

# Article Review: Atenolol Importance as a Medication and in Industry

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## ABSTRACT

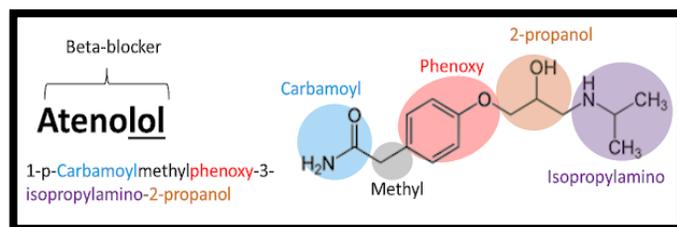
Atenolol is used with or without other medications to help patients with hypertension (high blood pressure) by reducing their blood pressure. High blood pressure causes heart attacks, strokes, and kidney failure. Moreover, atenolol is also utilized to treat chest pain and to help patients to stay survival after they have a heart attack. It's chemical structure sometimes called a benzene acetamide. It is known as a cardio-selective drug and betal-selective medication too. Scientists have proven in long term investigations for five years that oral administration of atenolol has no effect on hemodynamic. In addition to its role in the medical field, may also introduce several industrial fields, such as water treatment, and also complications with transitional metals.

## 1. ATENOLOL

Atenolol is a cardio-selective medication and known beta1-selective medication as well. It is also available as the brand-name drug Tenormin. This is mean atenolol applies smaller blocking activity on beta2 ones in lung rather than on myocardial beta1-receptors. Moreover, the bronchial system is kept open by beta2 receptors. When the receptors are jammed spasm of bronchial can happen and sever lack of oxygen in the body blood can be demonstrated. Hence atenolol is a very selective cardio medication; it can decrease the risk of bronchospastic reactions when utilizing [1].

## 2. STRUCTURE

Atenolol chemical structure might be known as a benzene acetamide, [1-p- carbamoyl methyl phenoxy-3 isopropylamino-2-propanol]. The molecular and structural formula of atenolol is C<sub>14</sub>H<sub>22</sub>N<sub>2</sub>O<sub>3</sub> and the molecular weight is 266.34 as shown Figure 1. Atenolol is relatively soluble in water (26.5 mg/mL) at room temperature and it is considered a polar hydrophilic molecule. Atenolol as a lipid insoluble molecule is excreted by kidneys and has little brain penetration.



C<sub>14</sub>H<sub>22</sub>N<sub>2</sub>O<sub>3</sub>  
M.W. 266.34

Fig:1: The molecular and structural formula of atenolol [2].

## 3. APPROACH OF ATENOLOL SYNTHESIS

Atenolol is synthesized from butyl-p-hydroxyphenylacetate that is easily gained from an esterification of p-hydroxyphenylacetic acid and 1-butanol. The condensation reaction of butyl-p-hydroxyphenylacetate and chloroepoxide using pyridine as a catalyst resulting of mixture 70% target intermediate product and 30% of by-product 1-[p-[(butoxycarbonyl)methyl]-phenoxy]-2,3-epoxypropane then HCl is added to convert all 30% of by-product to the target intermediate product. Due to existence of chiral atom in intermediate molecule 1-[p-[(butoxy-carbonyl) methyl]-phenoxy]-3-chloro-propan-2-ol the racemic mixture is formed. The crude product is purified by recrystallization in ethyl acetate to obtain atenolol pure racemate in 95% yield.

## 4. INDICATIONS AND CLINICAL USE [3,4]:

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- reducing high blood pressure (hypertension)
- decreasing chest pain (angina)
- decreasing the work on the patient heart muscle to push blood through the patient body, after a heart attack

### 5. THE BIOLOGICAL PROCESS [5, 6].

Atenolol is a 2<sup>nd</sup> b-block generation and it considers a bselective antagonist. Thus the selectivity is not complete and at bigger doses it inhibits b-2 adrenoceptors chiefly positioned in vascular musculature and bronchial hence the most medication influences of atenolol are on the cardiovascular system as shown in Table 1. When simulation of b-receptors is little the negative influences of ionotropic and chronotropic are small. Atenolol reduces the predictable increase in heart rate or myocardial contractility when sympathetic nervous system is activated such as during exercise or stress. The exercise prompts the cardiac output (CO) lower influenced due to a rise in stroke volume. It reduces the influences of catecholamine on elements of myocardial oxygen consumption such as heart rate and contractility. The entire peripheral resistance which has been reported by researchers is affected by period concentration, decreasing heart rate, blood pressure and cardiac index. It has demonstrated in some studies [7] that oral taking of atenolol in chronic way either increases the vascular resistance by 5% or have no effects. Researchers have demonstrated in long term investigations that oral administration of atenolol has no influence on hemodynamic after five years of therapy [8].

Table 1: Atenolol cardiac influences

1.Negative Chronotropic	reducing the heart rate
2.Negative dromotropic	reducing the conduction
3.Negative inotropic	reducing contractility
4.Anti arrhythmic	
5.Anti ischemic	

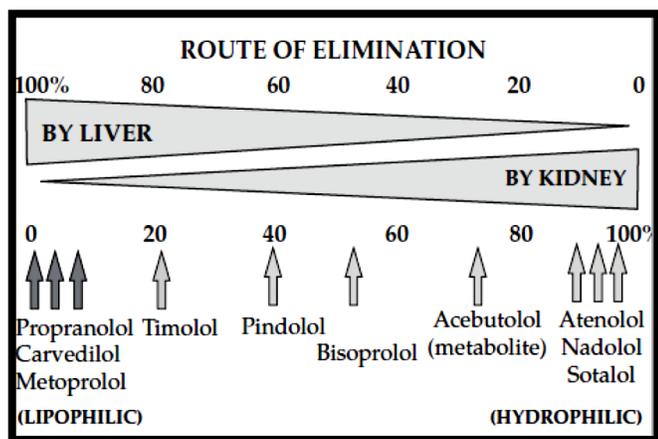


Fig:2: Schematic chart of elimination routes [2].

### 6. THE ATENOLOL SELECTIVITY

Atenolol has a great selectivity and affinity for  $\beta_1$ -adrenoreceptors and this is because of different interactions between aryloxypropanolamine-group and several of amino acid for the rest of proteins [9]. One of the most significant factors stabilized the influence of atenolol to sort linking to the receptor energetically useful is the ionic interaction between the negatively charged aspartic acid 113 and hydrogen atom of the protonated amine functional group as shown in Figure 3. It has also demonstrated the existence of hydrogen bonding between the asparagine 293 and the hydroxyl group of atenolol. Recently, it was showed that there is an interaction between the aryl of atenolol and phenylalanine 290 and tryptophan 286 like a  $\pi$ - $\pi$  interaction sandwich.

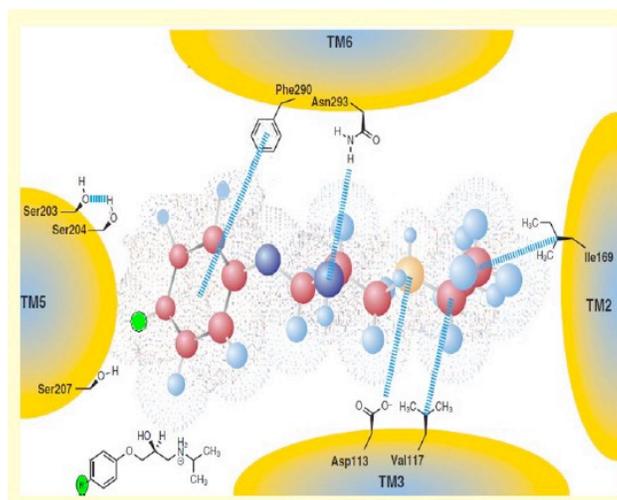


Fig:3: Interactions of atenolol functional groups with the receptor [10].

### 7.SOME SIDE EFFECTS OF ATENOLOL UTILIZING [11].

Below is the most common atenolol side influences on patients.

- Reduce the temperature for hands and feet
- Struggle in emptying the bowels, commonly associated with hardened feces (Constipation)
- dizziness
- headache
- breath smallness
- unexplained exhaustion
- leg pain
- reducing the blood pressure less than usual.

### 8. INDUSTRIAL APPLICATION

#### 8.1. TREATMENT OF WATER [12]:

Atenolol has industrial applications where it has been utilized with water purification as shown in Figure 4. Treatment of water can be significantly improved by transformation of atenolol using chlorine and UV light (254 nm) then photo-cleavage of N-Cl bond to form a free radical,

as most of micro-pollutants have secondary amine units. This research includes the study of kinetic transformation mechanism of atenolol amines with chlorine in the presence of UV light [13].

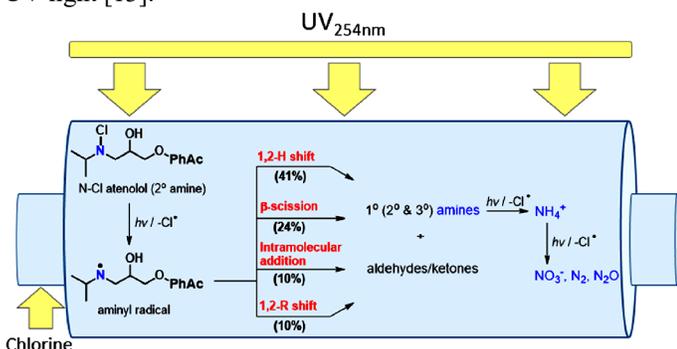
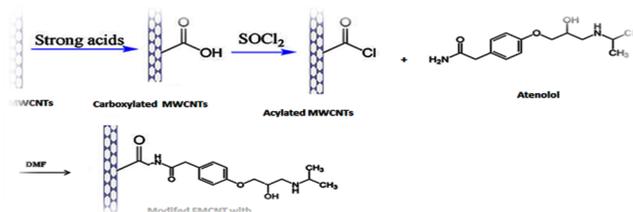


Fig: 4: Transformation of atenolol (ATN) [14].

## 8.2. MODIFIED FUNCTIONALIZED MULTIWALL CARBON NANOTUBES (FMWCNT) [15].

Atenolol has also used to modify the functionalized multiwall carbon nanotubes to be utilized as a cardiovascular medications having active nitrogen which can chemically react with functionalized multiwall carbon nanotubes as shown in Scheme 1. This kind of products can be characterized by using FTIR spectroscopy to prove the presence of amide group due to the new linkage. The SEM technique was used to determine the morphology of modified nanotubes dimensions.



Scheme1: Strategy for modified functionalized multiwall carbon nanotubes (FMWCNT) synthesis [15].

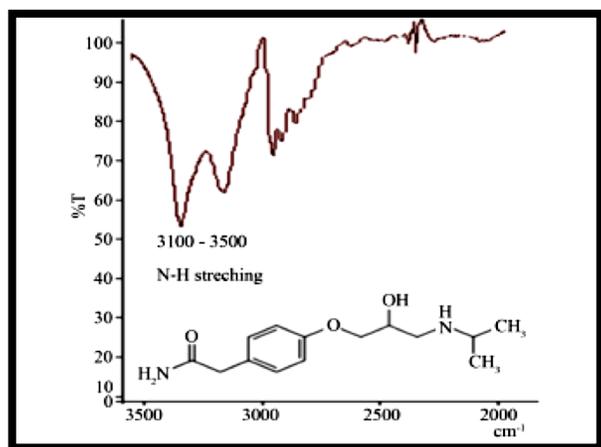


Fig:5: Pure atenolol FTIR spectrum [16].

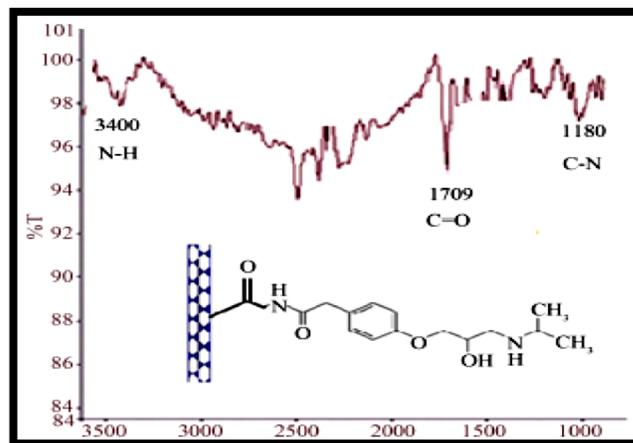


Fig: 6: Modified functionalized multiwall carbon nanotubes (FMWCNT) FTIR spectrum [17].

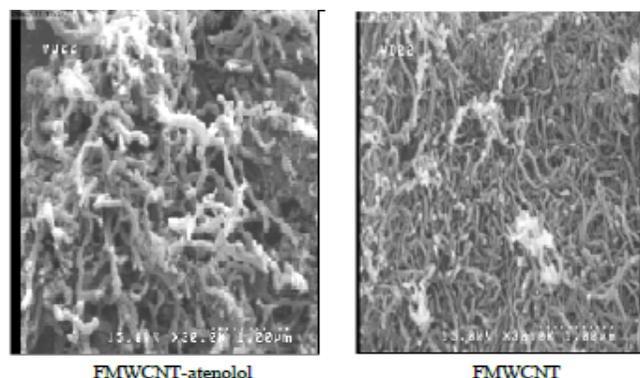


Fig:7: SEM images of functionalized multiwall carbon nanotubes (FMWCNT) and FMWCNT-atenolol [17].

## 9. CONCLUSIONS

Atenolol can be utilized for lowering high blood pressure with or sometime without other medications. Patients with high blood pressure can get heart attacks, strokes, and sometimes even they have kidney failure. Atenolol is also used to help patients with chest ache after heart attack to help them get survival. Moreover, this medication is also used in industry beside its importance in the medical field, such as water treatment, and also modifies the functionalized multiwall carbon nanotubes.

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## أهمية الاتينولول في المجال الطبي والصناعي

بنين سلام و عماد يوسف و محمد حسين المشهداني

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الخلاصة:

يستخدم أتينولول مع أو بدون أدوية أخرى لمساعدة المرضى الذين يعانون من ارتفاع ضغط الدم لخفض ضغط الدم. ارتفاع ضغط الدم يسبب النوبات القلبية والسكتات الدماغية والفشل الكلوي. أضاف الى ذلك، يستخدم أتينولول أيضاً لعلاج ألم الصدر عند المرضى بعد تعرضهم لأزمة قلبية. يسمى التركيب الكيميائي أحياناً أسيتاميد البنزين. ومن المعروف باسم الدواء الانتقائي القلب والأدوية الانتقائية بيتا I أيضاً. أثبت العلماء في دراسات طويلة الأمد لمدة خمس سنوات أن تناول الأتینولول عن طريق الفم ليس له تأثير على الدورة الدموية. بالإضافة إلى دورها في المجال الطبي، يمكن أيضاً إدخال العديد من المجالات الصناعية، مثل معالجة المياه، وأيضاً مضاعفات المعادن الانتقالية.

**الكلمات المفتاحية:** أتينولول، ارتفاع ضغط الدم، انتقائي القلب، ماء