were 26% at 5 and 35% at 10 years post-initial diagnosis.¹⁴ Recurrent urolithiasis can burden patients' physical and mental aspects.¹⁵ However, dietary or behavioral risk factors potentially exacerbate stone formation engendered by supersaturation,

Table 2. Patient's demographics.

Demographics	Patients number	Percentage (%)
Sex		
Female	12	50
Male	12	50
Marriage		
Yes	19	79.2
No	5	20.9
Religion		
Yes	16	66.7
No	8	33.3
Education		
Elementary	1	4.2
Middle school	5	20.8
High school	11	45.8
College	5	20.8
Graduate school	2	8.3
Income		
<2000\$	7	29.2
<4000\$	9	37.5
<6000\$	6	25.0
<8000\$	1	4.2
>8000\$	1	4.2

nucleation, crystal growth, and aggregation.¹⁶ Therefore, lifestyle modifications to reduce risk factors may be the most effective strategy in preventing urolithiasis. According to recent guidelines,¹⁷ sufficient fluid intake and maintaining urine output to 2.0–2.5 L/day were recommended. Furthermore, excessive dietary oxalate may increase urolithiasis risk.¹⁸ Although multicomponent dietary interventions were heterogeneous, low protein and sodium and non-poor calcium may reduce recurrence¹⁹; obesity is also considered a urolithiasis risk factor.²⁰ Therefore, lifestyle adjustments to avert urolithiasis onset are vital for urolithiasis patients.

Unfortunately, daily lifestyle modifications can be challenging for patients, but new technology could offer new opportunities to maintain efforts. Behavioral adjustment techniques applied through smartphone, tablet, or computer applications could facilitate self-monitoring and goal setting.²¹ These mobile healthcare applications have already expanded areas such as diabetes, obesity, antismoking, stress management, and depression.²² In addition, platforms such as YouTube further influence patient lifestyles, as does the excessive disease information flooding the internet.²³ AI programs like ChatGPT can summarize data into key points without expending considerable time or effort.

However, whether these briefs can be trusted is another matter. Because circulating online data sources have not been verified, errors may occur during the recapitulations. AI programs provide answers by collecting web information statistically closest to the correct answer, but this answer may be incorrect. Last February, Google's new chatbot Bard was based on the LaMDA LLM and delivered incorrect answers, diminishing Google's stock. Thus, future developments may require authoritative verification to refine AI chatbot reliability.

Nevertheless, AI chatbot programs could aid in low-complexity tasks and facilitate the information flow.²⁴ In the clinical field, AI chatbots can summarize clinical information, medical documentation, insurance company letters, patient education, and scheduling,²⁴ improving physician efficiency by reducing simple and repetitive labor. In addition, AI chatbots are similar to high-quality medical databases and can provide solid recommendations with high-level evidence.²⁵ These programs could also ascertain evidence for writing articles by completing a case report's outline, drafting, and conclusions.²⁶ The AI chatbot renaissance could resolve current limitations in the near future.

However, modern AI chatbots cannot replace a real doctor. AI hallucination is a primary concern, in which an AI provides a confident response that does not seem to be justified by its training data. Upon reference checking, some references were invalid or never surfaced,²⁷ potentially fostering adverse effects on decision-making and leading to ethical and legal issues. In addition, AI output depends on training data; thus, accurate data effectuate accurate results. Data is still primarily manually produced by humans, but someday AI will automatically fill in records. Nonetheless, regarding risk management, advanced AI chatbot programs would alleviate physician burden and encourage scientific progression.

This study does acknowledge some limitations. First, a larger subject pool and specific disease entity are needed for patient generalizations. However, we verified that the AI chatbot program could refashion AI impressions from urinary stone patients, a disease in which lifestyle adjustments are critical. This study evidences that AI chatbots can be implemented for medically assisting patients in the future. Second, this study used GPT-3.5; GPT-3.5 is

Table 3. Scores pre- and post-survey regarding the ChatGPT explanatory note.

		Pre-survey	Post-survey	<i>p</i> -Value
AI questionnaire	1	4.0 ± 0.5	4.4 ± 0.5	0.002
	2	2.6 ± 0.8	2.5 ± 0.9	0.705
	3	3.7 ± 0.9	4.1 ± 0.5	0.026
	4	3.6 ± 0.9	4.0 ± 0.7	0.02
	5	3.1 ± 0.9	2.7 ± 0.6	0.013
	6	3.7 ± 0.9	4.0 ± 7.8	0.021
	7	2.0 ± 0.8	2.1 ± 0.6	0.527
	8	2.9 ± 1.2	3.0 ± 1.2	0.681
	9	2.3 ± 0.9	2.4 ± 1.0	0.448
	10	3.8 ± 0.8	4.0 ± 0.6	0.132
	11	4.1 ± 0.6	4.2 ± 0.7	0.257
	12	4.0 ± 1.0	4.2 ± 0.5	0.577
	13	4.2 ± 0.6	4.3 ± 0.4	0.48
	14	2.8 ± 1.1	2.7 ± 1.3	0.796
	15	3.6 ± 0.9	3.7 ± 0.8	0.457
	16	3.9 ± 0.8	4.2 ± 0.7	0.107
	17	3.6 ± 1.2	3.4 ± 1.2	0.248
	18	2.5 ± 1.0	2.5 ± 1.1	0.963
Total	Positive	40.3 ± 4.5	41.2 ± 4.3	0.216
	Negative	20.0 ± 2.4	21.3 ± 2.3	0.009
Score differences	Positive	0.88 ± 2.8		
	Negative	1.3 ± 2.1		

Table 4. Associated factors for mean score differences in negative AI questionnaires; multivariate linear regression analysis.

Mean score differences in negative AI questionnaires			
Factor	$\beta \pm SE$	<i>p</i> -Value	Adjusted R^2
Multivariate analysis for entered methods with stepwise elimination			
Intercept	4.198 ± 1.33		
Education	-0.943 ± 0.412	0.032	0.155

Table 5. Satisfaction questionnaires for the explanatory note by ChatGPT.

Questions	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
The explanatory note by ChatGPT helped further my understanding about the disease.	0	0	5 (20.8%)	16 (66.7%)	3 (12.5%)
The explanatory note sounded confident.	0	0	8 (33.3%)	14 (58.3%)	2 (8.3%)
The explanatory note sentences were awkward.	2 (8.3%)	12 (50%)	8 (33.3%)	2 (8.3%)	0
I would like this type of explanatory note by ChatGPT in the future.	2 (8.3%)	2 (8.3%)	6 (25%)	10 (41.7%)	4 (16.7%)

limited as it only considers information up to 2021, whereas GPT-4 is trained on newer data. GPT-4 demonstrated an improved understanding of complex surgical information compared to GPT-3.5.²⁸ However, GPT-3.5 results were reliable as urinary stone preventions have primarily stayed the same. Third, we did not validate the Korean translation by the Google translator. Most ChatGPT training data was in English, and translation into other languages is challenging. However, the Google translator used displayed acceptable performance in translating highly academic writings.²⁹ Lastly, we only confirmed short-term changes in AI perception, not long-term lifestyle changes.

Conclusions

Our study investigated perception changes in urolithiasis patients after receiving an explanatory note provided by an AI chatbot program. Patients with lower education levels will likely express negative impressions after learning from the explanatory note. In addition, most patients expressed unmet needs for disease understanding. For improving and adapting the new technology in healthcare, negative human responses must be considered. Improving patient perception will enable upgraded AI technology to integrate into medical healthcare.

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