

## Original Article

# Comparing the efficacy and safety of different medications used to treat overactive bladder in various patient demographics

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### Abstract

**Background:** OAB is one of the most common problems which are associated with symptoms like urgency, frequency, and incontinence affecting patients' quality of life. Pharmacological therapy that targets OAB includes various medications including anticholinergic drugs, beta-3 agonists among which each has its specific action profile and side effects. Hence, while these treatments can be administered, the knowledge gap on the effectiveness and side effects of these treatments for patients of different demographics persists.

**Aim:** The goal of this work is to evaluate outcomes in treatment of OAB using different medications – oxybutynin, tolterodine, solifenacin and mirabegron with comparison of effectiveness and safety in different subgroups of patients depending on age, gender and comorbidities.

**Method:** This present comparative study used new RCT, meta-analysis, and observational studies. Studies were informed of clinical trials, patients' documents, and pharmacovigilance databases. Regarding the inclusion criteria, the relevance of the effects on the efficacy and safety of the medications in different populations was investigated. Characteristics of patients were compared using ANOVA and regression analysis to compare and examine the outcomes with the help of SPSS and R software.

**Results:** In the reviewed study it was established that oxybutynin and tolterodine provide good relief from OAB. However, they pose distinct side effects especially in patients from the geriatric population. Solifenacin has comparable effectiveness to alogliptin with less harm to patients' physical well-being. This is a beta-3 adrenoceptor agonist that offers symptom control with different risks as compared to the previous option, which is hypertension. Also, efficacy and safety were significantly affected by patient characteristics, including age and comorbidity status. The survey also gathered qualitative information from patients and healthcare workers describing definite implementation dilemmas and usage experiences of these drugs.

**Conclusion:** The findings of this study provide a general support for the practice of personalized medicine in the treatment of OAB. Adjusting treatment options to a patient's characteristics will help enhance the chance of a positive outcome while reducing the likelihood of side effects. Research result adds to the existing pool of knowledge regarding the efficacy of various medicines in different population groups, which is informative for tasks of medical practice and public health legislation.

**Keywords:** Overactive Bladder, OAB, efficacy, safety, anticholinergics, beta-3 agonists, patient demographics, personalized medicine

## Introduction

Overactive Bladder (OAB) is defined as the complaint of bothersome urinary urgency, and may also include urge incontinence, and usually frequency, and nocturia. In many aspects it has an influence on the patients' life, it changes their routines, restricts communication and affects the mood and emotions. OAB is a very common ailment that presently impacts millions of people globally and it has higher prevalence especially in the geriatric population. The cost of OAB is high since it impacts the social and working abilities of affected persons in addition to incurring high charges towards the definite demand of medical facilities and lost production. A drug regimen is the mainstay of OAB treatment directed at relieving symptoms and enhancing the patient's quality of life. The classes of drug which are most frequently applied are anticholinergic ones and beta-3 agonists. Oxybutinin, tolterodine, solifenacin are used to block the muscarinic receptors in the bladder to decrease the contractions of the bladder wall. These medications are commonly administered and effective in controlling mature urge and the number of urinations per day. Still, the potential application is restricted by side effects like dry mouth, constipation, and cognitive impairment, especially in elderly patients [1].

Mirabegron, for instance, falls under the newest category of beta-3 agonists that targets the receptors in the bladder thus enhancing the muscle relaxation resulting in increased capacity of the bladder. Mirabegron is considered well tolerated with fewer side effects that are related to the anticholinergic class, making the agent a good option for patients with side effects or contraindications to use of anticholinergics. Nonetheless, beta-3 agonists are associated with hypertension and are best avoided in patient diagnosed with severe uncontrolled hypertension. The reasons to review the effectiveness and side effects of OAB [2] medications depending on the patients' characteristics are the dissimilar manifestations of the disease and treatment outcomes in clinical practice. However, It should also be remembered that other aspects like age, gender, presence of other diseases may affect both the effectiveness and side effects of OAB medications. For example, the adverse effects of anticholinergics are known may be worse in older patients, while newer patients benefit from the use of anticholinergics. Likewise, it should be noted that common diseases like diabetes, cardiovascular disease or cognitive

impairment also affect the choice of therapy and prognosis. It is thus significant to comprehend these demographic differences to support the concept and practice of the use of characteristics of patient's Population in giving out treatment to gain maximum advantages and minimum harm [3].

Hence, there are evident research gaps when it comes to the range of medications available for OAB. The majority of clinical trials involve the majority of the adult population leaving out elderly and those with compromised health. Therefore, there is scarce evidence on the effectiveness and tolerability of OAB medications in these subgroups of patients. Additionally, there is a lack of studies directly comparing various OAB medications, which might significantly limit the clinician's ability to choose the most appropriate treatment for the given patient. Moreover, there is a general deficit of real-world data regarding the long-term efficacy and safety of OAB medications as well as patients' adherence to the therapy, which is crucial for evaluating the long-term outcomes of the treatment of chronic disorders. The goals of the current study are to ascertain how effective the drugs for OAB syndromes are and how complaisant they are within different age and gender factors and concomitant diseases. Therefore, while this study will systematically review the currently available evidence and perform subgroup analysis to establish the effectiveness and side effects of each drug in the patients' [4]subpopulation, it will go a long way in helping researchers and clinicians find the most effective medications for the given ailments. They come handy to indicate which treatment strategies to employ in order to enhance the operation of a health care facility with a focus on the improvement of the lots of a health consumer [5].

Towards this end the paper shall use both experimental research designs such as randomized controlled trials and non-experimental research designs such as observational research studies and meta analysis. A variety of data will be retrieved from clinical trials, patients' medical records, and pharmacovigilance sources [6]. The exposure of patients to OAB medications will also be compared with the demographic subgroups and the safety and effectiveness of medication in each group will be examined. Specifically, efficacy will be determined from changes in the frequency and magnitude of the reported urinary incontinence episodes and urgency, and changes in the frequency of micturition, and an

improvement in the quality of life of the patients when controlled for safety outcomes. The implications of the research presented in this paper will be vital for the daily clinical practice as well as for the healthcare policy. Through the presentation of sound data regarding the effectiveness of OAB medications, the study will assist clinicians in arriving at specific treatment decisions based on a patient's characteristics. In this way, the outcome of the proposed individualization approach is the possibility to achieve maximum therapeutic efficacy, and, at the same time, minimize potential side effects that may harm patients and lead to low perceived quality of received treatment and, therefore, to the poor compliance. Also, the study will educate healthcare policymakers [7] on the safest and ideal treatment

### Methodology

The above study procedure involves comparative assessment of all the medications prescribed for the treatment of Overactive Bladder (OAB) in terms of safety and efficiency. Namely, it uses RCTs, meta-analyses, and observational studies to evaluate the effectiveness of the medications in consideration of patients' characteristics that were not fully controlled in the trials [9].

The effectiveness and safety of OAB medications have been compared in observational studies only; therefore, this work utilizes both RCTs and meta-analysis. RCTs are highly regarded for their internal validity as they randomly assign participants to the various treatment groups thus reducing rxTion bias and enabling clean etiological inferences on the efficacies of the various treatment interventions. Meta-analysis is used in order to combine the results of several RCTs and observational studies, which provide a view on the medication performance in various contexts and in different population. Data from observational studies supplement this as they include mere reports of day to day use of medications, patients' compliance, and over time effects [10].

Each of these drugs is used to treat OAB, and the review takes into consideration the following drugs: oxybutynin, tolterodine, solifenacin, M3 receptor antagonist, and mirabegron. Oxybutynin and tolterodine are drugs that belongs to the anticholinergic group that affects the muscarinic receptors in the bladder and specially intended to reduce the symptoms of urgency and frequency. Solifenacin is another anticholinergic which also has similar therapeutic value but with possibly fewer side

modalities for various patients to enhance formulation of coherent guidelines and policies regarding the management of OAB. Consequently, this work tries to fill the latter gap in the literature by presenting a systematic review of the effectiveness and side effects of OAB drugs in patients of different age, gender, and ethnicity. The findings will provide improved direction on the patterns of effects that different factors have on the treatment of OAB which will consequently enhance the manner in which the condition is managed. Since OAB is becoming more common, and crucial for the older population, consequently, this study is relevant and crucial for enhancing the quality of life of millions of sufferers [8].

effects. Mirabegron, a beta-3 agonist, acts on the smooth muscle of the bladder and its wall, thus increasing its capacity to hold urine through bladder relaxation; it is a good option for patients experiencing and who cannot withstand side effects associated with anticholinergic agents [11].

To strengthen the data collected for the study, the following sources are used; Clinical trials give original information on the effectiveness and safety of medications and include randomized controlled trial and cohort studies. Improving patient records from healthcare facilities give an actual picture of the effectiveness of the treatments and associated side effects. Information about adverse drug reactions submitted to databases of pharmacovigilance are used with. Specific criteria applied in the inclusion of the studies are those that provide information on the drugging for the efficacy and safety of the medications within a given demography of the patient group. This reduces the number of papers or investigations for inclusion and removes studies that do not feature satisfying data quality, combined endpoints, incomplete results, or diseases unrelated to the medications or events of focus [12].

Depending on demographic affinities, the study divides the patient population into different demographic subgroups for further examination. These are the age: young adults, middle aged, elderly; and gender: male and female; comorbidity includes diabetes, cardiovascular disease, and cognitive impairment. The sample size is determined by the fact that there is a requirement to obtain adequate statistical significance to compare medications within the various categories of populations. This entails use of

power analysis and the factors it involves include the effect size, variability in the outcomes and the level of significance [13].

Ethics is an important factor taken into consideration starting from the study. It is also important to ensure that the research meets all the laid down ethical standards and requirements governing research and as a result various ethical review boards give their approvals. Patients' permission is sought for all experiments carried out during clinical trials, and patient identity is concealed during data collection and analysis with compliance to data protection laws. For observational and meta-analytical components, ethics are always to guarantee proper consent for using secondary analysis data and data sharing.

Several dependent variables are explored in the study among them being efficacy and safety results. While efficacy is the core determinant of LUTS/bph therapy, the focus is on counting of UI episodes, changes in urinary urgency and frequency, and finally the enhanced quality of life according to patients. Safety is measured with the rate of side effects and their seriousness which includes for anticholinergics dry mouth and constipation; for beta-3 agonists hypertension. Independent variables include type of medicine and comparison is easy between different medications; patient characteristics do enable understanding of how treatment result may differ depending on the characteristic of the patient [14].

statistics analysis uses different methods to analyze the collected data towards arriving at the results. Analysis of Variance (ANOVA) applies when comparing outcome measures concerning efficacy and safety of different medications. Regression analysis assists in determining the effects of independent factors such as the type of medication and the patient's characteristics on the outcome factors. Subgroup analysis is performed to compare the efficacy of the medications with respect to various demographic criteria, which offers valuable information regarding how age, gender and the presence of other conditions affect treatment results. These studies are usually carried out using certain statistical software like; SPSS and R, which are efficient and accurate. These tools enable the strength of the hypothesis, confidence interval analyses and the interaction effects to be established.

In summary, this methodology provides the most critical aspects of a sound evaluation of OAB medication in terms of efficiency as well as a cure,

alongside the real-world data based on high-quality randomized trials and more sophisticated analytical instruments. The approach is relevant to the evaluation of treatments be it regarding their effectiveness or side effects, within different patient populations, thus offers key information regarding how to manage OAB optimally to enhance patient satisfaction.

## Results

Through the study, the effectiveness/safety of various medications used for managing OAB has been established together with the performance comparison of these drugs across the various OAB patient groups. The statistics presented below vividly illustrate that the examined drugs may differ quite significantly in terms of both effectiveness, and side effects. Oxybutynin, tolterodine, solifenacin, and mirabegron are all effective to a certain extent, in decreasing the number of UI episodes, urinary urgency, and frequency. Oxybutynin and tolterodine which belong to the group of anticholinergics help alleviate these symptoms, although with undesirable side-effects like dryness of the mouth, constipation and memory impairment which makes the patient intolerant to the medicine, especially the elderly patients. In this case, solifenacin is as effective as oxybutynin and tolterodine with lesser side effects that are associated with the two medications. A beta-3 agonist mirabegron has an advantage over oxybutynin in terms of efficacy in increasing bladder capacity and the decrease of urgency, but it has different side effects such as hypertension and headache [15].

The patients' efficacy is shown to vary across the patient characteristics. In many cases, older adults have a better response to mirabegron in terms of efficacy of the drug, specifically regarding the symptoms, yet with significantly lesser effects on the cognition as compared to the anticholinergics. For the younger patients, both anticholinergics and beta-3 agonists effectively relieve the concerned symptoms; however, the younger patients can better tolerate anticholinergics. Gender differences are less significant with regards to the effectiveness of the treatment, but patients of the female sex can have different side effects compared to male patients. Conditions like diabetes and cardiovascular disease affect drug effectiveness; for example, anticholinergics cause dry mouth and constipation in patients with diabetes, less effective the drugs like

beta-3 agonists are for patients with severe hypertension. These results are supported by statistical analyses such as ANOVA test and regression analyses where p-values obtained reveal the statistical significance of differences in efficacy of various medications by the demographic characteristics of the subject patients, while confidence intervals that are obtained reveal precision of these estimates.

The safety profiles of the medications are quite distinct from one another. The side effects are different for the two drugs and oxybutynin, for example, is reported to cause more anticholinergic side effects than tolterodine; however, both drugs are likely to cause side effects especially to elderly patients and patients with cognitive disorders. Although solifenacin also belongs to the class of anticholinergics, it prospects are a little better as it has reported fewer side effects. Conversely, mirabegron relates to hypertension and headache, which are highly relevant to the disease states in patients with cardiovascular issues. This work's comparison of aggregate safety profiles show that in former all-encompassing comparative studies, anticholinergics were associated with higher overall adverse event risk than beta-3 agonists; however, the particular type of adverse effects differs from medication to medication and depends on the age. Secondary analyses indicate that patients with interactions of geriatric syndromes and multiple comorbidities are at higher risk of side effects, affecting the medication's tolerance and compliance [16].

It is even crucial to undertake subgroup analyses to know further about the struggle of the disadvantageous groups. The efficacy plays a vital role in every case but more significantly safety is, more especially when they are dealing with elderly patients; despite the fact that mirabegron has fewer side effects

some elderly patients always suffer some effects associated with cardiovascular health. The patients with comorbidities, as for most of them it is a complex of diseases, true for the medication side effects worsening their state; it becomes crucial to choose between the medication efficacy and the possible side effects influencing the patient's overall condition significantly. Such analytical procedures demonstrate that individualized therapeutic strategies in breast cancer should be tailored based on the primary disease and possible comorbidities.

Patients' and healthcare providers' view and concern real-life situations and experiences with OAB medications according to results of qualitative studies. Various clinical issues are mentioned by patients, including inability to control side effects like dry mouth due to anticholinergics and hypertension due to beta-3 agonists interfering with the patient's willingness to continue treatment. As well stated by various healthcare providers, while the drugs bring good results, the side effects of anticholinergics become a major issue that limits the long-term use of the medicine, particularly among those of a senior age. Providers also note the deficit of patient education, with regard to adverse effects prevention and proper treatment adherence. Some of the issues can be viewed as operational, for example, there are decisions to be made regarding the balance between safety and effectiveness as well as addressing patients' needs as individuals with unique health conditions and preferences. In general, the findings of the study help to reveal the differences in OAB medications' efficacy and safety depending on patients' characteristics. Such information is vital for effective treatment and enhancing the lives of patients by resorting to proven, specific methods.

Aspect	Key Findings	Impact
<b>Medication Effectiveness</b>	Oxybutynin, tolterodine, solifenacin, and mirabegron reduce UI episodes and urgency.	All are effective; solifenacin and mirabegron show fewer side effects.
<b>Side Effects</b>	Oxybutynin and tolterodine cause dryness, constipation, memory impairment. Solifenacin has fewer side effects. Mirabegron causes hypertension and headache.	Anticholinergics have more side effects, especially in the elderly. Beta-3 agonists are better tolerated by older adults.



<b>Patient Characteristics</b>	Older adults respond better to mirabegron with fewer cognitive effects. Younger patients tolerate anticholinergics well. Diabetes and cardiovascular conditions affect drug effectiveness.	Efficacy varies by age and comorbidities; individualized treatment is crucial.
<b>Safety Profiles</b>	Anticholinergics (oxybutaine, tolterodine) have higher adverse event risk. Solifenacin has fewer side effects. Mirabegron linked to hypertension.	Safety varies; anticholinergics pose more risk to elderly and those with cognitive disorders.
<b>Statistical Analysis</b>	ANOVA and regression analyses show statistically significant differences in drug efficacy based on demographics.	Provides a precise understanding of drug effectiveness and safety across different patient groups.
<b>Patient and Provider Views</b>	Patients struggle with side effects like dry mouth and hypertension, affecting treatment adherence. Providers note issues with anticholinergic side effects and lack of patient education.	Highlights need for better patient education and management of side effects for effective long-term treatment.

### Discussion

The conclusion reached from the result of this study would be useful for assessing the effectiveness and side-effect-profiles of OAB drugs so that patients can maximised the receipt of health care for this condition based on demographic factors. The results are discussed while referencing previous research and current recommendations for the treatment of OAB to provide the reader with an informative outlook on present and future trends in the management of OAB. The present investigation's results identify noteworthy differences in OAB medications' effectiveness and tolerability profiles. Oxybutinin and Tolterodine are some of the drugs that have been noted to be highly effective in the management of symptoms such as urgency and frequency. However, their use is restricted by side effects such as dry mouth, constipation and anticholinergic cognitive impairment in the elderly. This accords with prior works that affirm the effectiveness of anticholinergics while at the same time pointing out the possibility of serious adverse, most prominently in susceptible patients. Thus, solifenacin is comparable in efficacy to other anticholinergics though its side effect profile is slightly more favorable, in line with earlier studies

indicating that the drug provides better efficacy-to-tolerability balance [17].

Thus, the beta-3 agonist mirabegron offers symptom improvement with fewer adverse effects than anticholinergics at the cost of hypertension and headache. This is similar to what the literature reviews denote about Mirabegron and its benefits in minimizing anticholinergic load. Nevertheless, its safety / efficacy ratio implies precautions since it has cardiovascular side effects especially in patients with a history of co-morbid cardiovascular disease. In consideration of these findings, the study aligns with current guidelines on treatment of OAB where emphasis is made on the use of tailored intervention based on the patient's condition and response to treatment.

The results imply that OAB treatment directs should consider individual patients' demographic characteristics. Considering older adults as a sensitive population to the negative impact of anticholinergics, mirabegron appears to offer similar strengthening effects with minimal cognitive side effects. Therefore, applicability of mirabegron for hypertensive individuals may be relevant since it has noted cardiovascular impact. The management of OAB medications according to the study should involve

consideration of patient characteristics such as age, gender and coexisting medical conditions. It is also important to note that anticholinergics are very effective in managing the symptoms of PD however the side effects of the drug must be addressed; other legitimate treatments should be entertained once the side effects overcome the benefits [18].

As such, the study has implications for the healthcare policies and guidelines regarding the management of OAB. Based on the results of this study, the current guidelines of treatment support the use of individualised treatment plans since patients with rheumatoid arthritis are different in some ways. Government agencies in charge of policy formulation should try to incorporate such concepts in national and regional policies to make sure that standard treatment procedures are based on the most up-to-date information on the effectiveness and safety of the drugs. Moreover, the research underlined the crucial importance of legislation that holds all necessary treatments for patients with OAB accessible, considering that those patients' needs are highly individual. The future policy should concentrate itself on the increase in the availability of newer and safer medicines and the difficulties encountered by certain categories of clients.

The study's key strength is its methodological approach which includes main RCTs, meta-analysis and observational, that allows a rigorous assessment of OAB drugs. The application of multiple databases and Multiple Hypothesis Testing not only increases the credibility of the discovered facts, but also allows one to compare the treatments more meticulously. However, it has some limitations: selection bias and other intrinsic problems of observational studies and deviations in the quality of the data received from various sources. The generalizability is limited by the type of population enrolled in the studies and by the exclusion of some patients with comorbidities or other relevant OAB presentation.

More future research pointing to the following areas should be conducted in order to extend the current study's findings. Consequently, more research needs to be done in an attempt to establish the durability of OAB medications' advantages over time and the long-term security of the available products. Moreover, the investigations into new medications and treatment approaches can reveal the better strategy for the patients who have adverse reactions to current therapies or develop side effects that are intolerable to

bear. Better translational performance can be accomplished by acquiring more various patient populations in research such as patients with comorbidity and elder patients to approve how and to which extent treatments work among diverse population types.

Conclusively, the findings from this study enable understanding of comparative effectiveness and safety patterns of OAB medications, whilst the use of tailored treatment strategies and decision-making frameworks as well as clinical practice guidelines and policy development. Although there are certain limitations of this study, the obtained strengths present a clear picture of the currently available treatment methods for OAB; however, the issues identified within the research limitations/deficiency's part could be more elaborated and developed to provide better techniques for the management of OAB and better patient outcomes.

### Conclusion

This paper provides a comprehensive literature review on the effectiveness and safety of OAB drugs; although oxybutynin and tolterodine demonstrated promising results in relieving the symptoms, serious side-effects especially in patient's aged over 65 years were noted. Mirabegron is specifically a beta-3 agonist, and characterized by low risk of cognitive side effects, however, a disadvantageous aspect can be the possible cardiovascular effects. Thus, the results of the present study seem to call the focus on individualised medicine and the necessity of considering patient characteristics such as age, gender, or concomitant diseases with regard to treatment options. This study adds to the progress made in OAB treatment by informing decision-making on the kind of medication to prescribe depending on patient characteristics in a bid to benefit the patients through accurate prescription borne out of better knowledge and understanding of patients' conditions.

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