TITLE

"BRAIN, SPINAL AND NERVE INJURY TREATMENT"

FIELD OF THE INVENTION

THIS INVENTION relates to a method of therapy of brain, spinal and nerve injury. There is also provided a formulation which is particularly useful in the method.

Injury to the brain results in the development of motor and cognitive deficits that contribute to the significant morbidity experienced by survivors of brain injury. Moreover, it is an occurrence that has the highest incidence in younger members of society. Accordingly, injury to the brain is responsible for the greatest loss of productive life as compared to any other disease process. Despite this, there is no effective therapy to improve outcome after brain injury. We disclose the use of a method of therapy as a robust pharmacologic intervention for the treatment of brain injury. Use of this therapy significantly improves both motor and cognitive outcome in mild to severe experimental brain injury and has also been found to have beneficial effect also for the treatment of spinal cord and nerve injuries.

BACKGROUND OF THE INVENTION

It is well known that brain injury results in the development of neurologic deficits through two mechanisms. The first of these is known as primary mechanisms. These occur at the time of the injurious event and include mechanical processes such as laceration, tearing, stretching and compression of nerve fibres. Little can be done for this type of injury once it has occurred. The second mechanism is secondary injury, which includes biochemical and physiological processes, initiated by a primary injury but which manifest with time after the injury. It has been demonstrated that much of the morbidity after brain injury is associated with the development of this secondary injury. Given that the secondary

injury develops from minutes to days after the primary event, there exists a window of opportunity to pharmacologically prevent this type of injury and significantly improve resultant outcome. However, the factors that make up secondary injury must first be identified and then "antifactors" developed to inhibit the injury process.

Our studies have concentrated on identifying secondary injury factors after brain injury and developing interventional therapies. One of the factors that we had previously identified[1-4] as critical to determining outcome after injury was brain magnesium ion concentration. This ion is a regulatory factor in a number of biochemical and physiological processes that are activated after brain injury. Indeed, a decrease in the magnesium ion concentration was observed to exacerbate the injury process while an increase in the concentration of magnesium ion was noted to attenuate the injury process and result in an improved outcome[5]. The treatment of brain injury with magnesium has since been shown to be effective[1,6-10] even when administered up to 24 hours after the primary event, and the success of the treatment in experimental animal studies has subsequently led to clinical trials in human brain injury.

Despite the attenuation of deficits after brain injury with magnesium administration, it was clear that there were still motor and cognitive deficits that persisted after the treatment. Our attention was particularly drawn to the fact that in younger animals, the accumulation of water in the brain (ie. cerebral oedema or brain swelling) was still present and that this may present a significant risk factor. Indeed, in a recent clinical study[11], delayed brain swelling was responsible for 50% of all deaths recorded in young victims of brain injury.

STATEMENT OF INVENTION

In one aspect, the invention provides an injectable formulation comprises a substance P receptor antagonist and a magnesium compound, wherein the combined use of the magnesium compound and the substance P receptor antagonist results in greater protection against injury than either of the magnesium compound or the substance P receptor antagonist used alone.

In one embodiment, there is disclosed a step of administration of the formulation to the patient suffering from brain injury. Alternatively, each of the components of the formulation may be administered separately or separated by a time delay that does not affect the effectiveness of the therapy, e.g. 1-30 minutes and up to 24 hours.

Substance P is an excitatory neurotransmitter and has a role in pain transmission and is a peptide having the structure RPKPEEFFGLM-NH_2. It is from the hypothalamus, CSN and intestine and increases smooth muscle contraction of the G1 tract.

It is known that substance P binds to a number of receptors inclusive of the NK1 receptor (i.e. neurokinin 1 receptor), the NK2 receptor and the NK3 receptor. These receptors are believed to have a role in blood travelling to the brain.

Therefore, a substance P antagonist is a substance that inhibits binding of substance P to any one of the receptors referred to above. A list of suitable substance P antagonists is referred to in Tables 1, 2 and 3 attached herewith.

Reference may also be made to NK1 receptor antagonists as described in US Patent 5,990,125 which are incorporated herein by reference as constituting substance P antagonists that may be utilized in the formulation of the invention. This has specific reference to compounds of structures Ia, Ib, Ic, Id, Ie, X, XVI, XVII, XVIII, XIX, XX and XXI, as well as other antagonists comprising

quinuclidine, piperidine ethylene diamine, pyrrolidine and azabornane derivatives and related compounds that exhibit activity as substance P receptor antagonists as described in column 33 of the US Patent 5,990,125.

Such receptor antagonists may be employed having regard to the dosages referred to in column34 of US Patent 4,990,125

and in various forms of administration i.e. alone or with various pharmaceutically acceptable carriers or diluents by oral administration or parental administration as referred in column 34 of US Patent 5990125.

The activity of various substances as substance P receptor antagonists for use in the invention may also be determined by the assays referred to in columns 35-36 of US Patent 5990125.

Reference also may be made to substance P receptor antagonists described in US Patent 5977104 including the various dosage forms and dosages referred to in this reference which is also totally incorporated herein by reference.

Reference also may be made to US Patent 4481139 which describes various peptide antagonists, which is also totally incorporated herein by reference.

It will also be understood that the term "Substance P" as used herein may also include within its scope various truncated forms or analogues as described in US Patent 4481139, which is totally incorporated herein by reference.

Reference also may be made to US Patent 4985896 which refers to various piperdine and morpholine derivatives for use as substance P antagonists for use in the present invention or piperazino derivatives as described in US Patent 5981520. Each of these references are totally incorporated herein by reference.

Reference also may be made to piperidinyl compounds as NK1 or NK2 antagonists for use in the invention referred to in US Patent 5998444 which is also totally incorporated herein by reference.

It will also be appreciated that tachykinin antagonists referred to in US Patent 4981744 may also be used as substance P antagonists in the invention and thus, this reference is also totally incorporated herein.

Reference may also be made to EP-A-1035115 which is totally incorporated herein by reference, which refers to N-benzyl-4-tolylnicotinamides and related compounds as NK1 receptor antagonists for use in the invention.

Reference may be made to International Publication WO 0050398 which is totally incorporated herein by reference, which refers to various phenyl and pyridinyl derivatives as NK1 receptor antagonists for use in the invention.

Reference is also made to International Publications WO 0050401, WO 0053572, WO 0073278 and WO 0073279, which refer to 3-phenylpyridines, biphenyl derivatives, 5-phenyl-pyrimidine derivatives and 4-phenyl-pyrimidine derivatives respectively which specifications are also totally incorporated herein by reference. These specifications refer to NK1 receptor antagonists for use in the present invention.

Reference also may be made to the 1998 Sigma Catalogue and more particularly pages 1194-1997 which describe modifications of substance P or substance P fragments, which may be used as substance P antagonists, for use in the invention. This publication is also totally incorporated herein by reference.

In relation to the magnesium compound, this may comprise any suitable source of magnesium ion such as magnesium chloride, magnesium sulphate, magnesium oxalate, magnesium gluconate or other non toxic magnesium salt.

The pharmaceutical preparations in accordance with this invention can in addition also contain preservatives, solubilizers, sabilizers, wetting agents, emulsifiers, sweeteners, colorants, flavorants, salts for varying the osmotic pressure, buffers, masking agents or antioxidants. They can also contain still other therapeutically valuable substances. Thus the term "comprising" used in the specification should be interpreted in this context. The

dosage can vary within wide limits and can, of course, be fitted to the individual requirements in each particular case. In general, a dosage of 1 to 20000mg per patient, preferably 10 to 5000mg and more preferably 50 to 2000mg of the substance P receptor antagonist should be appropriate.

In relation to the development of the inventive concept, it was established by the present inventors that one reason for acute water accumulation in the brain after injury was the result of vasogenic oedema formation. This is caused by an increased permeability of the blood brain barrier thus permitting vascular proteins and water to enter the extracellular space in the brain and case swelling. Few studies have examined how this increased blood brain barrier permeability contributes to the development of neurological deficits after injury, and no studies have investigated whether inhibition of brain swelling improves outcome. Studies of migraine[12, 13] have suggested that the vasculature of the dura matter (outer meningeal layer) becomes more permeable to vascular components as a result of substance P release. We therefore hypothesised that substance P may have a similar effect on the cerebral vasculature, where such an effect could lead to increased blood brain barrier permeability and vasogenic cerebral oedema. We further hypothesised that administration of a substance P receptor antagonist may prevent brain swelling and the development of delayed neurologic deficits after injury. This hypothesis was a result of our discovery referred to above, that water accumulated in the brain as a result of vasogenic oedema formation.

In a second aspect, the invention provides a use of a substance P receptor antagonist for the preparation of a medicament for the reduction of blood brain barrier permeability.

In a third aspect, the invention provides a use of a substance P receptor antagonist for the preparation of a medicament for the reduction of formation of vasogenic oedema.

In a fourth aspect, the invention provides a use of a substance P receptor antagonist for the preparation of a medicament for the prevention of acute water accumulation in the brain after injury.

In another embodiment, there is disclosed a use of a substance P receptor antagonist for reducing brain barrier permeability and/or vasogenic cerebral oedema.

EXPERIMENTAL

A number of commercially synthesised substance P receptor antagonists are currently available from standard scientific chemical suppliers, as is apparent from Tables 1, 2 and 3. We chose to use the compound N-acetyl-L-tryptophan based on its low lipid

solubility that limits its ability to naturally cross the blood brain barrier and the fact that it is relatively inexpensive. Administration of N-acetyl-L-tryptophan at an intravenous dose of 246mg/kg (saline vehicle) given at 30 minutes after brain injury resulted in a significant improvement of cognitive outcome in brain injured animals as assessed by the Barnes Circular Maze. Similarly, there was a significant improvement in motor outcome of animals as assessed by the otarod test. These improvements in outcome were apparent at 24 hours after brain injury and persisted for the 14 day assessment period. Control (vehicle tested) animals has significantly worse neurologic outcome than treated animals at all time points tested.

Animals treated with N-acetyl-L-tryptophan had a significant reduction in brain water accumulation (ie. cerebral oedema) at 24 hours after injury as compared to vehicle treated controls. This was consistent with the observation that N-acetyl-L-tryptophan reduced brain penetration of Evans blue at 5 hours after injury, the time associated with maximum blood brain barrier permeability after brain injury. Thus, N-acetyl-L-tryptophan administered at 30 minutes after brain injury reduced blood brain barrier permeability and reduced vasogenic oedema formation. The fact that these effects were noted with a non-permeable formulation of the NK1 antagonist suggests that the effects were largely mediated by vascular receptors and not dependent upon central receptors.

Administration of N-acetyl-L-tryptophan at 24.6 mg/kg also significantly improved cognitive outcome of brain injured animals. However, the drug had less of a beneficial effect on motor outcome. Moreover, because there was always some residual cognitive and motor deficits noted in all treated animals, the beneficial effects of treatment with the NK1 antagonist were less apparent when injury of mild severity was induced as opposed to injury of a severe nature. This is a major limitation given that mild head injury has the greatest

Incidence in brain injury patients.

COMBINATION MAGNESIUM AND N-ACETYL-L-TRYPTOPHAN

The most common form of brain injury is mild head injury. Guidelines to be introduced next year (2000) by the World Federation of Neurological Surgeons will recommend that all cases of minor head injury with any complications such as vomiting, nausea, loss of consciousness or amnesia MUST present to a hospital. This will place considerable pressure on the health system to adequately treat these individuals such that secondary injury does not develop any further. Currently, there is no such therapy.

Our results with N-acetyl-L-tryptophan suggest that this compound closes the blood brain barrier after head injury and reduces brain swelling or cerebral oedema. This is extremely important in young victims of head injury who are particularly vulnerable to delayed brain swelling. Furthermore, our results with magnesium therapy suggest that magnesium treatment is effective at reducing neurologic deficits not necessarily associated with increased blood brain permeability. We therefore propose that a combination of a substance P antagonist with a magnesium compound or salt will be a particularly effective therapy for the treatment of brain injury irrespective of severity.

Combination administration of 246 mg/kg N-acetyl-L-tryptophan plus 30 mg/kg magnesium sulphate (intravenously) resulted in a profound attenuation of both motor and cognitive deficits that was significantly greater than obtained with either drug in isolation (FIG. 1 and FIG. 2).

Each of the compounds in the combination formulation has a number of properties that make it particularly attractive for use in brain injury.

Substance P (SP) antagonists have been shown to rapidly improve mood by antagonising substance P induced anxiety. Thus, they are effective in treating post-injury depression. From the

word described above, it is apparent that SP antagonists reduce blood brain barrier permeability and inhibit the formation of vasogenic oedema and post-injury brain swelling or cerebral oedema. The antagonists also have been shown to inhibit pain. There are high numbers of substance P

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receptors in the hippocampus and striatum, those parts of the brain that are known to be associated with learning and memory. Inhibition of binding with SP antagonists may thus prevent substance P induced deficits in learning and memory. Our evidence presented above suggests that this may be the case. This has never been shown previously. Indeed, there has been no literature on the role of substance P, or any neuropeptides, in brain injury.

Magnesium affects over 300 cellular enzymes. It is not surprising, therefore, that magnesium has numerous targets at which it may improve outcome. These include, amongst others, blocking glutamate induced excitotoxicity, improving membrane stability and reducing the production of reactive oxygen species, improving energy status, inhibiting calcium channels, reducing neurotransmitter release, inhibiting mitochondrial transition pore opening, and inhibiting apoptosis. Notably, it also blocks glutamate induced release of substance P. Physiologically, magnesium has been shown[14-17] to improve cerebral blood flow, reduces cerebral vasospasms, and reduces vascular ceramide and prostaglandin production.

The combined use of magnesium and the substance P antagonist results in greater protection against neural injury than either drug used alone.

We have previously shown that magnesium has a beneficial effect in trauma when administered at intravenous doses ranging from 16 to 60 mg/kg. When administered as an intramuscular injection, the effective dose varies form 45 to 90 mg/kg. The target is to increase free magnesium concentration in the blood to approximately 1.0mM, which is double the normal blood free magnesium concentration. Beneficial results are observed irrespective of the magnesium salt used.

Our studies with the substance P antagonist has demonstrated that the effective i.v. dose varies from 24.6 mg/kg to

240.6 mg/kg or higher, with the higher doses having a greater beneficial effect on motor outcome. Moreover, these doses pertain to antagonists that have low lipid solubility and thus limited blood brain barrier permeability. A highly lipid soluble formulation should exact the same beneficial actions, however, there may be centrally mediated side-effect that may be inappropriate.

When used in combination, the formulation may vary in the range described for the individual components. We have achieved excellent results using the maximum i.v. doses described for the individual components.

The combination magnesium/SP antagonists is expected to be useful in the following conditions:

- As a "first-aid" prophylactic treatment following traumatic brain injury
- As a "first-aid" prophylactic treatment following minor head injuries, including concussion
- As a therapy following non-traumatic brain injuries, including stroke, hypoxia and any form of brain injury where oedema is implicated
- As a maintenance therapy following brain injury

REFERENCES

1. Vink R, McIntosh TK, Demediuk P, Weiner MW, Faden AI: Decline in intracellular free magnesium concentration is associated with irreversible tissue injury following brain trauma. *J Biol Chem* 263: 757-761, 1988

2. Vink R, Heath DL, McIntosh TK: Acute and prolonged alterations in brain free magnesium following fluid percussion induced brain trauma in rats. *J Nurochem* 66:2477-2483, 1996

3. Heath DL, Vink R: Brain intracellular free magnesium concentration declines following impact-acceleration induced brain injury in rats. *Neurosci Res Commun* 18: 163-168, 1996

4. Heath DL, Vink R: Traumatic brain axonal injury produces sustained decline in intracellular free magnesium concentration. *Brain Research* 738: 150-153, 1996

5. McIntosh TK, Faden AI, Yamakami I, Vink R: Magnesium deficiency exacerbates and pretreatment improves outcome following traumatic brain injury in rats: ^{31}P magnetic resonance spectroscopy and behavioural studies. *J Neurotrauma* 5: 17-31, 1988

6. Vink R, McIntosh TK: Pharmacological and physiological effects of magnesium on experimental traumatic brain injury. *Magnesium Res* 3: 163-169, 1990

7. Heath DL, Vink R: Magnesium sulphate improves neurologic outcome following sever closed head injury in rats. *Neuroscience Letters* 228: 175-178, 1997

8. Heath DL, Vink R: Neuroprotective effects of MgS04 and MgC12 in closed head injury: a comparative phosphorus NMR study. *J Neurotrauma* 15: 183-189, 1998

9. Heath DL, Vink R: Delayed therapy with magnesium up to 24 hours following traumatic brain injury improves motor outcome. *J Neurosurg* 90: 504-509, 1999

10. Heath DL, Vink R: Optimisation of magnesium therapy following sever diffuse axonal brain injury in rats. *J Pharmacol Exp Ther* 288: 1311-1316, 1999

11. Feickert HG, Drommer S, Heyer R: Severe head injury in children: impact of risk factors. *J Trauma* 47: 33-38, 1999

12. Moskowitz MA: The neurobiology of vascular head pain. *Ann Neurol* 16: 157-168, 1984

13. Ferrari MD: Migraine. *Lancet* 351: 1043-1052, 1998

14. Altura BT, Altura BM: The role of magnesium in etiology of strokes and cerebrovasospasm. *Magnesium* 1: 277-291, 1982

15. Farago M, Szabo C, Dora E, Horvath I, Kovach AGB: Contractile and endothelium-dependant dilatory responses of cerebral arteries at various extracellular magnesium concentration. *J Cereb Blood Flow Metab* 11: 161-164, 1991

16. Kemp PA, Gardiner SM, March JE, Rubin PC, Bennett T:Assessment of the effects of endothelin-1 and magnesium sulphate on regional blood flows in conscious rats, by the colour microsphere reference technique. *Br J Pharmacol* 126: 621-626, 1999

17. Morril MA, Gupta RK, Kostellow AB, Gy M, Zhang A, Altura BT, Altura BM: Mg2+ modulates membrane sphingolipid and lipid second messenger levels in vascular smooth muscle cells. *FEBS Lett* 167-171, 1998

TABLE 1

NK1 Receptor Antagonists

Chemical Code	Chemical Name
CGP49823	(2R,4S)-2-benzyl-1-(3,5-dimethylbenzoyl)-N-[(4-quinolinyl)methyl]-4-piperineamine) dihydrochloride
CP-96,345	2S,3S)-cis-(2(diphenylmethyl)-N-[(2-methoxyphenyl)methyl]-1-azabicyclo[2.2.2]octan-3-amine
CP-99,994	((2S,3S)-cis-3-(2-methoxybenzylamino)-2-phenyl-piperidine)dihydrochloride
CP-122,721	(+)-2S,3S)-3-(2-methoxy-5-trifluoromethoxybenzyl)amino-2-phenylpiperidine
FK 888	(N2-[(4R)-4-hydroxy-1-(1-methyl-1H-indol-3-yl)carbonyl-L-propyl\-N-methyl-N-phenylmethyl-L-3-(2-naphthyl)-alaninamide
GR203040	(2S,3S and 2R,3R)-2-methoxy-5-tetrazol-1-yl-benzyl-(2-phenyl-piperidin-3-yl)-amine
GR-205171	3-Piperidinamine,N-[[2-methoxy-5-[5-(trifluoromethyl)-1H-tetrazol-1-yl]phenyl]methyl]-2-phenyl-, (2S-cis)-
GR 82334	[D-Pro9,]spiro-gamma-lactam]Leu10, Trp11]physalaemin-(1-11)
GR 94800	PhCO-Ala-Ala-DTrp-Phe-DPro-Pro-Nle-NH2
HSP-117	3-Piperidinamine,N-[[2,3-dihydro-5-(1-methylethyl)-7-benzofuranyl]methyl]2-phenyl-, dihydrochloride, (2S-cis)-
L 703,606	1-Azabicyclo[2.2.]octan-3-amine,2-(diphenylmethyl)-N-[(2-idophenyl)methyl]-, (2S-cis)-, oxalate
L 732,138	N-acetyl-L-tryptophan
L 733,060	((2S,S)-3-((3,5-bis(trifluoromethyl)phenyl)methyloxy)-2-phenyl piperidine
L 742,694	(2-(S)-(3,5-bis(trifluromethyl)benzyloxy)-3-(S)-phenyl-4-(5-(3-oxo-1,2, 4-triazolo)methylmorpholine
L 754,030	2-(R)-(1-(R)-3, 5-bis(trifluoromethyl)phenylethoxy)-3-(S)-(4-fluoro)phenyl-4-(3-oxo-1,2,4-triazol-5-yl)methylmorpholine

L 668,169	L-Phenylalanine, N-[2-[3-[[N-[2-(3-amino-2-oxo-1-pyrrolidinyl)-4-methyl-1-oxopentyl]-L-methionyl-L-glutaminyl-D-tryptophyl -N-methyl-L-phenylalanyl]amino]-2-oxo-1-pyrrolidinyl]-4-methyl-1-oxopentyl]-L-methionyl-L-glutaminyl-D-tryptophyl-N-methyl-, cyclic (8->1)-peptide, [3R-[1[S*[R*(S*)]], 3R*]]-
LY 303241	1-Piperazineacetamide, N-[2-[acetyl[(2-methoxyphenyl)methyl]amino]-1-(1H-indol-3-ylmethyl)(ethyl]-4-phenyl-, (R)-
LY 303870	(R)-1-[N-(2-methoxybenzyl)acetylamino]-3-(1H-indol-3-yl)-2-[N-(2-(4-(pi peridinyl)piperidin-1-yl)acetyl)amino]propane
LY 306740	1-Piperazineacetamide, N-[2-'acetyl[(2-methoxyphenyl)methyl]amino]-1-(1H-indol-3-ylmethyl)ethyl]-4-cyclohexyl-, (R)-
MEN 11149	2-(2-naphthyl)-1-N-[(1R,2S)-2-N-[1(H)indol-3-ylcarbonyl]aminocyclohexanecarbonyl]-1-[N'-ethyl-N'-(4-methylphenylacetyl)] diaminoethane
MK-869	3H-1,2,4-Triazol-3-one, 5-[[2-[1-[3,5-bis(trifluoromethyl)phenyl]ethoxy]-3-(4-fluorophenyl)-4-morpholinyl]methyl]-1, 2-dihydro-, [2R-[2α(R*), 3α]]-
PD 154075	(2-benzofuran)-CH2OCO]-(R)-alpha-MeTrp-(S)-NHCH(CH3) Ph
R-544	Ac-Thr-D-Trp(FOR)-Phe-N-MeBzl
RP-67580	(3aR, 7aR)-7,7-diphenyl-2[1-imino-2(2-methoxyphenyl)-ethyl]+++perhydroisoindol-4-one hydrochloride
RPR 100893	(3aS, 4S, 7aS)-7, 7-diphenyl-4-(2-methoxyphenyl)-2-[(S)-2-(2-methoxyphenyl)proprionyl]perhydroisoindol-4-ol
Spendide	Tyr-D-Phe-Phe-D-His-Leu-Met-NH2
Spantide II	D-NicLys1, 3-Pal3, D-Cl2Phe5, Asn6, D-Trp7.0, Nle11-substance P
Spantide III	L-Norleucinamide, N6-(3-pyridinylcarbonyl)-D-lysyl-L-prolyl-3-(3-pyridinyl)-L-alanyl-L-prolyl-3,4-dichloro-D-phenylalanyl-L-asparaginyl-D-tryptophyl-L-phenylalanyl-3-(3-pyridinyl)-D-alanyl-L-leucyl-
SR140333	(S)-1-[2-[3-(3,4-dichlorphenyl)-1 (3-isopropoxyphenylacetyl) piperidin-3-yl] ethyl]-4-phenyl-1 azaniabicyclo [2.2.2]octane
WIN-41,708	(17beta-hydroxy-17alpha-ethynyl-5alpha-androstano[3,2-b]pyrimido[1,2-a]benzimidazole
WIN-62,577	1H-Benzimidazo[2,1-b]cyclopenta[5,6]naphtho[1,2-g]quinazolin-1-ol, 1-ethynyl-2,3,3a,3b,4,5,15,15a,15b,16,17,17a-dodeachydro-15a,17a-dimethyl-, (1R, 3aS, 3bR, 15aR, 15bS, 17aS)-

TABLE 2

NK2 Receptor Antagonists

Chemical Code	Chemical Name
SR-48,968	(S)-N-methyl-N[4-(4-acetylamino-4-[phenylpiperidino)-2-(3,4-dichlorophenyl)-butyl]benzamide
L-659,877	cyclo[Gln,Trp,Phe,Gly,Leu,Met]
MEN 10627	cyclo(Met-Asp-Trp-Phe-Dap-Leu)cyclo(2beta-5beta)
SR 144190	(R)-3-(1-[2-(4-benzoyl-2-(3,4-difluorophenyl)-morpholin-2-yl)-ethyl]-4-phenylpiperidin-4-yl)-1-dimethylurea
GR 94800	PhCO-Ala-Ala-D-Trp-Phe-D-Pro-Pro-Nle-NH2

TABLE 3

NK3 Receptor Antagonists

Chemical Code	Chemical Name
SR-142,801	(S)-(N)-(1-(3-(1-benzoyl-3-(3,4-dichlorophenyl)piperidin-3-yl)propyl)-4-phenylpiperidin-4-yl)-N-methyl acetamide
R820	3-indolylcarbonyl-Hyp-Phg-N(Me)-Bzl
R486	H-Asp-Ser-Phe-Trp-beta-Ala-Leu-Met-NH2
SB 222200	(S)-(-)-N-(a-ethylbenzyl)-3-methyl-2-phenylquinoline-4-carboximide
L 758,298	Phosphonic acid, [3-[[2-[1-[3,5-bis(trfluoromethyl)phenyl]ethoxy]-3-(4-fluorophenyl)-4-morpholinyl]methyl]-2,5-dihydro-5oxo-1H-1,2,4-triazol-1-yl]-, [2R-[2α(R*), 3α]]-
NK-608	(2R,4S)-N-[1-{3,5-bis(trifluormethyl)-benzoyl}-2-(4-chloro-benzyl)-4-piperidinyl]-quinoline-4-carboxamide

FIGURE 1.

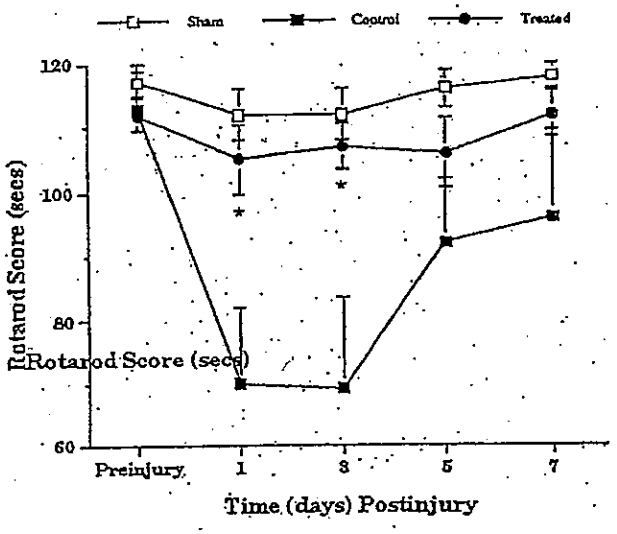
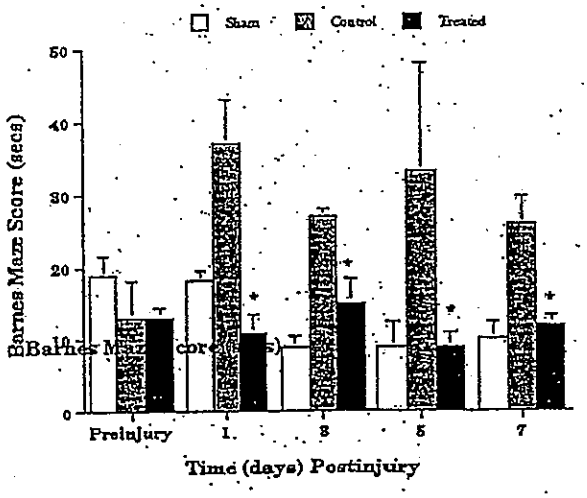


FIGURE 2.



CLAIMS

1. An injectable formulation for treatment of brain, spinal cord and nerve injury comprising a substance P receptor antagonist in combination with a magnesium compound.

2. An injectable formulation as claimed in claim 1, wherein the combined use of the substance P receptor antagonist and the magnesium compound results in greater protection against injury than either of the substance P receptor antagonist and the magnesium compound used alone.

3. A formulation according to claim 1 or 2, characterized in that the dosage of the magnesium compound is sufficient to increase free magnesium concentration in the blood to approximately 1.0 mM.

4. A formulation according to claim 1 or 2, characterized in that the dosage of the magnesium compound is sufficient to double the normal blood free magnesium concentration.

5. A formulation according to any one of claims 1 to 4, for separate administration of the substance P receptor antagonist and the magnesium compound.

6. A formulation as claimed in any one of claims 1 to 5, wherein the substance P receptor antagonist is an NK1 receptor antagonist.

7. A formulation as claimed in claim 6, wherein the NK1 receptor antagonist is selected from the group consisting of CGP49823, CP-96,345, CP99,994, CP-122,721, FK88, GR203040, GR205171, GR82334, GR94800, HSP-117, L-703,606 oxalate, L-732,138, L-733060, L-742,694, L-745,030, L-668,169, LY-303241, LY-303870, LY306740, MEN-11149, MK-869, PD-154075, R-544, RP-67580, RPR100893, Sendide, Spantide II, Spantide III, SR140333, WIN-41,7098, WIN-62,577.

8. A formulation as claimed in any one of claims 1 to 5, wherein the substance P receptor antagonist is an NK2 receptor antagonist.

9. A formulation as claimed in claim 8, wherein the substance P receptor antagonist is selected from the group consisting of SR-48968, L-659877, GR103537, MGN-10627, SR144190 and GR94800.

10. A formulation as claimed in any one of claims 1 to 5, wherein the substance P receptor antagonist is an NK3 receptor antagonist.

11. A formulation as claimed in claim 10, wherein the substance P receptor antagonist is selected from the group consisting of SR-143,801, R820, R486, SB222200, L758,298 and NKP608.

12. A formulation as claimed in any one of claims 1 to 11, wherein the magnesium compound is selected from the group consisting of magnesium chloride, magnesium sulphate, magnesium oxalate, magnesium gluconate, or other non-toxic magnesium salt.

13. A formulation as claimed in any one of claims 1 to 12, wherein the dosage of the substance P receptor antagonist is 1-20,000mg per patient.

14. A formulation as claimed in any one of claims 1 to 12, wherein the dosage of the substance P receptor antagonist is 10-5,000mg per patient.

15. A formulation as claimed in any one of claims 1 to 12, wherein the dosage of the substance P receptor antagonist is 50-2,000mg per patient.

16. The use of a substance P receptor antagonist for the preparation of a medicament for the reduction of blood brain barrier permeability.

17. The use of a substance P receptor antagonist for the preparation of a medicament for the reduction of formation of vasogenic oedema.

18. The use according to claim 17, wherein the vasogenic oedema is a vasogenic cerebral oedema.

19. The use of a substance P receptor antagonist for the preparation of a medicament for the prevention of acute water accumulation in the brain after injury.

20. The use according to any one of claims 16 to 19, wherein the substance P receptor antagonist has low lipid solubility.

21. The use according to any one of claims 16 to 19, wherein the substance P receptor antagonist is administered with a magnesium compound.

22. The use according to claim 21, wherein the magnesium compound administered is sufficient to double the normal blood free magnesium concentration.

23. The use according to claim 21, wherein the magnesium compound administered is sufficient to increase free magnesium concentration in the blood to approximately 1.0 mM.

24. A formulation substantially as herein described with reference to the Experimental Section.

25. The use of a substance P receptor antagonist substantially as herein described with reference to the Experimental Section.

26. The use of a substance P receptor antagonist in combination with a magnesium compound or salt substantially as herein described with reference to the Experimental Section.

27. The invention substantially as herein described.