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(54) SECONDARY AMINO TETRAZOLYLOXYPROPANOLS

(71) We, BRISTOL-MYERS COMPANY, a Company organised and existing under the laws of the state of Delaware, United States of America, of 345 Park Avenue, State of New York 10022, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

The present invention relates to heterocylic carbon compounds of the tetrazole series, to pharmaceutical compositions containing them and to their use in the treatment of certain body conditions.

A substantial body of prior art has developed during the last ten years involving compounds of the 3-aryloxy-2-hydroxypropylamine series which have β-adrenergic receptor blocking activity and are useful in the treatment of cardiovascular diseases including hypertension, angina pectoris, and cardiac arrhythmias. These structures are typified by the substance 1-isopropylamino-3-(1-naphthoxy)-2-propanol which is currently in medical use under the non-proprietary name propranolol. Propranolol and a related group of naphthoxypropanolamines are described in U.S. Patent No. 3,337,628. A large number of patents have been granted since that time on carbocyclic ethers in which other aromatic rings replace the naphthoxy group of propranolol. Many of these compounds are in the phenoxy series and others are phenoxy compounds with fused heterocyclic rings. More recently, (heterocyclo)oxypropanol-amine ethers have been described in which the ring of the foregoing compounds is replaced with a heterocyclic ring. Representative compounds of this type are found in the following patents and publications.

3-(3-*tert.*-Butylamino-2-hydroxypropoxy)-2-methyl-4-pyranone, U.S. Patent No. 3,828,076

3-Morpholino-4-(3-*tert.*-butylamino-2-hydroxypropoxy)-1,2,5-thiadiazole, U.S. Patent No. 3,891,639

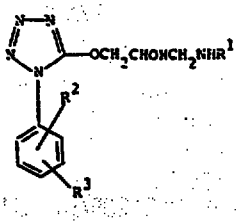
2-(3-*tert.*-Butylamino-2-hydroxypropoxy)-3-phenylpyrazine, U.S. Patent No. 3,946,009

2-(3-*tert.*-Butylamino-2-hydroxypropoxy)thiazole, U.S. Patent No. 3,983,010

5-(3-*tert.*-Butylamino-2-hydroxypropoxy)-3-methyl-1-phenylpyrazole, U.S. Patent No. 3,920,691

1-(*tert.*-Butylamino)-3-[(1-phenyl-5-tetrazolyl)oxy]-2-propanol, Antonio, et al., J. Med. Chem. *21*, 123-126 (1978).

The compounds of the present invention are represented by the following formula



Formula I

In the foregoing formula, R^1 is selected from the group consisting of 2-(3-indolyl)-1,1-dimethylethyl, adamantyl, alkyl having 1 to 12 carbon atoms, hydroxy-alkyl having 2 to 12 carbon atoms with the hydroxyl group attached to a carbon atom other than that carbon atom attached to the nitrogen atom, alkenyl having 3 to 12 carbon atoms, cycloalkyl having 3 to 6 ring atoms, cycloalkylalkyl having 4 to 12 carbon atoms including 3 to 6 ring atoms, cycloalkenyl having 5 to 6 ring atoms, carbocyclic aralkyl having 7 to 12 carbon atoms, substituted carbocylic aralkyl having 7 to 18 carbon atoms, carbocyclic aryloxyalkyl having 8 to 12 carbon atoms, and substituted carbocyclic aryloxyalkyl having 8 to 18 carbon atoms wherein said substituted aralkyl and said substituted aryloxyalkyl groups each have 1 or 2 ring substituents selected from the group consisting of halogen, alkoxy having 1 to 6 carbon atoms, alkyl having 1 to 6 carbon atoms, and alkenyl having 3 to 6 carbon atoms, R^2 is hydrogen or methyl, and R^3 is hydrogen, methyl, halogen including chlorine, bromine, iodine, and fluorine, nitro, or acetamido.

The invention includes compounds having the foregoing structural formula and the acid addition salts thereof. For medical use, the pharmaceutically acceptable acid addition salts are preferred. The pharmaceutically acceptable acid addition salts are those salts in which the anion does not contribute significantly to the toxicity or pharmacological activity of the salt, and as such, they are the pharmacological equivalents of the bases having the foregoing structural formula. In some instances, the salts have physical properties which make them more desirable for pharmaceutical formulation purposes such as solubility, lack of hygroscopicity, compressibility with respect to tablet formation and compatibility with other ingredients with which the substances may be used for pharmaceutical purposes. Acid addition salts which do not meet the foregoing criteria for pharmaceutical acceptability, for instance as to toxicity, are sometimes useful as intermediates for isolation and purification of the present substances or for other chemical synthetic purposes such as separation of optical isomers. Such salts are also part of the invention.

The acid addition salts are made by reaction of a base of the foregoing structural formula with the acid preferably by contact in solution. They may also be made by metathesis or treatment with an anion exchange resin under conditions in which the anion of one salt of the substance is replaced by another anion under conditions which allows for separation of the undesired species such as by precipitation from solution or extraction into a solvent or elution from or retention on an anion exchange resin. Pharmacuetically acceptable acids for the purposes of salt formation include hydrochloric, hydrobromic, hydroiodic, citric, acetic, benzoic, phosphoric, nitric, mucic, isethionic, methanesulfonic, *p*-toluenesulfonic, gluco-saccharic, palmitic, heptanoic, and others.

The compounds of the present invention shown by the foregoing structural formula contain an asymmetric carbon atom in the propanolamine side chain and occur as optically active isomers as well as racemic mixtures thereof. The present invention is intended to include both the optically active and racemic forms. Some of the substances of the present invention contain an asymmetric carbon atom in the R^1 substituent, and diastereoisomeric pairs of racemates exist.

Resolution of racemic mixtures to provide the optically active isomers of the foregoing compounds is carried out, for example, by forming a salt with an optically active acid many, of which are known to those skilled in the art, such as optically active tartaric, mandelic, cholic, O,O-di-*p*-toluoyl tartaric, and O,O-dibenzoyl tartaric acids, or other acids conventionally employed for this purpose. The claims, therefore, will be understood to embrace the products in the form of the several racemic mixtures as well as in the form of the optically active isomers where appropriate.

The compounds of the present invention show antiarrhythmic activity, β-adrenergic blocking activity, and vasodilator activity. They are relatively non-toxic and exert the foregoing physiologic effects at doses substantially below those at which adverse pharmacologic signs are exhibited. Moreover, a substantial margin exists between the doses at which adverse pharmacologic signs are exhibited and those doses which are lethal. Oral or parenteral doses in the range of 2 to 20 mg./kg. are generally suitable.

A representative compound of the present invention is the substance of Formula I in

which R^1 is *tert.*-butyl, and R^2 and R^3 are hydrogen. The preparation of this substance is described in Example 1 hereof. This substance is about 1/10 as potent a β-adrenergic blocking agent as propranolol on a dosage weight basis (conscious rat treated orally; blocking of the hypotension and tachycardia caused by isoproterenol). However, it has outstanding anti-arrhythmic activity in animal tests. Antiarrhythmic effects equivalent to those of quinidine sulfate and lidocaine, two substances which are in widespread clinical use as anti-arrhythmic agents, are obtained with substantially lower doses of the substance of Example 1.

Employing the method of Byrne et al., J. Pharmacol. Exp. Therap., January 1977, for evaluating the ability of the compound to abolish ouabain-induced ventricular tachycardia in the dog, the results shown in Table I compared to those for quinidine and lidocaine were obtained.

TABLE I

Ouabain-induced ventricular tachycardia

	Quinidine	Lidocaine	Example 1
MED*	6 mg/kg (i.v.)	3 mg/kg (i.v.)	1 mg/kg (i.v.)
End point	normal rhythm	normal rhythm	normal rhythm
Duration	>2 hr.	4-6 min.	>30 min.
EKG effects	prolonged QRS	none	none
BP effects	decrease 15-20%	decrease 8-12%	none

*median effective dose

In a surgically-induced arrhythmia in the dog according to the method of Harris, Circulation, *1*, 1318 (1950), the substance of Example 1 yielded the results shown in Table II compared to quinidine and lidocaine.

TABLE II

Occluded coronary artery, dog

	Quinidine	Lidocaine	Example 1
MED*	10 mg/kg (i.v.)	2 mg/kg (i.v.)	5 mg/kg (i.v.)
Onset	1 hr.	1 min.	5 min.
Duration	6 hr.	10-12 min.	4-5 hr.
Side effects	ataxia vomiting	agitation	none

*minimum effective dose to reduce ectopic beats by 50%

The vasodilator action of the present compounds can be demonstrated in the dog hind limb preparation in which the change in perfusion pressure at constant flow rate is measured.

The therapeutic processes of this invention comprise systemic administration of an effective, non-toxic amount of a compound of Formula I or a pharmaceutically acceptable acid addition salt thereof to a mammal having a disease state resulting from excessive stimulation of the β-adrenergic receptors, or to a mammal requiring vasodilation, or to a mammal having a cardiac arrhythmia or predisposed thereto. An effective amount is construed to mean a dose which exerts a β-adrenergic blocking action, a vasodilator effect, or an antiarrhythmic effect without undue toxic side effects. By systemic administration, it is intended to include both oral and parenteral routes. Examples of parenteral administration are intravenous injection or infusion, and intraperitoneal, intramuscular or subcutaneous injection. Rectal administration by ointment or suppository may be employed. Dosage will vary according to the route of administration with from about 0.05 to 100 mg./kg. body weight of 1-(*tert.*-butylamino)-3-[(1-phenyl-5-tetrazolyl)oxy]-2-propanol or a pharmaceutically acceptable acid addition salt thereof generally providing the desired therapeutic effect. When administered orally, a dose of 0.5 mg./kg. to 10 mg./kg. body weight is preferred.

For the preparation of pharmaceutical compositions containing the compounds of Formula I in the form of dosage units for oral administration, the compound is mixed with a solid, pulverulent carrier such as lactose, sucrose, sorbitol, mannitol, potato starch, corn starch, amylopectin, cellulose derivatives, or gelatin, as well as with glidents such as magnesium stearate, calcium stearate, polyethylene glycol waxes or the like and pressed into tablets. The tablets may be used uncoated or coated by known techniques to delay

disintegration and absorption in the gastrointestinal tract and thereby provide a sustained action over a longer period. When coated tablets are wanted, the above prepared core may be coated with concentration solution of sugar, which solution may contain e.g. gum arabic, gelatin, talc, titanium dioxide or the like. Furthermore, the tablets may be coated with a lacquer dissolved in an easily volatile organic solvent or mixture of solvents and if desired, dye may be added to this coating.

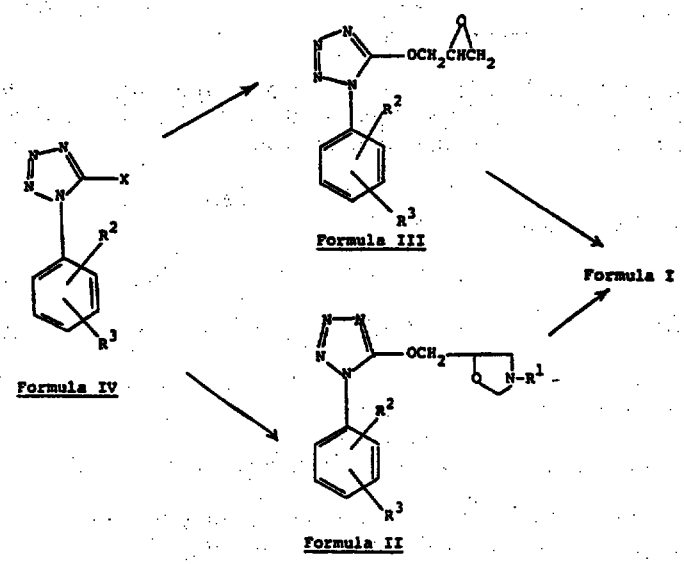
In the preparation of soft gelatin capsules consisting of gelatin and, e.g., glycerine and the like, the active ingredient is mixed with a vegetable oil. Hard gelatin capsules may contain granules of the active ingredient in combination with a solid, pulverulent carrier such as lactose, sucrose, sorbitol, mannitol, starch (such as e.g. potato starch, corn starch, or amylopectin), cellulose derivatives or gelatin.

Dose units for rectal administration may be prepared in the form of suppositories containing the compound in a mixture with a neutral fat base, or in the form of a gelatin-rectal capsule with a mixture of vegetable oil or parafin oil.

Liquid preparations suitable for oral administration are suspensions, syrups and elixirs containing from about 0.2% by weight to about 20% by weight of the active ingredient.

A suitable injectible composition comprises an aqueous solution of a water soluble pharmaceutically acceptable acid addition salt adjusted to physiologically acceptable pH.

There is also provided by the present invention a process for the preparation of the compounds of Formula I which is outlined in the following reaction scheme in which R^1, R^2, and R^3 have the same meaning as above, and X is chlorine or bromine.



This process employs methods known in the prior art for the preparation of 1-secondary-amino-3-(heterocyclo)oxy-2-propanols as represented by the patents and publications previously cited herein.

The process involves reaction of a 1-(R^2,R^3-phenyl)-5-chloro(or bromo)-1*H*-tetrazole of Formula IV with either a 3-R^1-5-oxazolidinylmethanol or with a glycidol both in the presence of a strong base which results in displacement of the halogen atom and formation of an intermediate ether or Formula II or Formula III, respectively.

The intermediate of Formula II is converted to the product Formula I by hydrolysis under acidic conditions. The product of the process is optionally then converted to the base form or acid addition salt form as desired. The hydrolysis of compounds of Formula II is accomplished with dilute mineral acid of from 0.1 N to 1 N concentration at temperatures of from about 20-100°C. The product can be recovered as the free base by neutralization of the hydrolysis mixture and collecting the precipitate. Acid addition salts may be obtained by evaporating the hydrolysis mixture or by reaction of the free base with acid. Purification is accomplished by conventional means such as recrystallization.

The conversion of the ether of Formula III into the product of Formula I is carried out simply by heating the ether either neat or in the presence of a reaction inert organic solvent with an amine of the formula R^1NH_2. No catalyst or condensation agent is required. Suitable solvents include 95% ethanol but other reaction inert organic liquids in which the reactants are soluble may be employed. These include but are not limited to benzene,

tetrahydrofuran, dibutyl ether, butanol, hexanol, methanol, dimethoxyethane, ethylene glycol, etc. Suitable reaction temperatures are from about 60-200°C.

In summary, the present invention provides a process for the preparation of the compounds of Formula I according to which a 1-(R^2,R^3-phenyl)-5-halotetrazole of Formula IV is contacted under reaction conditions with a 3-R^1-5-oxazolidinylmethanol or with glycidol to yield, respectively, a 1-(R^2,R^3-phenyl)-5-tetrazolyl ether of Formula II or Formula III and converting said ether into the product of Formula I by hydrolysis under acidic conditions when an ether of Formula II is employed or by reaction at a temperature of 60-200°C. with a primary amine of the formula R^1NH_2 alone or in the presence of a reaction inert organic solvent when an ether of Formula III is employed. Thereafter, when the substance of Formula I is obtained as the free base, it may be neutralized with a suitable acid to form the acid addition salt. When the substance of Formula I is obtained as the acid addition salt, it may be converted to the free base by neutralization with a base and elimination of the undesired salt of said base produced by the neutralization.

In the following procedures temperatures are expressed in degrees Centigrade. When designated "corr.", melting points are corrected values according to the USP method. The nuclear magnetic resonance (NMR) spectral characteristics refer to chemical shifts (δ) expressed as parts per million (ppm) versus tetramethylsilane as reference standard. The relative area reported for the various shifts corresponds to the number of hydrogen atoms in the individual substituent and the nature of the shift as to multiplicity is reported as broad singlet (bs), singlet (s), multiplet (m), doublet (d), triplet (t), or quadruplet (q) with coupling constant reported where appropriate. The format is NMR (solvent): δ (relative area, multiplicity, J value). Abbreviations employed are EtOH (ethanol), HOAc (acetic acid), Et_2O (ethyl ether), DMF (dimethylformamide), MeOH (methanol), *i*-PrOH (isopropanol), Nujol (mineral oil - Registered Trade Mark), $DMSOd_6$ (deuterodimethylsulfoxide), IR (infrared), KBr (potassium bromide), EtOAc (ethyl acetate), d (decomposition), IPE (isopropyl ether). Others are common and have well established meanings. The infrared spectra described include only absorption wave numbers (cm^{-1}) having functional group identification value. Unless indicated otherwise, KBr was employed as diluent for IR spectral determinations.

Synthesis of various compounds of Formula I via 3-R^1-5-oxazolidinylmethyl ethers of Formula II is illustrated in Examples 1-34.

Example 1. 1-(tert.Butylamino)-3-[(1-phenyl-5-tetrazolyl)-oxy]-2-propanol.-

A solution of 8.0 g. (0.07 mol) of potassium *tert.*-butoxide and 9.5 g. (0.06 mol) of 3-(*tert.*-butyl)-5-oxazolidinylmethanol in 250 ml. of THF is heated at reflux for 30 min. 1-Phenyl-5-chlorotetrazole, 10.9 g. (0.06 mol), dissolved in 100 ml. of THF, is then added portionwise during 30 min., and the mixture refluxed for 3 hr. The solvent is then removed by distillation *in vacuo* to yield a viscous syrup-like residue. This residue contains the intermediate 1-phenyl-5- 3-(*tert.*-butyl)-5-oxazolidinylmethoxy -1*H*-tetrazole which is hydrolyzed by heating for 40 min on the steam bath with 225 ml of 0.3 *N* HCl. The hydrolysis mixture is filtered, neutralized with NH_4OH and chilled to yield the crude base as a white precipitate which is collected. The crude base is converted to the hydrochloride salt by dissolving in Et_2O and treatment of the solution with EtOH-HCl, recrystallized from EtOH-EtOAc, mp 152.5-154.5° (corr.). NMR ($CDCl_3$): 1.46 (9, s); 3.13 (2 m); 4.68 (3, m); 5.64 (1, bs); 7.52 (5, m); 8.30 (1, bs); 9.50 (1, bs). IR: 690, 765, 1460, 1510, 1570, 1600. 2780.

Anal. Found: C, 51.24; H, 6.65; N, 21.43.

Examples 2-34. Additional 1-(R^1NH)-3-[(1-phenyl-5-tetrazolyl)oxy]-2-propanols.-

By substitution of various 3-R^1-5-oxazolidinylmethanols for 3-(*tert.*-butyl)-5-oxazolidinylmethanol in the process of Example 1, the following products of the present invention can be prepared.

TABLE III

Secondary amines of Formula I

Example No.	R^1
2	*n*-octyl
3	*n*-dodecyl
4	cyclohexyl
5	1-methylethyl
6	*n*-butyl
7	allyl
8	2-butenyl
9	cyclopropyl
10	cyclopentyl
11	1-cyclohexenyl
12	benzyl
13	2-phenylethyl
14	1-naphthylmethyl
15	2-(2-(2-propenyl)-6-methylphenyl)ethyl
16	2-(4-methoxyphenyl)ethyl
17	2-(3,4-dichlorophenyl)ethyl
18	2-(4-hexyloxyphenyl)-1-methylethyl
19	(4-fluorophenyl)methyl
20	(4-bromophenyl)methyl
21	(4-iodophenyl)methyl
22	2-(4-tolyl)-2-propyl
23	4-(*tert.*-butyl)-2-naphthyl methyl
24	2-(phenoxy)ethyl
25	2-(phenoxy)-1-methylethyl
26	2-(phenoxy)-1-ethylethyl
27	2-(1-naphthoxy)-1-ethylethyl
28	2-(4-bromophenoxy)ethyl
29	2-(4-fluorophenoxy)ethyl
30	2-(4-*tert.*-butylphenoxy)-1-propylethyl
31	2-(3-hexyloxyphenoxy)-1-methylethyl
32	2-(3-chloro-4-methoxyphenoxy)ethyl
33	2-(2-(2-propenyl)-6-methylphenoxy)ethyl
34	1-methyl-2-phenethyl

The 3-R^1-5-oxazolidinylmethanols required as starting materials in the foregoing examples may be prepared by known methods, for instance by reductive alkylation of the amine R^1NH_2 with glyceraldehyde employing a 5% palladium-on-carbon catalyst and methanol or other suitable solvent. When using optically active glyceraldehyde, the optically active end product of Formula I is obtained. When 1-methyl-2-phenethylamine is employed as starting material, 1,2-dihydroxy-3-(1-methyl-2-phenethylamino)propane is obtained. The resulting aminopropane diol is then converted to the desired 3-R^1-5-oxazolidinyl-methanol by reaction with 37% aqueous formaldehyde in refluxing benzene with continuous removal of the water produced as by-product. In this fashion, 1,2-dihydroxy-3-(1-methyl-2-phenethylamino)propane yields 3-(1-methyl-2-phenethyl)-5-oxazolidinylmethanol.

The synthesis of various 1-(R^2,R^3-phenyl)-5-chloro (or bromo) tetrazoles of Formula IV, their reaction with glycidol to form glycidyl ethers of Formula III, and reaction of the latter with various R^1NH_2 primary amines to yield various products of Formula I is illustrated in Examples 35-67.

R^2,R^3-SUBSTITUTED TETRAZOLES OF FORMULA IV

Example 35. 5-Chloro-1-(2,4-dimethylphenyl) tetrazole.-

A solution of 2,4-dimethylphenylisonitrile (Ugi, et al., Angew. Chem. Internat. Ed. (Engl.) *4*, 472 (1965)) (14.8 g., 0.11 mole) in 100 ml. of acetonitrile was stirred at ice bath temperature while chlorine gas was bubbled in. When TLC indicated that the isonitrile had been consumed, the solvent was removed *in vacuo*, leaving 22.7 g . of the oily isocyanodichloride. To a solution of the latter in 130 ml. of acetone was added a solution of 7.3 g. (0.11 mole) of sodium azide in 25 ml. of water. After one hour, the acetone was evaporated *in vacuo* and the aqueous residue was extracted with ethyl acetate. The extract

was washed with water and brine, dried (Na_2SO_4) and evaporated to provide 24.5 g. of a waxy solid. Trituration with isopropyl ether-hexane gave 18.9 g. of the chlorotetrazole, m.p. 75-77°.

Similar treatment of other isocyanodichlorides yielded the tetrazoles listed in Table IV. substitution of an isocyanodibromide or of bromine for chlorine in Example 35 yields the corresponding bromo-tetrazole intermediate of Formula IV.

TABLE IV

5-Chloro-1-(R^2,R^3-phenyl)tetrazole of Formula IV

Example No.	R^2,R^3	Recryst. Solvent	m.p.
36	2,4-DiMe	IPE-hexane	75-77°
37	2-Cl, 4-Me	not recrystallized	101-102°
38	4-Cl	Maggiuli & Paine, U.S. 3,437,665 (1969)	
39	4-NO_2	Kauer & Sheppard, J. Org. Chem. *32*, 3580 (1967)	
40	4-$NHCOCH_3$*	not recrystallized	146-151°

*Prepared by acylation of 1-(4-aminophenyl)-5-chloro-1*H*-tetrazole (Kauer & Sheppard, *op. cit.*) with acetic anhydride/pyridine (1:1 molar basis) in acetonitrile as solvent.

GLYCIDYL ETHERS OF FORMULA III

Example 41. 2,3-Epoxy-1-[(1-phenyl-5-tetrazolyl)oxy]-propane.-

Sodium hydride (11.9 g., 0.050 mole), washed free of mineral oil with hexane, was stirred in 1.8 1. of DMF at ice-water temperature while a solution of 72.3 g. (0.40 mole) of 1-phenyl-5-chlorotetrazole and 29.6 g. (0.40 mole of glycidol in 1.8 1. of DMF was added dropwise during 4 hours. The solution was allowed to stand at 25° overnight (16 hours), diluted with 12 1. of H_2O and extracted with ethyl acetate. The extracts were washed with water, dried (Na_2SO_4), and evaporated to give 75.7 g. of product, m.p. 77-81°. Recrystallization from MeOH-*i*-PrOH gave 55.8 g., m.p. 83-84°.

Various 1-(R^2,R^3-phenyl)-5-chloro (or bromo) tetrazoles were converted according to the method of Example 40 to the ethers listed in Table V.

TABLE V

Glycidyl ethers of Formula III

Example No.	R^2,R^3	Recryst. Solvent	m.p.
42	H	MeOH-*i*-PrOH	83-84°
43	4-Cl	Benzene-Hexane	88.5-89°
44	4-Cl, 2-Me	Benzene-Hexane	101-102°
45	2,4-DiMe	*i*-PrOH	82.5-84.5°
46	4-NO_2	*i*-PrOH	107-110.5°
47	4-$NHCOCH_3$	EtOH	169-170°

ADDITIONAL PRODUCTS OF FORMULA I

Example 48. 1-(tert.-Butylamino)-3-[(1-phenyl-5-tetrazolyl)-oxy]-2-propanol Hydrochloride.-

2,3-Epoxy-1-[(1-phenyl-5-tetrazolyl)-oxy]propane (43.7 g., 0.20 mole) was heated at the reflux temperature in 150 ml. of *tert.*-butylamine and 300 ml. of benzene for 9 hours. The solvents were evaporated *in vacuo* and the residual oil was dissolved in 100 ml. of EtOH and acidified with ethanolic HCl. Dilution with diethyl ether gave 44.8 g. of the hydrochloride of the product, m.p. 73-82°. Recrystallization from *i*-PrOH-IPE gave 30.8 g., m.p. 152.5-154.5° (corr.)

Similarly prepared were additional examples shown in Table VI. In each instance, elemental analyses for carbon, hydrogen, and nitrogen confirmed the formulas given in the table.

TABLE VI

Additional products of Formula I

Example No.	R^2,R^3	R^1	Recryst. Solvent	Molecular Formula	m.p.°+	NMR	IR
49	H	1,1-dimethyl-propyl	MeOH-IPE	$C_{14}H_{23}N_5O_2.HCl$	174-176	(DMSO-d_6) 0.89 (3, t, 6.7 Hz) 1.28 (6, s) 1.69 (2, q, 6.7 Hz) 3.08 (2, m) 4.56 (3, m) 6.08 (1, bs) 7.70 (5, m) 8.75 (1, bs)	688, 760, 1455, 1505, 1570, 1595, 2800, 2970, 3320
50	H	1-adamantyl	MeOH-IPE	$C_{20}H_{27}N_5O_2.HCl$	197.5-198.5	(DMSO-d_6) 1.67 (6, m) 2.00 (9, m) 3.30 (2, m) 4.66 (3, m) 6.22 (1, d, 5.6 Hz) 7.80 (5, m) 9.00 (2, bs)	690, 760, 1460, 1510, 1575, 1600, 2860, 2930
51	H	1-methylethyl	MeOH-IPE	$C_{13}H_{19}N_5O_2.HCl$	154.5-156.5	(DMSO-d_6) 1.30 (6, d, 6.3 Hz) 3.16 (3, m) 4.66 (3, m) 6.00 (1, bs) 7.80 (5, m) 9.30 (2, bs)	690, 765, 1445, 1460, 1505, 1575, 1600, 2820, 2980

TABLE VI (cont...)

Example No.	R^2,R^3	R^1	Recryst. Solvent	Molecular Formula	m.p.°+	NMR	IR
52	H	methyl	MeOH-IPE	$C_{11}H_{15}N_5O_2$.HCl	161-163	(DMSO-d_6) 2.57 (3, s) 3.00 (2, m) 4.40 (3, m) 6.10 (1, bs) 7.69 (5, m) 9.19 (2, bs)	690, 768, 1000, 1450, 1505, 1570, 1595, 2800, 2960
53	H	cyclohexyl-methyl	CH_3CN	$C_{17}H_{27}N_5O_2$.HCl	141.5-143.5	(DMSO-d_6) 1.10 (6, m) 1.70 (5, m) 2.92 (4, m) 4.58 (3, m) 6.10 (1, bs) 7.70 (5, m) 9.10 (2, bs)	685, 755, 1130, 1450, 1505, 1570, 1595, 2860, 2930, 3290
54	H	cyclohexyl	MeOH-IPE	$C_{16}H_{23}N_5O_2$.HCl	170-171	(DMSO-d_6) 0.9-2.2 (10, m) 3.07 (3, m) 4.51 (3, m) 5.50 (1, bs) 7.70 (5, m) 9.08 (2, bs)	690, 760, 1450, 1460, 1500, 1510, 1570, 1600, 2860, 2960
55	H	1,1,3,3-tetra-methylbutyl	CH_3CN-IPE	$C_{18}H_{29}N_5O_2$.HCl	165.5-166.5	(DMSO-d_6) 1.03 (9, s) 1.45 (6, s) 1.71 (2, s) 3.10 (2, m) 4.57 (3, m) 7.71 (5, m) 8.60 (1, bs) 9.15 (1, bs)	690, 760, 1450, 1505, 1570, 1600, 2800, 2966

TABLE VI (cont...)

Example No.	R^2,R^3	R^1	Recryst. Solvent	Molecular Formula	m.p.°+	NMR	IR
56	H	cyclopentyl	EtOH	$C_{15}H_{21}N_5O_2.HCl$	160-161.5	(DMSO-d_6) 1.72 (8, m) 3.12 (2, m) 3.51 (1, m) 4.60 (3, m) 6.12 (1, bs) 7.72 (5, m) 9.25 (1, bs) 9.45 (1, bs)	690, 760, 1450, 1500, 1570, 1600, 2780, 2960
57	H	2,5-$Me_2C_6H_3$-$OCH_2CH(CH_3)$-	EtOH	$C_{21}H_{27}N_5O_3.1/2C_2H_2O_4$*	162-163.5	(DMSO-d_6) 1.28 (3, d, 6.5 Hz) 2.23 (6, s) 3.02 (2, m) 3.36 (1, m) 3.79 (2, m) 4.22 (1, m) 4.64 (2, d, 5.8 Hz) 7.00 (3, m) 7.08 (3, bs) 7.69 (5, m)	685, 760, 1450, 1500, 1565, 1590, 1610, 2960
58	H	$-C(CH_3)_2CH_2OH$	MeOH-IPE	$C_{14}H_{21}N_5O_3.HCl$	132-134	(DMSO-d_6) 1.27 (6, s) 3.16 (2, m) 3.51 (2, s) 4.57 (3, m) 5.72 (2, bs) 7.71 (5, m) 8.52 (1, bs) 9.00 (1, bs)	685, 755, 1070, 1450, 1500, 1570, 1595, 2780, 2970

TABLE VI (cont...)

Example No.	R^2,R^3	R^1	Recryst. Solvent	Molecular Formula	m.p.°+	NMR	IR
59	4-Cl	1,1-dimethyl-ethyl	EtOH	$C_{14}H_{20}ClN_5O_2.HCl$	181-182	(DMSO-d_6) 1.37 (9, s) 3,16 (2, m) 4.64 (3, m) 6.20 (1, bs) 7.90 (4, m) 9.30 (2, bs)	830, 1090, 1380, 1500, 1570, 1600, 2800, 2990
60	4-Cl	1-methylethyl	MeOH-IPE	$C_{13}H_{18}ClN_5O_2.HCl$	181-182	(DMSO-d_6) 1.32 (6, d, 6.4 Hz) 3.18 (3, m) 4.60 (3, m) 5.72 (1, bs) 7.82 (4, m) 9.20 (2, bs)	840, 1100, 1410, 1450, 1505, 1575, 1600, 2860, 2980, 3340
61	4-Cl	1,1-dimethyl-propyl	MeOH-IPE	$C_{15}H_{22}ClN_5O_2.HCl$	185.5-186.5	(DMSO-d_6 + CF_3COOH (8:1) 0.86 (3, t, 6.8 Hz) 1.25 (6, s) 1.67 (2, q, 6.8 Hz) 3.11 (2, m) 4.65 (3, m) 7.82 (4, m) 8.85 (2, bs)	830, 1090, 1455, 1505, 1570, 1600, 2800, 2980

TABLE VI (cont...)

Example No.	R^2,R^3	R^1	Recryst. Solvent	Molecular Formula	m.p.°+	NMR	IR
62	4-Cl, 2-Me	1,1-dimethyl-ethyl	MeOH-IPE	$C_{15}H_{22}ClN_5O_2.HCl$	170-172	(DMSO-d_6) 1.30 (9, s) 2.18 (3, s) 3.06 (2, m) 4.41 (3, m) 5.25 (1, bs) 7.62 (3, m) 9.00 (2, bs)	820, 880, 110, 1379, 1455, 1500, 1570, 2780, 2980,
63	2,4-DiMe	1,1-dimethyl-ethyl	MeOH-IPE	$C_{16}H_{25}N_5O_2.HCl$	172-173	(DMSO-d_6) 1,30 (9, s) 2.11 (3, s) 2.38 (3, s) 3.02 (2, m) 4.30 (3, m) 5.60 (1, bs) 7.30 (3, m) 9.10 (2, bs)	825, 1030, 1380, 1455, 1510, 1570, 2780, 2980
64	4-NO_2	1,1-dimethyl-ethyl	MeOH-IPE	$C_{14}H_{20}N_6O_4.HCl$	171-172	(DMSO-d_6) 1.33 (9, s) 3.10 (2, m) 4.58 (3, m) 8.33 (4, m) 8.80 (1, bs) 9.30 (1, bs)	750. 850, 1350, 1450, 1500, 1530, 1570, 1600, 1615, 2980

TABLE VI (cont...)

Example No.	R^2,R^3	R^1	Recryst. Solvent	Molecular Formula	m.p.°+	NMR	IR
65	H	3,4-$MeO_2C_6H_3CH_2$-		$C_{19}H_{23}N_5O_4.C_4H_4O_4$	175-176	(DMSO-d_6) 3.10 (2, m) 3.82 (6, s) 4.20 (2, s) 4.64 (3, m) 6.25 (2, s) 7.50 (5, m)	685, 758, 1025, 1260, 1460, 1520, 1570, 1600, 1700, 2830
66	4-$NHCOCH_3$	*tert.*-Bu	MeOH-IPE	$C_{16}H_{24}N_6O_3.HCl.1/4H_2O$	185-186	(DMSO-d_6) 1.33 (9, s) 2.11 (3, s) 3.10 (2, m) 4.51 (3, m) 6.04 (1, bs) 7.76 (4, m) 8.90 (2, bs) 10.46 (1, bs)	835, 1315, 1410, 1520, 1540, 1570, 1600, 1675, 2980
67	H	2-(3-indolyl)- 1,1-dimethylethyl					

+°C (corr.)
* hemi-oxalate
maleate

Example 68. Tablets.-
The following ingredients are blended in the proportion by weight indicated according to conventional pharmaceutical techniques to provide a tablet base.

Ingredient	Amount
Lactose	79
Corn starch	10
Talcum	6
Tragacanth	4
Magnesium stearate	1

This tablet base is blended with sufficient 1-(*tert.*-butylamino)-3-[(1-phenyl-5-tetrazolyl)oxy]-2-propanol or a pharmaceutically acceptable acid addition salt thereof to provide tablets containing 10, 20, 40, 80, 160 and 320 mg. of active ingredient, and compressed in a conventional tablet press. Other compounds of Examples 2-34, or 48-67 may be substituted as active ingredient.

Example 69. Dry Filled Capsules.-
The following ingredients are blended in a conventional manner in the proportion by weight indicated.

Ingredient	Amount
Lactose, U.S.P.	50
Starch	5
Magnesium stearate	2

Sufficient 1-(*tert.*-butylamino)-[(1-phenyl-5-tetrazolyl)-oxy]-2-propanol or a pharmaceutically acceptable acid addition salt thereof is added to the blend to provide capsules containing 10, 20, 40, 80, 160 and 320 mg. of active ingredient which is filled into hard gelatin capsules of a suitable size. Other compounds of Examples 2-34, or 48-67 may be substituted as active ingredient.

Example 70. Solution.-
A solution of 1-(*tert.*-butylamino)-[(1-phenyl-5-tetrazolyl)oxy]-2-propanol hydrochloride is prepared from the following ingredients.

Ingredient	Amount
Active ingredient	20 g.
Sucrose, U.S.P.	400 g.
Sorbitol, U.S.P.	100 g.
Bentonite	20 g.
Flavors, q.s.	
Water, q.s. to make 1 liter	

Each milliliter of the suspension contains approximately 20 mg. of the active ingredient.
Various of the products of Examples 2-34, and 48-67 were evaluated as anti-arrhythmic agents in ouabain-induced ventricular tachycardia according to the method of Byrne, et al., *op cit.* The observations made are arranged in Table VII.

TABLE VII

Oubain-induced ventricular tachycardia

Example No.	MED[1] (mg/kg)	Activity Ratio	Duration	EKG Effects	BP Effects
1, 48	1	6/7	>30 min.	none	none
49	2	3/3	>30 min.	none	↓33%
65	10	1/3	>30 min.	bradycardia	none
50	3	2/2	>30 min.	none	none
59	2	3/3	3 min.	none[3]	↓70%
60	4	2/2	>30 min.	none	↓20%
5, 51	5	2/2	>30 min.	none	↓20%
61	2	2/2	>30 min.	none	none
62	12	2/3	>30 min.	none	none
63	7	2/2	20 min.	none	↓10%
52	13	2/2	>30 min.	none	↓10%
53	10	2/2	>30 min.	none	none
4, 54	2	2/2	>30 min.	none	↓20%
55	5	2/2	>30 min.	none	none
10, 56	3	2/2	>30 min.	none	none
57	5	2/2	>30 min.	none	none
58	5	3/3	>30 min.	bradycardia	none
64	3	2/2	>30 min.	none	none

1. minimum effective dose to convert to normal rhythm.
2. number of dogs converted to normal rhythm/number of dogs tested.
3. one dog died.

Certain substances were also evaluated against the surgically-induced arrhythmia in the dog according to the method of Harris, *op cit.* The observations made are arranged in Table VIII.

TABLE VIII

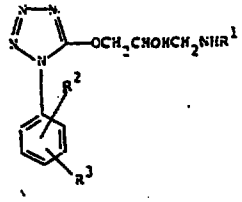
Occluded coronary artery, dog

Example No.	MED_{50}[1]	MED_{100}[1]	Onset	Duration	Side Effects
1, 48	5	>10	1 min.	>6 hr.	none
1, 48	20[2]	40[2]	30 min.	>6 hr.	none
49	–	5	1 min.	30 min.	2/5 died
65	–	10	2 min.	30 min.	trembling & agitation & diarrhea
65	20[2]	>20[2]	2 hr.	4.5 hr.	none
50	10	>10	2 min.	6 hr.	none
59	>10	>10	–	–	none
60	>10	>10	–	–	vomiting
5, 51	20	>20	2 min.	30 min.	ataxia
61	5	10	5 min.	1.5 hr.	1/5 died

1. minimum effective dose, 50% and 100% reduction of ectopic beats, intravenous administration mg/kg. body weight.
2. oral dose, mg/kg body weight.

WHAT WE CLAIM IS:-

1. A compound having the general formula I



I

TABLE VII

Oubain-induced ventricular tachycardia

Example No.	MED[1] (mg/kg)	Activity Ratio	Duration	EKG Effects	BP Effects
1, 48	1	6/7	>30 min.	none	none
49	2	3/3	>30 min.	none	↓33%
65	10	1/3	>30 min.	bradycardia	none
50	3	2/2	>30 min.	none	none
59	2	3/3	3 min.	none[3]	↓70%
60	4	2/2	>30 min.	none	↓20%
5, 51	5	2/2	>30 min.	none	↓20%
61	2	2/2	>30 min.	none	none
62	12	2/3	>30 min.	none	none
63	7	2/2	20 min.	none	↓10%
52	13	2/2	>30 min.	none	↓10%
53	10	2/2	>30 min.	none	none
4, 54	2	2/2	>30 min.	none	↓20%
55	5	2/2	>30 min.	none	none
10, 56	3	2/2	>30 min.	none	none
57	5	2/2	>30 min.	none	none
58	5	3/3	>30 min.	bradycardia	none
64	3	2/2	>30 min.	none	none

1. minimum effective dose to convert to normal rhythm.
2. number of dogs converted to normal rhythm/number of dogs tested.
3. one dog died.

Certain substances were also evaluated against the surgically-induced arrhythmia in the dog according to the method of Harris, *op cit.* The observations made are arranged in Table VIII.

TABLE VIII

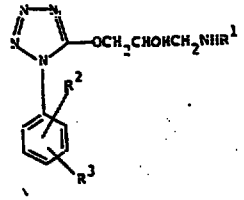
Occluded coronary artery, dog

Example No.	MED_{50}[1]	MED_{100}[1]	Onset	Duration	Side Effects
1, 48	5	>10	1 min.	>6 hr.	none
1, 48	20[2]	40[2]	30 min.	>6 hr.	none
49	–	5	1 min.	30 min.	2/5 died
65	–	10	2 min.	30 min.	trembling & agitation & diarrhea
65	20[2]	>20[2]	2 hr.	4.5 hr.	none
50	10	>10	2 min.	6 hr.	none
59	>10	>10	–	–	none
60	>10	>10	–	–	vomiting
5, 51	20	>20	2 min.	30 min.	ataxia
61	5	10	5 min.	1.5 hr.	1/5 died

1. minimum effective dose, 50% and 100% reduction of ectopic beats, intravenous administration mg/kg. body weight.
2. oral dose, mg/kg body weight.

WHAT WE CLAIM IS:-

1. A compound having the general formula I



I

wherein R^1 is 2-(3-indolyl)-1,1-dimethylethyl, adamantyl, alkyl having 1 to 12 carbon atoms, hydroxyalkyl having 2 to 12 carbon atoms having the hydroxyl group attached to a carbon atom other than that carbon atom attached to the nitrogen atom, alkenyl having 3 to 12 carbon atoms, cycloalkyl having 3 to 6 ring atoms, cycloalkylalkyl having 4 to 12 carbon atoms including 3 to 6 ring atoms, cycloalkenyl having 5 to 6 ring atoms, carbocyclic aralkyl having 7 to 12 carbon atoms, substituted carbocyclic aralkyl having 7 to 18 carbon atoms, carbocyclic aryloxyalkyl having 8 to 12 carbon atom or substituted carbocyclic aryloxyalkyl having 8 to 18 carbon atoms wherein the substituted aralkyl and substituted aryloxyalkyl groups each have 1 to 2 ring substituents which are independently halogen, alkoxy having 1 to 6 carbon atoms, alkyl having 1 to 6 carbon atoms or alkenyl having 3 to 6 carbon atoms;

R^2 is hydrogen or methyl and

R^3 is hydrogen, methyl, halogen, nitro, or acetamido.

2. A compound as claimed in claim 1 wherein R^1 is alkyl having 1 to 12 carbon atoms, alkenyl having 3 to 12 carbon atoms, cycloalkyl having 3 to 6 ring atoms, cycloalkenyl having 5 to 6 ring atoms, aralkyl having 7 to 12 carbon atoms, substituted aralkyl having 7 to 18 carbon atoms, aryloxyalkyl having 8 to 12 carbon atoms or substituted arlyoxyalkyl having 8 to 18 carbon atoms wherein the substituted aralkyl and substituted aryloxyalkyl groups each have 1 or 2 ring substituents which are independently halogen, alkoxy having 1 to 6 carbon atoms, alkyl having 1 to 6 carbon atoms, or alkenyl having 3 to 6 carbon atoms and R^2 and R^3 are both hydrogen.

3. A compound as claimed in claim 1 wherein R^1 is alkyl having 1 to 12 carbon atoms, and R^2 and R^3 are both hydrogen.

4. 1-(Methylamino)-3-[(1-phenyl-1*H*-tetrazol-5-yl)oxy]-2-propanol.

5. A compound as claimed in claim 1 wherein R^1 is branched alkyl having 3 to 8 carbon atoms, and R^2 and R^3 are both hydrogen.

6. 1-[(1-Methylethyl)amino]-3-[(1-phenyl-1*H*-tetrazol-5-yl)oxy]-2-propanol.

7. 1-[(1-Phenyl-1*H*-tetrazol-5-yl)oxy]-3-[(1,1,3,3-tetramethylbutyl)amino]-2-propanol.

8. A compound as claimed in claim 1 wherein R^1 is cycloalkyl having 3 to 6 ring atoms, and R^2 and R^3 are both hydrogen.

9. 1-(Cyclohexylamino)-3-[(1-phenyl-1*H*-tetrazol-5-yl)oxy]-2-propanol.

10. 1-(Cyclopentylamino)-3-[(1-phenyl-1*H*-tetrazol-5-yl)oxy]-2-propanol.

11. A compound as claimed in claim 1 wherein R^1 is branched chain alkyl having 3 to 8 carbon atoms, R^2 is hydrogen, and R^3 is chlorine.

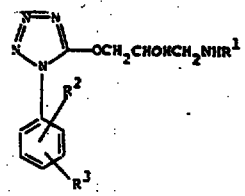
12. 1-[(1-(4-Chlorophenyl)-1*H*-tetrazol-5-yl]oxy]-3-[(1,1-dimethylpropyl) amino]-2-propanol.

13. A compound as claimed in claim 1 wherein R^1 is branched chain alkyl having 3 to 8 carbon atoms, R^2 is hydrogen, and R^3 is nitro.

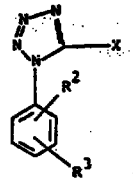
14. 1-[(1,1-Dimethylethyl)amino]-3-[(1-(4-nitrophenyl)-1*H*-tetrazol-5-yl]oxy]-2-propanol.

15. An acid addition salt of a compound as claimed in any one of claims 1 to 14.

16. A process for preparing a compound of the general formula 1:

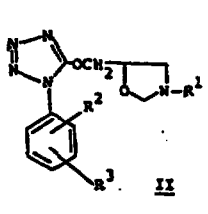


and the acid addition salts thereof wherein R^1, R^2 and R^3 are as defined in claim 1 which comprises reacting a compound of Formula IV

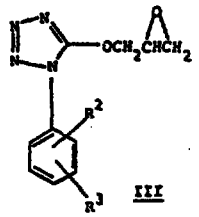


IV

wherein R^2 and R^3 are as previously defined and X is chlorine or bromine, with a 3-R^1-5-oxazolidinylmethanol or with glycidol to yield, respectively, an ether compound of the general Formula II or general Formula III



II



III

wherein R^1, R^2 and R^3 are as previously defined and converting the ether compound to a compound of Formula I by hydrolysis under acidic conditions when an ether compound of Formula II is produced, or by reaction at a temperature in the range of from 60 to 200°C with a primary amine of the Formula R^1NH_2 alone, or in the presence of a reaction inert organic solvent, when an ether compound of Formula III is produced and, if desired, forming the acid addition salt of a compound of Formula I by neutralization with a suitable acid.

17. A process as claimed in claim 16 wherein the hydrolysis of the compounds of Formula II is carried out using a dilute mineral acid having a concentration of from 0. IN to IN at a temperature in the range of from 20° to 100°C.

18. A process as claimed in claim 16 wherein the reaction of the compound of Formula III with the primary amine is carried out in 95% ethanol.

19. A process as claimed in claim 16 substantially as hereinbefore described with reference to any one of Examples 1 to 34, or 48 to 67.

20. A compound of Formula I whenever prepared by a process as claimed in any one of claims 16 to 19.

21. A pharmaceutical composition which comprises at least one compound as claimed in any one of claims 1 to 14 or claim 20, or a pharmaceutically acceptable acid addition salt as claimed in claim 15, together with a pharmaceutically acceptable diluent or carrier.

22. A pharmaceutical composition as claimed in claim 21 which is in unit dosage form.

23. A method of inhibiting β-adrenergic activity in a non-human mammal having a disease state resulting from excessive activation of the β-adrenergic receptors, which comprises administering to the mammal a non-toxic effective adrenergic β-receptor inhibiting dose of a compound as claimed in any one of claims 1 to 14, or claim 20, or of a pharmaceutically acceptable salt as claimed in claim 15, or of a pharmaceutical composition as claimed in claim 21 or claim 22.

24. A method of exterting a vasodilator effect in a non-human mammal host which comprises administering to a mammal in need of vasodilatation a non-toxic vasodilator effective dose of a compound as claimed in any one of claims 1 to 14, or claim 20, or of a pharmaceutically acceptable salt as claimed in claim 15, or of a pharmaceutical composition as claimed in claim 21 or claim 22.

25. A method of relieving or treating cardiac arrhythmia in a non-human mammal which comprises administering to a mammal subject to cardiac arrhythmia a non-toxic anti-arrhythmically effective dose of a compound claimed in claim 1.

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