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A Possible Role for Structured Water Utilizing Nanotechnology in Preventing Recurrent Urinary Tract Infections

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Abstract

Background and objectives: With increasing antimicrobial resistance, high costs, and antibiotic side effects, non-antibiotic options for preventing recurrent urinary tract infections are being explored. This study assessed the effectiveness of nanotechnology-structured water versus regular bottled water and low-dose Trimethoprim.

Methods: A randomized, double-blind, placebo-controlled clinical trial was conducted in Sulaimani city with 300 women who had previously received antibiotic treatment for recurrent urinary tract infections. The participants were divided into three groups: Group M (n=117) received nanotechnology-structured water for 12 months and placebo tablets for six months, administered daily. Group T (n=123) was given 100 mg of Trimethoprim daily for six months and ordinary bottled water for 12 months. Group O (n=109) received only ordinary bottled water for 12 months and placebo tablets for six months. Urine samples were collected at the study's start, during infection episodes, and at the end for urinalysis and cultures.

Results: Antibiotic-treated recurrent urinary tract infections occurred in 29% of participants, varying frequency across groups. Recurrence rates in Groups M and T were similar but significantly lower than in Group O. The time to the first recurrence differed notably among groups, with Group M (nanotechnology-structured water) showing an average of 169.44 days, surpassing Groups T and O. Group M had 9%, Group T 15%, and Group O 63% infections.

Conclusion: Nanotechnology-structured water shows potential as a preventative measure against recurring urinary tract infections, offering an alternative to costly medications with undesirable side effects.

Keywords: Antibiotic Prophylaxis, Nanotechnology Water, Recurrent Urinary Tract Infections

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Introduction

Urinary tract infections (UTIs) are the second most prevalent bacterial infection, which is more common in women than men. A recurrent infection will occur within three to six months of 25–35% of the initial episodes of urinary tract infections (UTIs), with a higher recurrence rate.[1] Low-dose antibiotic therapy administered intermittently or continuously has been used to treat and prevent recurrent UTIs. Alternative non-antibiotic prevention of recurrent UTIs is being sought after due to the growing resistance to antimicrobial agents, the significant financial burden, and the adverse effects of antibiotics.[2] Nanotechnology-produced structured water is a unique drinking water with unique properties that set it apart from regular water. It was created by applying various energy fields and electromagnetic fields. Nanowater is water that has undergone molecular modification to create smaller clusters of water molecules. Larger clusters of water molecules (H2O) connected by hydrogen bonds make up conventional water. These clusters are smaller in Nanowater, frequently consisting of smaller-than-normal water structures such as tetrahedral or hexagonal formations. The elements that make Nanowater include more compact water clusters and a decrease in the tendency of water molecules to group, frequently creating smaller, more stable structures—also enhanced Hydrogen Bonding: Modifications that give the water more structure by altering the hydrogen bonding network. Lastly, enhanced Solubility: Due to the changed molecular arrangement, minerals and other substances are more soluble.[3] The unique composition of Nanowater is believed to enhance water quality, potentially leading to several health benefits. These include improved hydration, as the smaller molecular clusters in Nanowater can more easily pass through cell membranes, thereby enhancing cellular hydration and the efficiency of waste removal and nutrient transport. Research suggests that Nanowater has a higher antioxidant potential than other substances. It can effectively neutralize dangerous free radicals, reduce oxidative stress, and potentially lower the risk of inflammation and chronic illnesses. Nanowater also has the potential to enhance detoxification by binding to heavy metals and toxins more effectively, thereby promoting healthy liver and kidney function. It shows it induces better Circulation: Because Nanowater is said to have a lower viscosity, blood flow may be enhanced, resulting in more effective delivery of nutrients and oxygen to tissues and organs.[4,5] The study aimed to assess the effectiveness of water structured with nanotechnology compared with continuous low-dose trimethoprim combined with bottled water to prevent recurrent urinary tract infections.

Patients and methods

A randomized, double-blind, placebo-controlled clinical trial is being place. The study involved (437) women with two or more UTIs in the previous six months or three or more UTIs in the last 12 months were recruited. The study was conducted from September 2014 to April 2017 in Sulaimani Teaching Hospital. We conducted comprehensive interviews with all patients to provide them with detailed information and obtained patients' consent by having them sign an informed consent form. Those patients had previously been advised on rUTI prevention by risk factor avoidance, non-antimicrobial methods, and eventually antimicrobial prophylaxis. Any urological risk factors must be identified and addressed. To remind those women about counteract measures to minimize the risks for rUTI, behavioral and personal hygiene measures such as (reduced fluid intake, chronic and post-coital delayed urination, wiping from back to the front after defecation, douching,

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and wearing occlusive underwear) are mentioned again. According to the established criteria, non-antimicrobial interventions were used to avoid rUTIs before study enrolment.[6,7] Hormonal replacement therapy with vaginal estrogen was considered for postmenopausal women. All patients who volunteered to participate in the trial were randomly assigned to one of three groups based on the CONSORT randomization guidelines. A simple randomization process was carried out using computerized random numbering software. All patients received continuous low-dose prophylaxis for prolonged periods (three to six months) or post-coital prophylaxis, as both reduced the rate of rUTIs. The antibiotic trimethoprim 100 mg once daily was chosen. All patients chose continuous low-dose prophylaxis over post-coital prophylaxis because they could not guarantee remembering to take post-coital prophylaxis and would miss such a regimen. They also demonstrated low compliance for self-administered short-term antimicrobial therapy. Patients meeting the criteria (n=349) aged (24-79 years) were divided into three groups: group M (n=117) received nanotechnology structured water and placebo tablets, group T (n=123) received Trimethoprim and ordinary bottled drinking water, and group O (n=109) who received ordinary bottled drinking water and placebo tablets. All patients were instructed on how to provide a urine specimen to minimize the chance of contamination. At the start of the study, midstream urine samples were taken for urinalysis and urine cultures. Later, when the participants developed a urinary tract infection, samples were retaken to confirm the infection and choose the appropriate antibiotics based on culture and sensitivity results. Finally, after the study, urine samples were taken (at the end of the 12th month). Any breakthrough infection should be treated according to culture and sensitivity results. Inclusion criteria required patients to have experienced two or more UTIs in the last six months or three or more UTIs in the previous 12 months. Patients were excluded if they had co-morbidities or conditions that could affect the urinary tract or their immunity, including immunotherapy, radiotherapy, malignancy, steroid use, chronic infections, chemotherapy, or immunosuppressive drugs. Patients with anatomical or surgical urinary tract abnormalities detected through history, physical examination, ultrasound, or renal function tests were excluded. Patients in Group M were given nanotechnology-structured water and a placebo tablet. Nanotechnology Structured Water, branded as Magnalife, is a specially treated form of water that alters its molecular structure to enhance health benefits. In Group T, they were given low-dose continuous antimicrobial prophylaxis in a single daily dose of 100 mg of Trimethoprim as a positive control group; also, they were given ordinary bottled drinking water. In contrast, group O was given ordinary bottled drinking water and placebo tablets as a negative control. The bottles were the same shape and not labeled to avoid bias in the study. Additionally, the tablets (trimethoprim and placebo tablets) were the same shape and color and were in similar containers when given to the patients. They were then told to drink provided water bottles in a daily dose of twenty milliliters for each kilogram of body weight and to take one tablet daily. The investigator instructed the subjects to maintain their usual eating, drinking, and physical activities. They were asked to continue taking their meds as usual. All patients were requested to come in if they had a symptomatic UTI at the end of the twelfth month of their participation. Genitourinary symptoms in urinary tract inflammation are evidenced by pyuria and a documented microbiologic pathogen by urine culture of 105 colony-forming units (CFU) /mL is required to diagnose symptomatic

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UTI. UTI symptoms include dysuria, frequency, urgency, suprapubic discomfort, and hematuria.[8] Based on the urine culture results, any patient who developed UTI during the study was given the necessary antibiotic and reported as infected in that group's data. Neither the investigator nor the patients were aware of the group of patients. Each patient was given a code, which was kept in a record to maintain the double-blind status of the study. At the study's end, all codes correlated with assigned treatment groups.The trial (NCT04306731) was filed on ClinicalTrials.gov. The University of Sulaimani's College of Medicine Ethics Committee approved the current study. All individuals gave informed consent.The statistical analysis of the study was performed using SPSS version 24. The data were coded, tallied, and presented descriptively. The analysis involved inferential data techniques, including descriptive statistics such as frequency, percentage, mean, standard deviation, and the Chi-square test. The significance of the test results was assessed using probabilistic criteria based on the P-value. Specifically, a P-value of less than 0.001 was considered highly significant, less than 0.05 was considered significant, and greater than 0.05 was deemed non-significant. A P value of less than 0.000 was also considered highly significant.

Results

At the end of the study, only 300 patients had been evaluated and followed up on. Those 300 patients were observed for twelve months. Just 87 (or 29%) of the 300 study participants had antibiotic treatment for a UTI. Only nine patients (9%) had antibiotic-treated UTIs in group M. In Group T, 15 patients (15%) had UTIs; in Group O, 63 patients (63%) had UTIs during the follow-up period, as shown in Table (1).

Table (1): shows the number of patients with recurrent UTIs and those with no UTIs in all groups during the 12 months of follow-up.

Group	Recurrent UTIs N %	No recurrent UTIs N %	Total number of patients
Group M	9 9 %	91 91 %	100
Group T	15 15 %	85 85 %	100
Group O	63 63 %	37 37 %	100

The number of patients with recurrent UTIs in Group M and Group T was not significantly different (p=1.92). In contrast, the number of patients in Group M and Group O differed significantly (p<0.001). Also, the number of patients in groups T and O was significantly different (p<0.001). For groups M, T, and O, the mean duration until the first UTI recurrence was 169.44 days, 160.07 days, and 121 days, respectively. Regarding the interval between the first UTI recurrence and the other three groups, there was a significant difference (p<0.001). Table (2) illustrates that, in contrast, the difference between groups M and T was not statistically significant (p=2.15).

Table (2): shows the mean time to the first recurrence of UTIs in days with the standard deviation.

The mean duration in days until the first UTI with the standard deviation	The mean duration in days until the first UTI with the standard deviation	T test	p value
Group M = 169.44 ± 12	Group T = 160.07 ± 10	1.75	P=2.15 non-significant difference
Group M = 169.44 ± 12	Group O = 121 ± 15	5.98	p<0.001 significant difference
Group T = 160.07 ± 10	Group O = 121 ± 15	4.91	p<0.001 significant difference

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Discussion

To our knowledge, this is the first study in Sulaimani Province to test the effects of nanotechnology-structured water on preventing recurrent urinary tract infections (UTIs) in females and to apply it in urology. Out of the three groups of patients, the structured water group had the lowest number of urinary tract infections. This can be explained by the fact that structured water differs from ordinary water because it has different physical characteristics, less surface tension, and other biological capabilities. This study observes that these differences account for the water's higher prophylactic effects. The trimethoprim group's results were comparable to those of the group receiving the Nanowater. It was slightly higher in the prevention category, though, which could be explained by the theory that the trimethoprim group might develop bacterial resistance, resulting in a slight increase in infection cases. Also, it may be attributed to the duration of the prophylaxis, which is 12 months of nanotechnology-structured water compared to 6 months of trimethoprim. Many studies have been carried out to investigate the effects of magnetic fields on biological tissues, including water. A study used ferrite magnets to create a magnetic field to examine the biological effects of the field on three different species of bacteria: Escherichia coli, Staphylococcus aureus, and Streptococcus mutans. When Streptococcus mutans and Staphylococcus aureus were cultivated under anaerobic conditions, there was a strength-dependent decrease in growth rate and maximum number of bacteria.[9]Another study found that magnetized water is as effective as mouthwash against Streptococcus mutans and has more excellent preventative activity against plaque than saliva. The study concluded that it can be used as an adjunct to commercially available mouthwashes. Furthermore, because magnetized water is alkaline and Streptococcus mutans are anaerobic, its alkaline property prevents anaerobic bacteria from growing, thereby reducing their count.[10] A study on how drinking magnetized water affected blood parameters revealed that it resulted in considerably greater WBC, lymphocytes, IgG, and IgM levels than those drinking regular water.[11] This may possibly explain the low rate of recurrent UTIs in our study. In another study, consuming magnetized water for four weeks preserved pancreatic cells while increasing insulin expression and antioxidant status in type 2 diabetic rats.[12] The effect of magnetized water on multidrug-resistant (MDR) Pseudomonas aeruginosa was investigated. It was revealed that exposure to magnetic water reduced the number of bacterial cells and increased the percentage of Pseudomonas aeruginosa death while reducing the ability to form a biofilm, resulting in biofilm formation loss.[13] On the other hand, increasing water intake has beneficial effects on the urinary tract, such as prevention and treatment of UTI.[14] Furthermore, increasing water intake will be an effective antimicrobial-sparing strategy that prevents recurrent cystitis in premenopausal women at high risk for recurrent UTIs because of their low daily water intake.[15] The results of group T were 15% recurrent UTIs, which is near to the results of other studies, which are 20.5% of UTIs in the trimethoprim group, and this little difference may be explained by the age group of their research, which was conducted among older age women. The mean time to the first UTI recurrence in group T was 160.07 days compared to the mean time to the first UTI, which is 91 days in the trimethoprim group in Marion et al. study. The discrepancy could be attributed to the age group difference; in their study, older women chose to take the median rather than the meantime.[16] In this study, nanotechnology structured water proved to

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be as effective as Trimethoprim in preventing UTI, and the results were similar to a study that indicated that magnetized water as an irrigant in root canal disinfection is as adequate as sodium hypochlorite in reducing or eliminating bacterial load in the canals.[17] This study's strength is its rigorous design, including a randomized, double-blind, placebo-controlled trial with 300 participants. It demonstrates for the first time that nanotechnology-structured water significantly reduces recurrent urinary tract infections compared to conventional treatments.This study has limitations because it only involved a few participants, and no long-term follow-up was performed. Furthermore, it involved a single antimicrobial agent, which might have different prophylactic effects on structured water.

Conclusion

Nanotechnology-structured water presents a promising approach to prevention against recurrent UTIs. This technique may provide an alternate method for people with recurring UTIs to treat their infections without the need for costly medications with adverse side effects. However, further studies are recommended to assess the effects of long-term use of this structured water.

Conflict of interest

None declared

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