



# Benign Prostatic Hyperplasia (BPH) Treatments

## Therapeutic Class Review (TCR)

January 17, 2012

---

No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, digital scanning, or via any information storage or retrieval system without the express written consent of Provider Synergies, L.L.C.

All requests for permission should be mailed to:

Attention: Copyright Administrator  
Intellectual Property Department  
Provider Synergies, L.L.C.  
10101 Alliance Road, Suite 201  
Cincinnati, Ohio 45242

The materials contained herein represent the opinions of the collective authors and editors and should not be construed to be the official representation of any professional organization or group, any state Pharmacy and Therapeutics committee, any state Medicaid Agency, or any other clinical committee. This material is not intended to be relied upon as medical advice for specific medical cases and nothing contained herein should be relied upon by any patient, medical professional or layperson seeking information about a specific course of treatment for a specific medical condition. All readers of this material are responsible for independently obtaining medical advice and guidance from their own physician and/or other medical professional in regard to the best course of treatment for their specific medical condition. This publication, inclusive of all forms contained herein, is intended to be educational in nature and is intended to be used for informational purposes only. Send comments and suggestions to [PSTCReDitor@magellanhealth.com](mailto:PSTCReDitor@magellanhealth.com).

## FDA-APPROVED INDICATIONS

Drug	Manufacturer	Hypertension	BPH
<b>Alpha-Blockers</b>			
alfuzosin ER (Uroxatral®) <sup>1</sup>	generic		X
doxazosin (Cardura®) <sup>2</sup>	generic	X	X
doxazosin ER (Cardura XL®) <sup>3</sup>	Pfizer		X
silodosin (Rapaflo™) <sup>4</sup>	Watson		X
tamsulosin (Flomax®) <sup>5</sup>	generic		X
Terazosin (Hytrin®) <sup>6</sup>	generic	X	X
<b>5-Alpha Reductase (5AR) Inhibitors</b>			
dutasteride (Avodart®) <sup>7</sup>	GSK		Treatment of symptomatic BPH in men with enlarged prostate to improve symptoms, reduce the risk of acute urinary retention, reduce the risk of the need for BPH-related surgery Treatment of symptomatic BPH in combination with the alpha-blocker tamsulosin <b>Limitations of use: Not approved for the prevention of prostate cancer.</b>
finasteride (Proscar®) <sup>8</sup>	generic		Treatment of symptomatic BPH in men with enlarged prostate to improve symptoms, reduce the risk of acute urinary retention, reduce the risk of the need for BPH-related surgery including transurethral resection of the prostate (TURP) or prostatectomy Treatment of symptomatic BPH in combination with the alpha-blocker doxazosin to reduce the risk of symptomatic progression of BPH <b>Limitations of use: Not approved for the prevention of prostate cancer.</b>
<b>5-Alpha Reductase (5AR) Inhibitors / Alpha-Blocker Combinations</b>			
dutasteride/tamsulosin (Jalyn®) <sup>9</sup>	GSK		Treatment of symptomatic BPH in men with enlarged prostate <b>Limitations of use: Not approved for the prevention of prostate cancer.</b>
<b>Phosphodiesterase 5 (PDE5) Inhibitors</b>			
tadalafil (Cialis®) <sup>10</sup>	Eli Lilly and Company		Treatment of signs and symptoms of BPH  <b>Note: tadalafil is also indicated for the treatment of erectile dysfunction, with or without BPH. This indication will not be included in this review.</b>

ER = extended release

## OVERVIEW

Benign prostatic hyperplasia (BPH) is one of the most common conditions in aging men. The symptoms of BPH are induced by hyperplastic changes in prostate tissue, leading to prostatic enlargement. The resulting obstruction increases urinary outflow resistance and results in an impaired detrusor muscle response. Although prostatic enlargement is mediated by epithelial and smooth muscle cells, the etiology of initial hyperplastic changes is currently unknown. Hormonal changes associated with aging are likely involved.<sup>11</sup>

Patients with BPH may present with bothersome lower urinary tract symptoms (LUTS) resulting from irritation (urinary frequency, nocturia, urgency, urge incontinence) and/or obstruction (difficulty initiating urination or passing urine, weak stream, involuntary postvoid dripping of urine, and sensation of incomplete bladder emptying).<sup>12,13</sup> Most men with BPH experience only mild or moderate symptoms of obstruction. Severe BPH, more likely to occur in men over 60 years of age, can lead to urinary retention, renal insufficiency, urinary tract infections, hematuria, and bladder stones. More serious complications, such as uremia and irreversible bladder dysfunction, are uncommon.<sup>14,15</sup>

Drugs used in the treatment of BPH relieve LUTS and prevent complications and, in some cases, are an alternative to surgical intervention.

As many as 14 million men in the United States have symptoms related to BPH. An estimated 50 percent of men demonstrate histopathologic BPH by age 60 years. This number increases to 90 percent by 85 years of age.<sup>16</sup>

According to the American Urological Association (AUA) 2010 standards, patients with mild symptoms of BPH (AUA Symptom Score  $\leq 7$ ) and patients with moderate or severe symptoms (AUA Symptom Score  $\geq 8$ ) who are not bothered by their symptoms (e.g., they do not interfere with the daily activities of living) should be managed using a strategy of watchful waiting.<sup>17</sup> Alpha-adrenergic blocker therapy is an appropriate treatment option for patients with LUTS secondary to BPH.

For pharmacological treatment, the 2010 AUA guidelines state that alfuzosin (Uroxatral), doxazosin (Cardura), tamsulosin (Flomax), and terazosin (Hytrin) are appropriate treatment options for patients with LUTS secondary to BPH.<sup>18</sup> Although there are slight differences in the adverse event profiles of these agents, the AUA states that all four agents have equal clinical effectiveness. Silodosin (Rapaflo) did not have published peer-reviewed studies prior to the deadline for literature evaluation for the guideline update.

The guidelines also state that the 5 $\alpha$ -reductase inhibitors, finasteride (Proscar) and dutasteride (Avodart), are appropriate and effective treatments for patients with LUTS associated with demonstrable prostatic enlargement, but they are not appropriate treatments for men with LUTS who do not have evidence of prostatic enlargement.

The 5 $\alpha$ -reductase inhibitors may be used to prevent progression of LUTS secondary to BPH and to reduce the risk of urinary retention and future prostate-related surgery.<sup>19</sup> These patients should also be advised of the disadvantages of this therapeutic approach (e.g., side effects such as sexual dysfunction) and the need for long-term daily therapy in comparison to a reasonable estimate of his baseline risk of progression (e.g., retention and the risks associated with BPH-related surgery) so an informed decision may be made.

Finally, according to the 2010 AUA guidelines, combination therapy utilizing an  $\alpha$ -adrenergic receptor blocker and a 5 $\alpha$ -reductase inhibitor presents an appropriate and effective treatment for patients who not only exhibit LUTS symptoms but also have definitive prostatic enlargement.

## PHARMACOLOGY

The dynamic component of BPH is associated with prostatic smooth muscle tone. A normal prostate gland is comprised of smooth muscle or stromal tissue and glandular tissue. Unlike a normal prostate, the prostate in patients with BPH contains a higher ratio (5:1) of stromal to glandular tissue.<sup>20</sup> Prostatic smooth muscle is innervated by  $\alpha_1$ - and  $\alpha_2$ -adrenergic receptors. The outer prostatic capsule, bladder neck, and proximal urethra also have a high concentration of  $\alpha_1$ -adrenergic receptors. Excessive stimulation of postsynaptic  $\alpha_1$ -adrenergic receptors causes the smooth muscle of the prostate, prostatic capsule, bladder neck, and proximal urethra to contract, and causes a decrease in the urethral lumen. Resultant obstructive voiding symptoms include difficulty in urination, a decreased force of urinary stream, urinary hesitancy, straining to void, incomplete bladder emptying, urinary dribbling, and intermittent urinary stream.<sup>21</sup>

Administration of  $\alpha_1$ -blockers relaxes both the bladder neck and prostatic smooth muscle, thus decreasing pressure in the bladder and urethra and improving urinary flow.<sup>22</sup> These agents are more effective at improving obstructive symptoms than irritative symptoms.<sup>23</sup> Tamsulosin (Flomax), alfuzosin (Uroxatral) and silodosin (Rapaflo) are  $\alpha$ -blockers related to doxazosin and terazosin. Unlike the other agents, tamsulosin, alfuzosin, and silodosin have higher affinity and selectivity for  $\alpha_{1a}$ -adrenergic receptors, which are located in nonvascular smooth muscle as is found in the prostate, than for  $\alpha_{1b}$ -adrenergic receptors located in vascular smooth muscle. This selectivity may result in a decreased incidence of adverse cardiovascular effects with tamsulosin, alfuzosin, and silodosin.<sup>24</sup>

The static element of BPH is associated with increased prostatic tissue mass; this mass mechanically blocks the urethra and produces resistance to urinary flow from the bladder. Testosterone is a key element in the pathophysiology of BPH in that it is converted in the prostate to 5 $\alpha$ -dihydrotestosterone (DHT), which stimulates growth of glandular and stromal cells.<sup>25,26</sup> Over time, progressive proliferation may lead to increased prostate size and bladder outlet obstruction.<sup>27</sup> The recommended pharmacologic approach to prostatic hyperplasia is administration of 5 $\alpha$ -reductase (5AR) inhibitors. By blocking the action of 5AR, the agents inhibit conversion of testosterone to DHT.<sup>28</sup> Proliferation of prostatic epithelial cells declines, resulting in decreased size of the prostate gland.

Dutasteride (Avodart) and finasteride (Proscar) are selective inhibitors of 5AR (5-alpha reductase). When given on a chronic basis, these agents decrease the serum concentration of DHT. Dutasteride inhibits both type I and type II isoforms of 5AR while finasteride specifically inhibits the type II isoform. The type II isoenzyme is primarily active in the reproductive tissues. The type I isoenzyme is also responsible for testosterone conversion in the skin and liver. These agents have no affinity for the androgen receptor.<sup>29,30</sup>

Tadalafil (Cialis) is a selective inhibitor of cyclic guanosine monophosphate (cGMP)-specific phosphodiesterase type 5 (PDE5). The effect of PDE5 inhibition on cGMP concentration in the corpus cavernosum and pulmonary arteries is also observed in the smooth muscle of the prostate, the bladder and their vascular supply. The mechanism for reducing BPH symptoms has not been established.<sup>31</sup>

## PHARMACOKINETICS

Drug	Bioavailability (%)	Protein Binding (%)	Peak Concentration (hrs)	Half-Life (hrs)	Liver Metabolism	Excretion in Urine (%)
<b>Alpha-Blockers<sup>32</sup></b>						
alfuzosin ER (Uroxatral) <sup>33</sup>	49-64 <sup>#</sup>	82-90	8	10	0-demethylation N-dealkylation oxidation	24
doxazosin (Cardura) <sup>34</sup>	65	98	2-3	22	0-demethylation hydroxylation	9
doxazosin ER (Cardura XL) <sup>35</sup>	54-59**	98	8-9	15-19	cytochrome P450	9
silodosin (Rapaflo) <sup>36</sup>	32	97	2.6	13.3	Glucuronidation, alcohol and aldehyde dehydrogenase and cytochrome P450	33.5
tamsulosin (Flomax) <sup>37</sup>	90	94-99	4-6*	14-15	cytochrome P450	76
terazosin (Hytrin) <sup>38</sup>	90	90-94	1-2	12-14	0-demethylation N-dealkylation hydrolysis	40
<b>5-Alpha Reductase (5AR) Inhibitors</b>						
dutasteride (Avodart) <sup>39</sup>	40-94	99	2-3	840	cytochrome P450	<1
finasteride (Proscar) <sup>40</sup>	63	90	1-2	6.2	cytochrome P450	39
<b>5-Alpha Reductase (5AR) Inhibitors / Alpha-Blocker Combinations</b>						
dutasteride/ tamsulosin (Jalyn) <sup>41</sup>	Refer to data on component ingredients					
<b>Phosphodiesterase 5 (PDE5) Inhibitors</b>						
tadalafil (Cialis) <sup>42</sup>	not determined	94	2	17.5	cytochrome P450	36

<sup>#</sup> The extent, but not the rate, of absorption is reduced by 50 percent in fasting conditions.

\* Food delays time to achieve peak tamsulosin (Flomax) serum concentrations by two to three hours and decreases total amount of drug absorbed by 30 percent. The manufacturer recommends that tamsulosin (Flomax) be taken about 30 minutes after the same meal each day.

\*\* Relative bioavailability compared to doxazosin IR.

Finasteride (Proscar) has a shorter terminal half-life (six hours) than dutasteride (Avodart) (five weeks). Compared to the  $\alpha$ -blockers, the onset of action of 5AR inhibitors is slower [one to three months for dutasteride and three to six months for finasteride]. This difference is related to the mechanism of action of the drugs more than to the pharmacokinetics.

## CONTRAINDICATIONS/WARNINGS

### Alpha-Blockers<sup>43,44,45,46,47,48</sup>

In patients with moderate or severe hepatic insufficiency, a reduction in clearance results in three-fold to four-fold higher plasma concentrations of alfuzosin (Uroxatral) compared to those in healthy subjects. As a result, alfuzosin (Uroxatral) is contraindicated in patients with moderate to severe hepatic impairment (Child-Pugh categories B and C). Alfuzosin should not be coadministered with potent CYP3A4 inhibitors such as ketoconazole, itraconazole, and ritonavir since alfuzosin blood levels are increased by these agents. Alfuzosin is contraindicated in patients with known hypersensitivity. Alfuzosin should be discontinued if symptoms of angina pectoris should newly appear or worsen. Additionally, in patients with a congenital or acquired QT prolongation who are receiving alfuzosin, they should be observed for QT prolongation. There has been no signal of Torsades de Pointes in the extensive post-marking experience with alfuzosin.

Doxazosin (Cardura, Cardura XL) and terazosin (Hytrin) are contraindicated in patients with a known sensitivity to quinazolines. The FDA has issued a box warning for doxazosin and terazosin regarding syncope and a potential “first-dose” hypotension and/or syncope with these agents, especially when given in conjunction with other antihypertensive drugs. Marked lowering of blood pressure can occur with alpha-blockers. Postural hypotension or syncope can occur with the first dose or first few days of therapy. Treatment with alpha-blockers should be initiated at bedtime using the lowest dose, and then increased slowly. Additional hypotensive agents should be coadministered with caution. If syncope does occur, patients should be placed in a recumbent position and treated supportively as necessary. Doxazosin ER (Cardura XL) should be used with caution in patients with evidence of mild or moderate hepatic dysfunction and is not recommended for use in patients with severe hepatic impairment.

Tamsulosin (Flomax) is contraindicated in patients with known hypersensitivity, reactions have included skin rash, urticaria, pruritus, angioedema, and respiratory symptoms. For patients that report a serious of life threatening sulfa allergy, caution is warranted with administering of tamsulosin. Doses of tamsulosin higher than 0.4 mg (e.g., 0.8 mg) should not be used in combination with strong inhibitors of CYP3A4 such as ketoconazole.

Silodosin (Rapaflo) is contraindicated in patients who are hypersensitive to silodosin or any other component in the formulation, patients taking other alpha-blockers, and patients on CYP3A4 inhibitors (e.g., ketoconazole, clarithromycin, itraconazole, ritonavir). Silodosin has not been studied in patients with severe hepatic impairment and is, therefore, contraindicated in these patients. The use of silodosin is also contraindicated in patients with severe renal impairment (creatinine clearance  $\leq 30$  mL/minute). Clinical studies have shown that the effect of moderate renal impairment (creatinine clearance 30 to 50 mL/min) on the pharmacokinetics of resulted in approximately a three-fold higher plasma concentration of silodosin compared to subjects with normal renal function. Dosages of silodosin should be reduced in patients with moderate renal impairment.

Patients should be evaluated to rule out carcinoma of the prostate prior to initiating therapy for BPH since this cancer and BPH cause many of the same symptoms.

Marked lowering of blood pressure can occur with alpha-blockers. Postural hypotension or syncope can occur with the first dose or first few days of therapy. Treatment with alpha-blockers should be initiated at bedtime using the lowest dose, and then increased slowly. Additional hypotensive agents should be coadministered with caution.

Intraoperative floppy iris syndrome (IFIS) has been observed during phacoemulsification cataract surgery in some patients treated with  $\alpha_1$ -blockers. Most reports involved patients taking an  $\alpha_1$ -blocker when IFIS occurred, but in some cases the  $\alpha_1$ -blocker had been stopped prior to surgery. It is recommended that male patients being considered for cataract surgery be specifically questioned during their pre-operative medication history to ascertain whether they have previously taken any of the  $\alpha_1$ -blockers and that therapy not be initiated prior to the scheduled surgery.<sup>49</sup>

Priapism is a rare occurrence with alpha-blockers, but it can lead to permanent impotence if not properly treated.

## **5AR Inhibitors<sup>50,51</sup>**

Dutasteride (Avodart) and finasteride (Proscar) are not to be administered to women or children. Additionally, women who are pregnant or who may become pregnant should not handle dutasteride capsules or finasteride tablets as the drug may be absorbed through the skin and broken or leaking capsules pose a fetal anomaly risk to a male fetus.

Dutasteride capsules should be swallowed whole due to the risk of irritation of the oropharyngeal mucosa if crushed or chewed.

5AR Inhibitors may reduce total serum prostate-specific antigen concentrations in patients by approximately 40 percent to 50 percent depending on length of administration. Interpretation of serial PSAs should follow the establishment of a baseline PSA after three to six months of therapy. Increases in PSA values above this baseline should be used for assessment of potential cancer-related changes in PSA. Interpretation of values after six months or more of therapy should be made by doubling the PSA value for comparison with normal values in untreated patients.

Two studies, one with dutasteride (Avodart) and one with finasteride (Proscar), show that 5AR inhibitors may increase the risk of development of high-grade prostate cancer. Whether the effect of 5AR inhibitors to reduce prostate volume, or study-related factors, impacted the results of the studies has not been established.

Patients with large residual urinary volume and/or severely diminished urinary flow should be carefully monitored for obstructive uropathy and may not be candidates for therapy with the 5AR inhibitors, dutasteride and finasteride.

## **Alpha-Blocker and 5AR Inhibitor Combinations<sup>52</sup>**

The first alpha-blocker and 5AR inhibitor combination product for the treatment of BPH, Jalyn (dutasteride and tamsulosin), was recently introduced into the market. As a combination product, adverse reactions as well as warnings and contraindications for this product consist of the reactions listed above for the component parts.

## **Phosphodiesterase 5 (PDE5) Inhibitors<sup>53</sup>**

Tadalafil (Cialis) is contraindicated in patients who are using any form of organic nitrate, either regularly and/or intermittently. Tadalafil is also contraindicated in patients with a history of known serious hypersensitivity reaction to tadalafil.

Tadalafil can cause mild systemic vasodilatory effects that may result in transient decreases in blood pressure. Patients with severely impaired autonomic control of blood pressure may be particularly

sensitive to the actions of vasodilators, including PDE5 inhibitors. Tadalafil is not recommended in combination with alpha blockers for the treatment of BPH because efficacy of the combination has not been adequately studied and because of the risk of blood pressure lowering.

Patients should not use tadalafil if sexual activity is inadvisable due to cardiovascular status.

Patients should seek emergency treatment if they experience an erection lasting more than four hours. Use tadalafil with caution in patients predisposed to priapism.

Patients should stop tadalafil and seek medical care if a sudden loss of vision occurs in one or both eyes, which could be a sign of Non Arteritic Ischemic Optic Neuropathy (NAION). Discuss increased risk of NAION in patients with history of NAION.

Patients should stop tadalafil and seek prompt medical attention in the event of sudden decrease or loss of hearing.

Prior to initiating treatment with tadalafil for BPH, consideration should be given to other urological conditions that may cause similar symptoms.

## DRUG INTERACTIONS<sup>54,55,56,57,58,59,60,61,62,63</sup>

### Alpha-Blockers

Concomitant use of alpha-blockers with strong CYP3A4 inhibitors (e.g., ketoconazole, clarithromycin, itraconazole, ritonavir) may cause an increased alpha-blocker exposure. The manufacturers of alfuzosin (Uroxatral) and silodosin (Rapaflo) state that use of these agents with strong CYP3A4 inhibitors are contraindicated. The manufacturer recommends using caution with concomitant administration of tamsulosin (Flomax) and strong CYP3A4 inhibitors. The effect of moderate CYP3A4 inhibitors (diltiazem, erythromycin, verapamil) on the pharmacokinetics may increase the concentration of alpha-blockers, and therefore use caution when administered with a moderate CYP3A4 inhibitor.

The concurrent administration of doxazosin (Cardura) and terazosin (Hytrin) with diuretics or other antihypertensive agents results in additive reduction in blood pressure. Initiation of terazosin in patients receiving beta-blockers can result in an accentuation of the first-dose effect. Based upon the differences in dose and formulation, the applicability of interactions to doxazosin ER (Cardura XL) is unknown.

Alfuzosin should not be coadministered with potent CYP3A4 inhibitors such as ketoconazole, itraconazole, and ritonavir since alfuzosin blood levels are increased by these agents. Doxazosin ER, dutasteride, and tamsulosin should be coadministered with CYP3A4 inhibitors with caution.

In addition, tamsulosin should be coadministered with caution in combination with moderate or strong inhibitors of CYP2D6 and CYP3A4 inhibitors. Tamsulosin when given concurrently should not exceed 0.4 mg daily due to the CYP 450 inhibition by cimetidine, paroxetine, and other strong CYP3A4 inhibitors. While definitive evidence of interaction with warfarin is inconclusive, the manufacturer recommends caution in concomitant administration with tamsulosin.

Although the pharmacokinetic and pharmacodynamic interactions with the use of multiple alpha-blockers have not been determined, interactions may be expected and these products should not be used in combination. Therefore, concomitant use of more than one alpha-blocker, including tamsulosin, alfuzosin, silodosin, prazosin, terazosin, and doxazosin, is not recommended. Concurrent

use of alpha-blockers with reserpine or mecamylamine is not recommended. Alpha-blocker use with centrally acting alpha agonists including clonidine, methyldopa, guanfacine, and guanabenz is not recommended.

The administration of alpha-blockers and antihypertensive medications has the potential to cause hypotension in some patients. Caution is advised when alpha-adrenergic blocking agents, including alfuzosin, are coadministered with phosphodiesterase type 5 inhibitors, (PDE5). Both agents are vasodilators that may lower blood pressure and concomitant use can result in symptomatic hypotension.

The administration of food may lead to decreased plasma concentrations of alpha-blockers. The manufacturers of these products recommend that alfuzosin, tamsulosin, and silodosin be taken immediately following a meal, which may decrease the risk of adverse effects.

The release of doxazosin ER may be delayed if given with drugs that decrease gastrointestinal motility.

## 5AR Inhibitors

The clearance of dutasteride (Avodart) is reduced by approximately 40 percent in patients given diltiazem or verapamil. The bioavailability of dutasteride is increased by 31 percent when given concomitantly with terazosin. Due to the large therapeutic index of dutasteride, the interactions are, in most cases, of little clinical significance.

## Alpha-Blocker and 5AR Inhibitor Combinations

Similar to adverse reactions, the drug interactions for the combination product dutasteride and tamsulosin are in keeping with the interactions of the individual components. The combination does not produce any new or increased interactions with other medications.

## Phosphodiesterase 5 (PDE5) Inhibitors

Tadalafil (Cialis) can potentiate the hypotensive effects of nitrates, alpha blockers, antihypertensives or alcohol.

CYP3A4 inhibitors (e.g. ketoconazole, ritonavir) may increase tadalafil exposure. For concomitant use with potent CYP3A4 inhibitors, dose adjustment of tadalafil may be needed.

CYP3A4 inducers (e.g. rifampin) may decrease tadalafil exposure.

## ADVERSE EFFECTS

Drug	Asthenia	Headache	Dizziness	Hypotension	Altered libido	Abnormal ejaculation	Impotence
<b>Alpha-Blockers</b>							
alfuzosin ER (Uroxatral) <sup>64</sup>	2.7	3.0	5.7	0.4	nr	nr	1-2
doxazosin (Cardura) <sup>65</sup>	8	9.9	15.6	1.7	0.8	≤1	1.1
doxazosin ER (Cardura XL) <sup>66</sup>	3.9	6	5.3	1.7	nr	nr	<1
silodosin (Rapaflo) <sup>67</sup>	1-2	2.4	3.2	2.6	nr	28.1	nr
tamsulosin (Flomax) <sup>68</sup>	7.8-8.5	19.3-21.1	14.9-17.1	0.2-0.4	1-2	8.4-18.1	reported
Terazosin (Hytrin) <sup>69</sup>	7.4	4.9	9.1	≤5.5	nr	nr	1.6-2
<b>5-Alpha Reductase (5AR) Inhibitors</b>							
dutasteride (Avodart) <sup>70</sup>	nr	nr	<0.4	nr	<3	1.4	0.8-4.7
finasteride (Proscar) <sup>71</sup>	1.6-5.3	2	2.3-7.4	1.2	2-10	1.8-7.2	2-18.5
<b>5-Alpha Reductase (5AR) Inhibitors / Alpha-Blocker Combinations</b>							
dutasteride/ tamsulosin (Jalyn) <sup>72</sup>	nr	nr	0.2-1.1	nr	0.1-4.5	0.1-7.6	0.3-5.5
<b>Phosphodiesterase 5 (PDE5) Inhibitors</b>							
tadalafil (Cialis) <sup>73</sup>	<2	4.1	1	nr	<2	nr	nr

nr = not reported

Adverse effects are reported as a percentage. Adverse effects data are obtained from package inserts and are not meant to be comparative or all inclusive. nr = not reported

As with any other non-deformable material, caution should be used when administering doxazosin ER (Cardura XL) to patients with preexisting severe gastrointestinal narrowing (pathologic or iatrogenic). Rare reports of obstructive symptoms in patients with known strictures administered another drug in this non-deformable extended-release formulation exist. Markedly increased GI retention times, as may occur in patients with chronic constipation, can increase systemic exposure to doxazosin and thereby potentially increase adverse effects.

## SPECIAL POPULATIONS<sup>74,75,76,77,78,79,80,81,82,83</sup>

### Pediatrics

None of the drugs are indicated for use in the pediatric population nor are there significant studies in children available.

### Pregnancy

Women who are pregnant or may become pregnant should not come into contact with dutasteride (Avodart, Jalyn) or finasteride (Proscar) because of the possibility of fetal anomaly to a male fetus. The 5AR inhibitors, dutasteride and finasteride, are Pregnancy Category X.

Alfuzosin (Uroxatral), tamsulosin (Flomax), silodosin (Rapaflo), and tadalafil (Cialis) are Pregnancy Category B. Tadalafil is not indicated for use in women. These products are not indicated for use in women. The other products in this class are Pregnancy Category C.

## Elderly

The cumulative incidence for hypotension with doxazosin (Cardura) and doxazosin ER (Cardura XL) appears to be age-related in clinical studies. Caution should be used in the elderly.

No overall differences in safety or effectiveness were observed in the geriatric population when compared to younger subjects for alfuzosin, tamsulosin, and silodosin, although the greater sensitivity of some elderly patients cannot be ruled out.

## Hepatic insufficiency

Because the liver is the primary metabolic pathway for metabolism of drugs in this class, caution should be used when administering any agent to patients with hepatic insufficiency.

Alfuzosin is contraindicated for use in patients with moderate to severe hepatic impairment (Child-Pugh categories B and C). The pharmacokinetics of alfuzosin have not been studied in patients with mild hepatic insufficiency.

Patients with moderate hepatic dysfunction do not require an adjustment in the tamsulosin or silodosin dosage. Tamsulosin and silodosin have not been studied in patients with severe hepatic dysfunction.

Doxazosin ER is also not recommended for use in patients with severe hepatic impairment. Dutasteride and finasteride should be used with caution in patients with severe hepatic insufficiency due to extensive metabolism by the liver.

Tadalafil (Cialis) for once daily use has not been extensively evaluated in patients with mild or moderate hepatic impairment. Therefore, caution is advised if tadalafil for once daily use is prescribed to these patients. Because of insufficient information in patients with severe hepatic impairment, use of tadalafil in this group is not recommended.

## Renal insufficiency

Silodosin (Rapaflo) is contraindicated in patients with severe renal impairment (creatinine clearance  $\leq 30$  mL/min).

Due to increased tadalafil (Cialis) exposure (AUC) limited clinical experience, and the lack of ability to influence clearance by dialysis, tadalafil for once daily use is not recommended in patients with creatinine clearance less than 30 mL/min or patients on hemodialysis. In patients with creatinine clearance 30 to 50 mL/min, start dosing at 2.5 mg once daily, and increase dose to 5 mg once daily based upon individual response.

## DOSAGES

Drug	Initial Dose for BPH	Maintenance Dose for BPH	Dosage Forms
<b>Alpha-Blockers</b>			
alfuzosin ER (Uroxatral) <sup>84</sup>	10 mg daily	10 mg daily	10 mg extended-release tablets
doxazosin (Cardura) <sup>85</sup>	1 mg daily	1 - 8 mg daily	1, 2, 4, 8 mg tablets
doxazosin ER (Cardura XL) <sup>86</sup>	4 mg daily	4 – 8 mg daily taken with breakfast	4, 8 mg extended-release tablets
silodosin (Rapaflo) <sup>87</sup>	8 mg daily Moderate renal impairment: 4 mg daily	8 mg daily Moderate renal impairment: 4 mg daily	4 mg, 8 mg capsules
tamsulosin (Flomax) <sup>88</sup>	0.4 mg daily	0.4 - 0.8 mg daily	0.4 mg capsules
terazosin (Hytrin) <sup>89</sup>	1 mg daily	2 - 20 mg daily	1, 2, 5, 10 mg capsules
<b>5-Alpha Reductase (5AR) Inhibitors</b>			
dutasteride (Avodart) <sup>*90</sup>	0.5 mg daily	0.5 mg daily	0.5 mg capsules
finasteride (Proscar) <sup>**91</sup>	5 mg daily	5 mg daily	5 mg tablets
<b>5-Alpha Reductase (5AR) Inhibitors / Alpha-Blocker Combinations</b>			
dutasteride/ tamsulosin (Jalyn) <sup>92</sup>	1 capsule daily (0.5 mg dutasteride/ 0.4 mg tamsulosin)	1 capsule daily (0.5 mg dutasteride/ 0.4 mg tamsulosin)	0.5 mg dutasteride/ 0.4 mg tamsulosin per capsule
<b>Phosphodiesterase 5 (PDE5) Inhibitors</b>			
tadalafil (Cialis) <sup>***93</sup>	5 mg daily Creatinine clearance 30 – 50 mL/min: 2.5 mg daily	5 mg daily Creatinine clearance 30 – 50 mL/min: may increase to 5 mg daily based on individual response	2.5, 5, 10, 20 mg tablets

\* For dutasteride, the same dose of 0.5 mg daily is used in combination therapy with tamsulosin. Also, the capsules should be swallowed whole and not chewed or opened.

\*\* For finasteride, the same dose of 5 mg daily is used in combination therapy with doxazosin.

\*\*\* For tadalafil, the dose should be taken at approximately the same time every day.

## CLINICAL TRIALS

### Search Strategy

Articles were identified through searches performed on PubMed and review of information sent by manufacturers. Search strategy included the FDA-approved use of all drugs in this class and BPH. Randomized, controlled comparative trials are considered the most relevant in this category. Studies included for analysis in the review were published in English, performed with human participants, and randomly allocated participants to comparison groups. In addition, studies must contain clearly stated, predetermined outcome measure(s) of known or probable clinical importance, use data analysis techniques consistent with the study question, and include follow-up (endpoint assessment) of at least 80 percent of participants entering the investigation. Despite some inherent bias found in all studies

including those sponsored and/or funded by pharmaceutical manufacturers, the studies in this therapeutic class review were determined to have results or conclusions that do not suggest systematic error in their experimental study design. While the potential influence of manufacturer sponsorship/funding must be considered, the studies in this review have also been evaluated for validity and importance.

### **alfuzosin (Uroxatral) versus doxazosin (Cardura)**

In a 14-week, multicenter, double-blind, baseline-controlled, dose-titration study, 210 men with moderate to severe LUTS were randomized to receive doxazosin 1 to 8 mg once daily or alfuzosin 5 to 10 mg divided in two or three daily doses.<sup>94</sup> International Prostate Symptom Score (IPSS) and maximum urinary flow rate were used to assess the efficacy of the treatment. At the end of the study, the mean dose of the two drugs [doxazosin 6.1 mg/day, alfuzosin 8.8 mg/day] was not equipotent. The mean change from baseline in total IPSS was statistically significant ( $p < 0.001$ ) for both doxazosin and alfuzosin. The mean change from baseline in irritative symptoms was also statistically significant ( $p < 0.001$  for both). The differences between the treatment groups were statistically significant in favor of doxazosin for both total IPSS ( $p = 0.036$ ) and irritative symptoms ( $p = 0.049$ ). The improvement between groups was also significantly different for postvoid residual urine volume, at -29.19 mL and +9.59 mL for doxazosin and alfuzosin, respectively ( $p = 0.002$ ). Improvements in mean and maximum urinary flow rates were similar for both treatments, at 1.5 and 1.2, and 2.8, and 2.5 mL/sec, respectively. Doxazosin and alfuzosin were both well tolerated, with most all-cause adverse events reported as mild or moderate.

### **alfuzosin (Uroxatral) versus tamsulosin (Flomax)**

In a randomized, double-blind, multicenter study, 625 patients with BPH were randomized to receive alfuzosin 10 mg, alfuzosin 15 mg, tamsulosin 0.4 mg, or placebo, each given once daily for 12 weeks with no initial dose titration.<sup>95</sup> The study was designed to compare each of the three active treatments with the placebo group. Alfuzosin 10 mg and tamsulosin 0.4 mg significantly improved urinary tract symptoms compared with placebo, with a mean change from baseline in IPSS of -6.5 for each of the two active treatment groups compared to -4.6 for placebo (adjusted  $p = 0.007$  and  $0.014$ , respectively). The difference in change between the higher dose of alfuzosin and placebo was not statistically significant. The median change from baseline in maximum urinary flow rate was significantly increased with all three active treatment regimens (all adjusted  $p = 0.02$  versus placebo). Dizziness was the most frequent adverse event, with an incidence of six, seven, and two percent in the alfuzosin 10 mg, alfuzosin 15 mg, and tamsulosin 0.4 mg groups, respectively, compared to a four percent incidence in the placebo group. The respective incidence rates of sexual function adverse events were three, one, eight, and zero percent.

In a randomized, double-blind, parallel-design trial, efficacy and safety of tamsulosin 0.2 mg daily ( $n = 40$ ) was compared to alfuzosin 10 mg daily ( $n = 36$ ) in 76 men with symptomatic BPH.<sup>96</sup> After eight weeks of treatment, IPSS, maximum urinary flow rate, Danish prostatic symptom sexual function score, and morbidity rates were compared. Both treatment regimens similarly improved IPSS and maximum urinary flow rate, did not alter sexual function, and were well tolerated. The incidence of adverse events was similar for tamsulosin (25 percent) and alfuzosin (19.4 percent).

## **doxazosin (Cardura) versus finasteride (Proscar) versus combination therapy versus placebo**

In the PREDICT trial, over 1,000 patients were randomized to placebo, doxazosin titrated to 1 to 8 mg daily, finasteride 5 mg daily, or a combination of both agents for 52 weeks.<sup>97</sup> Mean reduction in American Urological Association (AUA) Symptom Index was significantly greater in the doxazosin and combination groups than in either the finasteride or placebo groups. Maximum urinary flow rate increased significantly more in the doxazosin monotherapy (3.6 mL/sec) and combination therapy (4.1 mL/sec) groups than in either the finasteride monotherapy (1.9 mL/sec) or placebo (1.9 mL/sec) groups. Finasteride was not significantly different from placebo in either comparison. All treatments were generally well tolerated, with discontinuation rates due to adverse events in the active treatment groups similar to those in the placebo group.

The NIH-funded Medical Therapy of Prostatic Symptoms (MTOPS) study was a large, long-term (mean follow-up 4.5 years), double-blind trial involving 3,047 men with moderate or severe symptomatic BPH.<sup>98</sup> Patients were randomized to receive placebo, doxazosin 4 to 8 mg, finasteride 5 mg, or a combination of both doxazosin and finasteride. The primary outcome of risk of clinical BPH progression (symptom increase, urinary retention, urinary incontinence, renal insufficiency, or recurrent urinary tract infection) occurred in 17 percent of men treated with placebo, 10 percent of patients treated with doxazosin ( $p < 0.001$  versus placebo), 10 percent of men treated with finasteride ( $p = 0.002$  versus placebo), and 5.3 percent of those treated with combination therapy ( $p < 0.001$  compared to each of the other treatments). The outcomes of acute urinary retention and invasive therapy were significantly reduced by combination therapy by 81 and 67 percent, respectively ( $p < 0.001$  for each comparison with placebo). There was also a significant reduction in these risks with finasteride monotherapy ( $p < 0.001$ ) but not with doxazosin monotherapy. On average, patients in the study had smaller prostate glands than patients in most other studies; the difference accounts, at least in part, for the overall lower rate of urinary retention and invasive therapy. Discontinuation rates were 27 percent for doxazosin, 24 percent for finasteride, and 18 percent for combination therapy.

A study examined data from the MTOPS study to determine the relationship between baseline total prostate volume (TPV) and the effect of medical therapy in men with lower urinary tract symptoms (LUTS) secondary to BPH.<sup>99</sup> The 3,047 patients had been randomized to placebo, doxazosin 4 to 8 mg, finasteride 5 mg, or the combination of doxazosin and finasteride. In patients with a small prostate (baseline TPV less than 25 mL), combination therapy was no better than doxazosin alone for decreasing the risk of clinical progression of BPH and the need for invasive therapy (a secondary outcome). However, in patients with a moderate size (25 to less than 40 mL) or enlarged (40 mL or greater) prostate glands, combination therapy led to a greater decrease in the risk of clinical progression of BPH than either drug alone.

Another study also examined data from the MTOPS study to determine the effect of long term finasteride treatment on total prostate volume (TPV) regardless of baseline prostate size.<sup>100</sup> The average length of treatment was 4.5 years. Both combination therapy of doxazosin and finasteride and finasteride alone led to reduction of approximately 25 percent in total prostate volume compared to placebo over the full range of baseline prostate sizes.

### **doxazosin (Cardura) versus terazosin (Hytrin)**

Due to a lack of other data, this study has been included despite its lack of double-blind design. In a prospective, randomized study of patients with LUTS suggestive of BPH, 50 male patients received either doxazosin or terazosin once each night.<sup>101</sup> Forty-four percent of patients using doxazosin and 40 percent of patients using terazosin showed improvement in both IPSS and maximum urinary flow rate at the end of the third month of treatment; increase in maximum urinary flow rate ( $p<0.001$ ) and decrease in IPSS ( $p<0.01$ ) were significant for both doxazosin and terazosin. After three months, patients who did not show improvement in any of the parameters while receiving the originally assigned drug were switched to the other drug. Of these initial non-responders, four percent showed improvement both in IPSS and maximum urinary flow rate, and four percent showed improvement in IPSS but not in maximum urinary flow rate. The remaining 30 percent of patients did not show improvement in any of the parameters.

### **doxazosin ER (Cardura XL) versus doxazosin (Cardura)**

A randomized, double-blind, multicenter study in 795 men with BPH included a two-week washout period, two-week single-blind placebo run-in phase, and 13-week double-blind treatment phase.<sup>102</sup> Doxazosin ER was initiated at 4 mg daily and titrated to 8 mg daily after seven weeks, if indicated; doxazosin was initiated at 1 mg daily, titrated to 2 mg after one week, to 4 mg at three weeks, and to 8 mg at seven weeks if indicated, to achieve symptom control. The primary outcome measures were mean changes from baseline to the final visit for IPSS and maximum urinary flow rate adjusted for baseline values. Both doxazosin ER and doxazosin significantly improved the symptoms of BPH, as evidenced by reductions in total IPSS of  $-8.0\pm 0.3$  and  $-8.4\pm 0.3$  from baseline, respectively, compared with a reduction of  $-6.0\pm 0.4$  in patients on placebo. Doxazosin ER and doxazosin produced clinically comparable improvements in maximum urinary flow rates, with a greater improvement observed earlier following treatment with doxazosin ER than with doxazosin. Both active treatments produced significantly greater increases in maximum urinary flow rate compared with placebo. Overall incidence of adverse events was similar among patients treated with doxazosin ER and placebo and was slightly higher in those on doxazosin.

### **dutasteride (Avodart) versus placebo**

Three identical parallel, two-year, multicenter, placebo-controlled studies randomized 4,325 men with clinical BPH to placebo or dutasteride 0.5 mg daily.<sup>103</sup> After a one-month, single-blind, placebo lead-in period, patients were followed for 24 months in a double-blind fashion with multiple interval assessments. Results of the three studies were pooled. At 24 months, serum DHT was reduced from baseline by 90.2 percent ( $p<0.001$ ), and total prostate volume was reduced by 25.7 percent ( $p<0.001$ ) in the dutasteride group. The dutasteride-treated patients experienced a greater decrease in AUA Symptom Index compared to placebo-treated patients ( $p<0.001$ ). Similar changes were observed for the maximum urinary flow rate (2 versus 0.9 mL/sec,  $p<0.001$ ). Over two years, 90 patients (4.2 percent) experienced acute urinary retention in the placebo group compared to 39 (1.8 percent) in the dutasteride group for a risk reduction of 57 percent ( $p<0.001$ ). Similarly, the relative risk of experiencing BPH-related surgical interventions was reduced by 48 percent (2.2 percent for dutasteride versus 4.1 percent for placebo,  $p<0.001$ ). Dutasteride was well tolerated. Erectile dysfunction, altered libido, ejaculatory disorders, and gynecomastia were reported more frequently in patients receiving dutasteride. The studies were conducted by the manufacturer of dutasteride.

## **tamsulosin (Flomax) versus terazosin (Hytrin)**

Due to a lack of other data, this study has been included despite its lack of double-blind design. A multicenter, single-blind, randomized trial was performed to compare the safety and efficacy of an incremental-dose regimen of terazosin 1 to 2 mg and a fixed-dose regimen of tamsulosin 0.2 mg, each given once daily for four weeks.<sup>104</sup> Sixty-one patients with symptomatic BPH were enrolled in the study. Improvement was defined as a 25 percent decrease from baseline in IPSS, greater than one point increase in quality of life score, and 2.5 mL/sec increase in urinary flow rate. Both terazosin and tamsulosin produced statistically significant improvements in subjective and objective variables. Neither drug affected systolic or diastolic blood pressure or pulse rates. There was no statistically significant difference in the incidence of adverse effects between the two groups.

## **dutasteride (Avodart) versus tamsulosin (Flomax) versus combination therapy**

The CombaT study was a randomized, multicenter, double-blind study which enrolled 4,844 men, ages 50 years and older, with a diagnosis of BPH with mild to moderate LUTS and prostate enlargement (30 mL or greater).<sup>105</sup> Patients received either dutasteride 0.5 mg, tamsulosin 0.4 mg, or the combination once daily for four years. The primary endpoint at two years was the change in IPSS from baseline. Combination therapy resulted in significantly greater symptom improvements compared to monotherapy with dutasteride from month three and compared to monotherapy with tamsulosin from month nine ( $p < 0.001$  for each comparison). Improvement from baseline in peak urinary flow was significantly greater with combination therapy than with monotherapy with either agent from month six ( $p \leq 0.006$ ). Combination therapy was associated with a significant increase in drug related adverse events compared to monotherapy with either agent ( $p < 0.001$ ). The results at the completion of the four year study continued to demonstrate the superiority of combination to tamsulosin monotherapy in reducing the relative risk of acute retention (AUR) or BPH-related surgery.<sup>106</sup> The four year results also continued to show that combination therapy was not superior to dutasteride therapy for surgery risk, but did provide significantly superior symptomatic benefit than either monotherapy protocol. Safety and tolerability data at the four year period was consistent with previous results from tamsulosin and dutasteride monotherapies.

## **Step-Down Therapy – dutasteride (Avodart) and tamsulosin (Flomax)**

SMART-1 was a multicenter, randomized, double-blind trial. All patients receive dutasteride 0.5 mg and tamsulosin 0.4 mg daily for 24 weeks.<sup>107</sup> At week 24, patients received either combination therapy for an additional 12 weeks or were switched to dutasteride plus placebo. At the 30-week final assessment, 91 percent of patients treated with combination therapy and 77 percent of patients treated with dutasteride monotherapy reported feeling better or experiencing no change in urinary symptoms compared to week 24 ( $p = 0.001$ ). Among patients with moderate baseline symptoms who switched to dutasteride monotherapy, 84 percent switched without any obvious deterioration in symptoms. In patients with severe baseline symptoms, 42.5 percent in the combination group and 14 percent in the monotherapy group reported worsening of symptoms. Results from the IPSS data correlated with the subjective evaluations.

## **silodosin (Rapaflo) versus placebo**

Safety and efficacy of silodosin were evaluated in two Phase 3, 12-week, randomized, double-blind, multicenter studies.<sup>108</sup> The studies consisted of a total of 923 male participants with an average age of

64.6 years. The participants were randomized to receive either silodosin 8 mg once daily or placebo. The primary efficacy endpoint was the IPSS that included irritative symptoms (frequency, urgency, and nocturia) and obstructive symptoms (hesitancy, incomplete emptying, intermittency, and weak stream). Maximum urine flow rate (Qmax) was a secondary outcome measure. After 12 weeks, silodosin therapy resulted in significant decrease in IPSS compared with placebo (Study-1: -6.5 versus -3.6, respectively; Study-2: -6.3 versus -3.4, respectively;  $p < 0.0001$  in both studies). Patients in the silodosin group also had significantly improve Qmax scores (maximum urine flow rates), when compared to placebo, as early as two hours following the first dose and at 12 weeks of treatment. The silodosin group had statistically significant increases in Qmax versus placebo in both studies.

### **silodosin (Rapaflo) and tamsulosin (Flomax)**

A randomized, double-blind, placebo-controlled study evaluated the safety and efficacy of silodosin 8 mg daily, tamsulosin 0.2 mg daily, or placebo for 12 weeks in 457 patients.<sup>109</sup> The primary endpoint was the change from IPSS from baseline. The change in the total IPSS from baseline in the silodosin, tamsulosin, and placebo groups was -8.3, -6.8, and -5.3, respectively. There was a significant decrease in the IPSS versus placebo in the silodosin group from week one. The most common adverse event in the silodosin group was abnormal ejaculation, which occurred more often in the silodosin group than in the tamsulosin group (22.3 percent versus 1.6 percent, respectively). However, only five men (2.9 percent) discontinued treatment for abnormal ejaculation.

### **dutasteride (Avodart) and finasteride (Proscar)**

The Enlarged Prostate International Comparator Study (EPICS) was a multicenter, randomized double-blind, 12-month, parallel-group study.<sup>110</sup> Men over 50 years old with a diagnosis of BPH received once daily treatment with dutasteride 0.5 mg (n=813) or finasteride 5 mg (n=817). There was a four-week placebo run-in period then patients were randomized to receive dutasteride or finasteride for 48 weeks, followed by an optional 24-month, open-label phase in which patients received dutasteride 0.5 mg once daily. At month 12, a similar reduction in prostate volume, the primary endpoint, was reported in the finasteride group and the dutasteride group (26.7 and 26.3 percent, respectively;  $p = 0.65$ ).

### **tadalafil (Cialis) and placebo**

The safety and efficacy of tadalafil for the treatment of BPH was evaluated in two 12-week, double-blinded, placebo-controlled, parallel-design studies.<sup>111</sup> In Study-1, patients (n=1,058) were randomized to receive tadalafil 2.5 mg, 5 mg, 10 mg or 20 mg once daily or placebo. In Study-2, patients (n=325) were randomized to either tadalafil 5 mg once daily or placebo. The primary efficacy endpoint in both studies was the International Prostate Symptom Score (IPSS). Tadalafil 5 mg for once daily use resulted in statistically significant improvement in the total IPSS compared to placebo in both studies (Study-1: -2.2 and -4.8, respectively,  $p < 0.001$ ; Study-2: -3.6 and -5.6, respectively,  $p = 0.004$ ).

## **SUMMARY**

Head-to-head studies have not distinguished any of the alpha-blockers from one another in terms of effectiveness. However, selective alpha-blockers such as alfuzosin (Uroxatral), tamsulosin (Flomax), and silodosin (Rapaflo) may have a decreased incidence of hypotension-related adverse events.

The Enlarged Prostate International Comparator Study (EPICS) reported a similar reduction in prostate volume for the 5-Alpha Reductase (5AR) Inhibitors, dutasteride (Avodart) and finasteride (Proscar). Dutasteride and the alpha-blocker, tamsulosin, are available as the combination product, Jalyn. Two studies have shown that 5AR Inhibitors may increase the risk of development of high-grade prostate cancer; however, causal effects have not been established. 5-Alpha Reductase Inhibitors are not approved for the prevention of prostate cancer.

The phosphodiesterase 5 (PDE5) inhibitors, tadalafil (Cialis), has recently been approved for the treatment of the signs and symptoms of BPH, given as a once daily dosage.

The MTOPS and CombaT studies indicate that combination therapy is likely to be more effective at inhibiting disease progression than monotherapy with either agent. Combination therapy is most appropriate for men at highest risk for disease progression and for those experiencing symptoms of LUTS with demonstrable or indicated prostate enlargement. While combination therapy has demonstrated greater effectiveness than monotherapy, the combination product available has not proven more effective than coadministration of the individual products in treating disease progression and symptom relief.

## REFERENCES

- 1 Uroxatral [package insert]. Bridgewater, NJ; Sanofi-Synthelabo, December 2010.
- 2 Cardura [package insert]. New York, NY; Pfizer; July 2009.
- 3 Cardura XL [package insert]. New York, NY; Pfizer; July 2011.
- 4 Rapaflo [package insert]. Corona, CA; Watson; November 2011.
- 5 Flomax [package insert]. Ridgefield, CT; Boehringer Ingelheim; July 2011.
- 6 Hytrin [package insert]. North Chicago, IL; Abbott; July 2009.
- 7 Avodart [package insert]. Research Triangle Park, NC; GlaxoSmithKline; June 2011.
- 8 Proscar [package insert]. Whitehouse Station, NJ; Merck; June 2011.
- 9 Jalyn [package insert]. Research Triangle Park, NC; GlaxoSmithKline; June 2011.
- 10 Cialis [package insert] Indianapolis, IN; Eli Lilly and Company; October 2011.
- 11 Roehrborn CG and McConnell JD. "Etiology, pathophysiology, epidemiology and natural history of benign prostatic hyperplasia". In Campbell's Urology. Edited by PC Walsh, AB Retik, ED Vaughan, Jr. and AJ Wein. Philadelphia, PA: WB Saunders Company, chap 38, pp 1297-1330, 2002.
- 12 Kirby R, McConnell J. Benign Prostatic Hyperplasia. Oxford, England: Health Press; 1996.
- 13 Mosier W. Benign prostatic hyperplasia: focusing on primary care. Clin Rev. 1998; 8:55-58, 63-66, 68-70, 73-75.
- 14 AUA Guideline on Management of Benign Prostatic Hyperplasia. J Urol. 2003; 170:530-547.
- 15 Mosier W. Benign prostatic hyperplasia: focusing on primary care. Clin Rev. 1998; 8:55-58, 63-66, 68-70, 73-75.
- 16 Leveillee R. Benign Prostatic Hypertrophy. <http://emedicine.medscape.com/article/437359-overview>. Accessed January 17, 2012.
- 17 American Urological Association, Inc. Available at: [http://www.auanet.org/content/guidelines-and-quality-care/clinical-guidelines/main-reports/bph-management/chap\\_1\\_GuidelineManagementof\(BPH\).pdf](http://www.auanet.org/content/guidelines-and-quality-care/clinical-guidelines/main-reports/bph-management/chap_1_GuidelineManagementof(BPH).pdf). Accessed January 17, 2012.
- 18 American Urological Association, Inc. Available at: [http://www.auanet.org/content/guidelines-and-quality-care/clinical-guidelines/main-reports/bph-management/chap\\_1\\_GuidelineManagementof\(BPH\).pdf](http://www.auanet.org/content/guidelines-and-quality-care/clinical-guidelines/main-reports/bph-management/chap_1_GuidelineManagementof(BPH).pdf). Accessed January 17, 2012.
- 19 American Urological Association, Inc. Available at: [http://www.auanet.org/content/guidelines-and-quality-care/clinical-guidelines/main-reports/bph-management/chap\\_1\\_GuidelineManagementof\(BPH\).pdf](http://www.auanet.org/content/guidelines-and-quality-care/clinical-guidelines/main-reports/bph-management/chap_1_GuidelineManagementof(BPH).pdf). Accessed January 17, 2012.
- 20 Cooper KL, McKiernan JM, Kaplan SA. A-adrenoceptor antagonists in the treatment of benign prostatic hyperplasia. Drugs. 1999; 57:9-17.
- 21 De Mey C.  $\alpha$ 1 blockers for BPH: are there differences? Eur Urol. 1999; 36(suppl 3):52-63.
- 22 Mimata H, Nomura Y, Kasagi Y, et al. Prediction of  $\alpha$ -blocker response in men with benign prostatic hyperplasia by magnetic resonance imaging. Urology. 1999; 54:829-833.
- 23 Drug Facts and Comparisons. St. Louis, MO: Facts and Comparisons. 2000: 498-501.
- 24 AHFS Drug Information. Bethesda, MD: Am Soc Hlth-Syst Pharm. 2000: 3445-3446.
- 25 Randrup E, Baum N. Pharmacologic management of benign prostatic hyperplasia. Hosp Med. 1997; 33:43-53.
- 26 Keetch D. Medical therapy for benign prostatic hyperplasia. Infect Urol. 1997; 10:54-60.
- 27 Kirby R, McConnell J. Benign Prostatic Hyperplasia. Oxford, England: Health Press. 1996.
- 28 McConnell J, Wilson J, George F, et al. Finasteride, an inhibitor of 5 $\alpha$ -reductase, suppresses prostatic dihydrotestosterone in men with benign prostatic hyperplasia. J Clin Endocrinol Metab. 1992; 74:505-508.
- 29 Avodart [package insert]. Research Triangle Park, NC; GlaxoSmithKline, June 2011.
- 30 Proscar [package insert]. Whitehouse Station, NJ; Merck; June 2011.
- 31 Cialis [package insert] Indianapolis, IN; Eli Lilly and Company; October 2011
- 32 Lee M. Alfuzosin Hydrochloride for the Treatment of Benign Prostatic Hyperplasia. Am J Health-Syst Pharm. 2003; 60:1426-1439.
- 33 Uroxatral [package insert]. Bridgewater, NJ; Sanofi-Synthelabo, December 2010.

- 34 Cardura [package insert]. New York, NY; Pfizer; July 2009.
- 35 Cardura XL [package insert]. New York, NY; Pfizer; July 2011.
- 36 Rapaflo [package insert]. Corona, CA; Watson; November 2011.
- 37 Flomax [package insert]. Ridgefield, CT; Boehringer Ingelheim; July 2011.
- 38 Hytrin [package insert]. North Chicago, IL; Abbott; July 2009.
- 39 Avodart [package insert]. Research Triangle Park, NC; GlaxoSmithKline; June 2011.
- 40 Proscar [package insert]. Whitehouse Station, NJ; Merck; June 2011.
- 41 Jalyn [package insert]. Research Triangle Park, NC; GlaxoSmithKline; June 2011.
- 42 Cialis [package insert] Indianapolis, IN; Eli Lilly and Company; October 2011
- 43 Uroxatral [package insert]. Bridgewater, NJ; Sanofi-Synthelabo, December 2010.
- 44 Flomax [package insert]. Ridgefield, CT; Boehringer Ingelheim; July 2011.
- 45 Rapaflo [package insert]. Corona, CA; Watson; November 2011.
- 46 Cardura [package insert]. New York, NY; Pfizer; July 2009.
- 47 Hytrin [package insert]. North Chicago, IL; Abbott; July 2009.
- 48 Cardura XL [package insert]. New York, NY; Pfizer; July 2011.
- 49 American Urological Association, Inc. Available at: [http://www.auanet.org/content/guidelines-and-quality-care/clinical-guidelines/main-reports/bph-management/chap\\_1\\_GuidelineManagementof\(BPH\).pdf](http://www.auanet.org/content/guidelines-and-quality-care/clinical-guidelines/main-reports/bph-management/chap_1_GuidelineManagementof(BPH).pdf). Accessed January 17, 2012.
- 50 Proscar [package insert]. Whitehouse Station, NJ; Merck; June 2011.
- 51 Avodart [package insert]. Research Triangle Park, NC; GlaxoSmithKline, June 2011.
- 52 Jalyn [package insert]. Research Triangle Park, NC; GlaxoSmithKline; June 2011.
- 53 Cialis [package insert] Indianapolis, IN; Eli Lilly and Company; October 2011
- 54 Uroxatral [package insert]. Bridgewater, NJ; Sanofi-Synthelabo, December 2010.
- 55 Flomax [package insert]. Ridgefield, CT; Boehringer Ingelheim; July 2011.
- 56 Rapaflo [package insert]. Corona, CA; Watson; November 2011.
- 57 Cardura [package insert]. New York, NY; Pfizer; July 2009.
- 58 Hytrin [package insert]. North Chicago, IL; Abbott; July 2009.
- 59 Cardura XL [package insert]. New York, NY; Pfizer; July 2011.
- 60 Proscar [package insert]. Whitehouse Station, NJ; Merck; June 2011.
- 61 Avodart [package insert]. Research Triangle Park, NC; GlaxoSmithKline, June 2011.
- 62 Jalyn [package insert]. Research Triangle Park, NC; GlaxoSmithKline; June 2011.
- 63 Cialis [package insert] Indianapolis, IN; Eli Lilly and Company; October 2011
- 64 Uroxatral [package insert]. Bridgewater, NJ; Sanofi-Synthelabo, December 2010.
- 65 Cardura [package insert]. New York, NY; Pfizer; July 2009.
- 66 Cardura XL [package insert]. New York, NY; Pfizer; July 2011.
- 67 Rapaflo [package insert]. Corona, CA; Watson; November 2011.
- 68 Flomax [package insert]. Ridgefield, CT; Boehringer Ingelheim; July 2011.
- 69 Hytrin [package insert]. North Chicago, IL; Abbott; July 2009.
- 70 Avodart [package insert]. Research Triangle Park, NC; GlaxoSmithKline; June 2011.
- 71 Proscar [package insert]. Whitehouse Station, NJ; Merck; June 2011.
- 72 Jalyn [package insert]. Research Triangle Park, NC; GlaxoSmithKline; June 2011.
- 73 Cialis [package insert] Indianapolis, IN; Eli Lilly and Company; October 2011
- 74 Cardura [package insert]. New York, NY; Pfizer; July 2009.
- 75 Hytrin [package insert]. North Chicago, IL; Abbott; July 2009.
- 76 Cardura XL [package insert]. New York, NY; Pfizer; July 2011
- 77 Proscar [package insert]. Whitehouse Station, NJ; Merck; June 2011.
- 78 Uroxatral [package insert]. Bridgewater, NJ; Sanofi-Synthelabo, December 2010.
- 79 Flomax [package insert]. Ridgefield, CT; Boehringer Ingelheim; July 2011.
- 80 Avodart [package insert]. Research Triangle Park, NC; GlaxoSmithKline, June 2011.
- 81 Rapaflo [package insert]. Corona, CA; Watson; November 2011.
- 82 Jalyn [package insert]. Research Triangle Park, NC; GlaxoSmithKline; June 2011.
- 83 Cialis [package insert] Indianapolis, IN; Eli Lilly and Company; October 2011
- 84 Uroxatral [package insert]. Bridgewater, NJ; Sanofi-Synthelabo, December 2010.
- 85 Cardura [package insert]. New York, NY; Pfizer; July 2009.
- 86 Cardura XL [package insert]. New York, NY; Pfizer; July 2011.
- 87 Rapaflo [package insert]. Corona, CA; Watson; November 2011.
- 88 Flomax [package insert]. Ridgefield, CT; Boehringer Ingelheim; July 2011.
- 89 Hytrin [package insert]. North Chicago, IL; Abbott; July 2009.
- 90 Avodart [package insert]. Research Triangle Park, NC; GlaxoSmithKline; June 2011.
- 91 Proscar [package insert]. Whitehouse Station, NJ; Merck; June 2011.
- 92 Jalyn [package insert]. Research Triangle Park, NC; GlaxoSmithKline; June 2011.
- 93 Cialis [package insert] Indianapolis, IN; Eli Lilly and Company; October 2011
- 94 de Reijke TM, Klarskov P. Comparative efficacy of two alpha-adrenoreceptor antagonists, doxazosin and alfuzosin, in patients with lower urinary tract symptoms from benign prostatic enlargement. *BJU Int.* 2004; 93:757-62.
- 95 Nordling J. Efficacy and safety of two doses (10 and 15 mg) of alfuzosin or tamsulosin (0.4 mg) once daily for treating symptomatic benign prostatic hyperplasia. *BJU Int.* 2005; 95:1006-12.
- 96 Lapitan M, Acepcion V, Mangubat J. A comparative study on the safety and efficacy of tamsulosin and alfuzosin in the management of symptomatic benign prostatic hyperplasia: a randomized controlled clinical trial. *J Int Med Res.* 2005; 33(5):562-573.

- 97 Kirby RS, Roehrborn C, Boyle P, et al. Efficacy and tolerability of doxazosin and finasteride, alone or in combination, in treatment of symptomatic benign prostatic hyperplasia: the Prospective European Doxazosin and Combination Therapy (PREDICT) trial. *Urology*. 2003; 61:119-26.
- 98 McConnell JD, Roehrborn CG, Bautista OM, et al. The long-term effect of doxazosin, finasteride, and combination therapy on the clinical progression of benign prostatic hyperplasia. *N Engl J Med*. 2003; 349:2387-98.
- 99 Kaplan SA, McConnell JD, Roehrborn CG, et al. Combination therapy with doxazosin and finasteride for benign prostatic hyperplasia in patients with lower urinary tract symptoms and a baseline total prostate volume of 25ml or greater. *J Urol*. 2006; 175(1): 217-20.
- 100 Kaplan SA, Roehrborn CG, McConnell JD, et al. Long-term treatment with finasteride results in a clinically significant reduction in total prostate volume compared to placebo over the full range of baseline prostate sizes in men enrolled in the MTOPS trial. *J Urol*. 2008; 180(3): 1030-2.
- 101 Samli MM, Dincel C. Terazosin and doxazosin in the treatment of BPH: results of a randomized study with crossover in non-responders. *Urol Int*. 2004; 73:125-9.
- 102 Andersen M, Dahlstrand C, Hoyer K. Double-blind trial of the efficacy and tolerability of doxazosin in the gastrointestinal therapeutic system, doxazosin standard, and placebo in patients with benign prostatic hyperplasia. *Eur Urol*. 2000; 38(4):400-9.
- 103 Roehrborn CG. Efficacy and safety of a dual inhibitor of 5- $\alpha$ -reductase types 1 and 2 (dutasteride) in men with benign prostatic hyperplasia. *Urology*. 2002; 60:434-41.
- 104 Okada H, Kamidono S, Yoshioka T, et al. A comparative study of terazosin and tamsulosin for symptomatic benign prostatic hyperplasia in Japanese patients. *BJU International*. 2000; 85:676-681.
- 105 Roehrborn CG, Siami P, Barkin J, et al. The effects of dutasteride, tamsulosin and combination therapy on lower urinary tract symptoms in men with benign prostatic hyperplasia and prostatic enlargement: 2-year results from the CombaT study. *J Urol*. 2008; 179(2):616-21.
- 106 Roehrborn CG, Siami P, Barkin J, et al. The effects of combination therapy with dutasteride and tamsulosin on clinical outcomes in men with symptomatic benign hyperplasia: 4-year results from the CombaT study. *Eur Urol*. 2010; 57(1):123-31.
- 107 Barkin J, Guimaraes M, Jacobi G, et al. Alpha-blocker therapy can be withdrawn in the majority of men following initial combination therapy with the dual 5 $\alpha$ -reductase inhibitor dutasteride. *Eur Urol*. 2003; 44:461-466.
- 108 Rapaflo [package insert]. Corona, CA; Watson; November 2011.
- 109 Kawabe K, Yoshida M, Homma Y, et al for the Silodosin Clinical Study Group. Silodosin, a new alpha1A-adrenoceptor-selective antagonist for treating benign prostatic hyperplasia: results of a phase III randomized, placebo-controlled, double-blind study in Japanese men. *BJU Int*. 2006; 98(5):1019-24.
- 110 Nickel JC, Gillling P, Tammela TL, et al. Comparison of dutasteride and finasteride for treating benign prostatic hyperplasia: the Enlarged Prostate International Comparator Study (EPICS). *BJU Int*. 2011; 108(3):388-94.
- 111 Cialis [package insert] Indianapolis, IN; Eli Lilly and Company; October 2011.