TREATMENT OR PREVENTION OF CARDIOVASCULAR EVENTS VIA THE ADMINISTRATION OF A COLCHICINE DERIVATIVE

TECHNICAL FIELD

[0001] A method for the treatment and/or prevention of cardiovascular events in patients with established atherosclerotic vascular disease.

BACKGROUND ART

[0002] The following discussion of the background art is intended to facilitate an understanding of the present invention only. The discussion is not an acknowledgement or admission that any of the material referred to is or was part of the common general knowledge as at the priority date of the application.

[0003] In patients with atherosclerotic vascular disease, the diseased vessel wall is subject to injurious forces that promote plaque build-up and instability that may lead to coronary occlusion resulting in heart attack, ischemic stroke and sudden death. The response to injury within the diseased vessel is dependent on the architecture and content of atherosclerotic plaques. Lipid-rich plaques with a neo-vascular base are particularly susceptible to the effect of injury, which may leave them vulnerable to neutrophil infiltration. Neutrophils that enter the interstitial space may become activated upon exposure to the plaque contents, inciting an aggressive inflammatory response that may accelerate plaque instability increasing the risk of plaque enlargement and rupture and hence increasing the risk of clinical events.

[0004] Despite routine use of anti-platelet and statin therapy, patients with atherosclerotic vascular disease continue to be at risk of cardiovascular events, possibly because these treatments fail to target some of the inflammatory pathways implicated in the disease.

[0005] A number of additional treatments exist for the prevention or reduction in risk of coronary heart disease, including: antiplatelet agents (besides aspirin), anti-coagulants, angiotensin-converting-enzyme inhibitors (ACEIs); aldosterone receptor antagonists (ARAs); beta-blockers calcium channel blockers and/or nitrates.

[0006] However, many of these treatments are recommended for acute conditions and do not address or provide for a long-term reduction in cardiovascular events in patients with clinically stable atherosclerotic vascular disease.

[0007] It is against this background that the present invention has been developed.

[0008] The present invention seeks to overcome, or at least ameliorate, one or more of the deficiencies of the prior art mentioned above, or to provide the consumer with a useful or commercial choice.

SUMMARY OF INVENTION

[0009] The present invention provides a method for the treatment or prevention of a cardiovascular event in a subject comprising the step of:

administering a therapeutically effective amount of a compound of formula (I), a known colchicine derivative and/or a salt thereof.

[0010] The present invention provides a method for the treatment or prevention of a cardiovascular event in a subject with atherosclerotic vascular disease comprising the step of:

administering a therapeutically effective amount of a compound of formula (I), a known colchicine derivative and/or a salt thereof.

[0011] The present invention further provides a method for the treatment or prevention of a cardiovascular event in a subject with atherosclerotic vascular disease comprising the step of:

administering a therapeutically effective amount of a compound of formula (I), a known colchicine derivative and/or a salt thereof and one or more additional agents selected from the list comprising: a statin and/or an anti-platelet agent.

[0012] Preferably the atherosclerotic vascular disease is a coronary disease. The coronary disease may be stable or unstable.

[0013] The invention further provides a method for the treatment or prevention of a cardiovascular event in a subject comprising the step of:

administering a therapeutically effective amount of a compound of formula (I), a known colchicine derivative and/or a salt thereof

wherein the subject has coronary disease prior to administration of the therapeutically effective amount of a compound of formula (I), a known colchicine derivative and/or a salt thereof. Preferably the coronary disease is a stable coronary disease.

[0014] The present invention provides a method for reducing or preventing cholesterol crystal induced inflammation within atherosclerotic plaques in a subject, comprising the step of

administering a dosage of 0.5 mg or 0.6 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof.

[0015] The invention also provides for the use of a compound of formula (I), a known colchicine derivative and/or a salt thereof in the preparation of a medicament for the treatment or prevention of a cardiovascular event.

[0016] In addition, the invention provides a composition for the prevention or treatment of a cardiovascular event in a subject, the composition comprising a therapeutically effective amount of a compound of formula (I), a known colchicine derivative and/or a salt thereof and one or more pharmaceutically acceptable additives, excipients carriers and/or diluents.

[0017] Preferably, the composition comprises 0.5 mg or 0.6 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof.

[0018] Preferably, the composition further comprises one or more additional agents selected from the list comprising: a statin and/or an anti-platelet agent.

[0019] The present invention provides a regimen for the treatment or prevention of a cardiovascular event in a subject, the regimen comprising the step of:

administering a dosage of 0.5 mg or 0.6 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof once per day.

[0020] The present invention also provides a regimen for reducing or preventing cholesterol crystal induced inflammation within atherosclerotic plaques in a subject, the regimen comprising the step of:

administering a dosage of 0.5 mg or 0.6 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof once or more times per day.

[0021] Preferably, the subject being administered the regimen has atherosclerotic vascular disease, more preferably a coronary disease which may be a stable or unstable coronary disease.

FIGURES

[0022] Figure 1 is a flow chart of the subject enrolment process for Example 1.

[0023] Figure 2 is a graph of the time to first clinical event in each group by treatment.

[0024] Figure 3 is a table of the first time to clinical event across subgroups examined.

[0025] Figure 4 is series of graphs of the time to first clinical event in each group by treatment broken down into specific events.

DETAILED DESCRIPTION OF THE INVENTION

General

[0026] Those skilled in the art will appreciate that the invention described herein is susceptible to variations and modifications other than those specifically described. The invention includes all such variation and modifications. The invention also includes all of the steps, features, formulations and compounds referred to or indicated in the specification, individually or collectively and any and all combinations or any two or more of the steps or features.

[0027] Each document, reference, patent application or patent cited in this text is expressly incorporated herein in their entirety by reference, which means that it should be read and considered by the reader as part of this text. That the document, reference, patent application or patent cited in this text is not repeated in this text is merely for reasons of conciseness. Any manufacturer's instructions, descriptions, product specifications, and product sheets for any products mentioned herein or in any document incorporated by reference herein, are hereby incorporated herein by reference, and may be employed in the practice of the invention. No admission is made that any of the references constitute prior art or are part of the common general knowledge of those working in the field to which this invention relates.

[0028] The present invention is not to be limited in scope by any of the specific embodiments described herein. These embodiments are intended for the purpose of exemplification only. Functionally equivalent products, formulations and methods are clearly within the scope of the invention as described herein.

[0029] The invention described herein may include one or more range of values (eg. size, displacement and field strength etc). A range of values will be understood to include all values within the range, including the values defining the range, and values adjacent to the range which lead to the same or substantially the same outcome as the values immediately adjacent to that value which defines the boundary to the range.

[0030] Other definitions for selected terms used herein may be found within the detailed description of the invention and apply throughout. Unless otherwise defined, all other scientific and technical terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which the invention belongs. The term "active agent" may mean one active agent, or may encompass two or more active agents.

[0031] Throughout this specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

Detailed Description

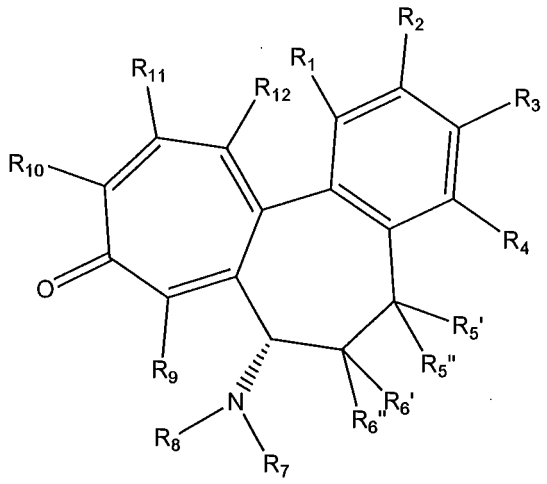
[0032] It is well known that consumption of a range of non-steroidal anti-inflammatory agents, such as Vioxx® (rofecoxib), Celebrex® (celecoxib), ibuprofen, Voltaren® (diclofenac), by patients with a previous history of coronary heart disease or other atherosclerotic vascular disease may lead to a significant increase in the risk of further cardiovascular events such as myocardial infarction. Other anti-inflammatory agents such as cortisone can also increase the risk of adverse effects and cardiovascular events in patients with a previous history of coronary heart disease. Despite the anti-inflammatory effects of these agents and their ability to reduce the markers of inflammation (such as a reduction in the levels of c-reactive protein), they are contra-indicated in the treatment of patients with coronary heart disease or other atherosclerotic vascular disease.

[0033] In atherosclerotic vascular disease, an artery wall thickens as a result of the accumulation of calcium and fatty materials such as cholesterol. It is a syndrome affecting arterial blood vessels, a chronic inflammatory response in the walls of arteries specifically due to atheromatous plaques. Disruption of the plaques may lead to acute coronary syndrome (including ischemic chest pain, acute myocardial infarction, unstable angina); cardiac arrest; and/or stroke such as non-cardio-embolic ischemic stroke.

[0034] Coronary disease and coronary heart disease is a form of atherosclerotic vascular disease caused by plaque building up along the inner walls of the arteries of the heart, which narrows the arteries and reduces blood flow to the heart. Stable coronary diseases are those that occur predictably in intensity, character or frequency at known levels of exertion or other stimuli. Unstable coronary diseases are those that change in intensity, character or frequency.

[0035] The inventors of the present invention have surprisingly found that administration of an anti-inflammatory agent within the group of compounds defined by formula (I) may treat or prevent cardiovascular events in patients with atherosclerotic vascular disease such as coronary heart disease.

Formula (I)



wherein:

R_1, R_2, R_3, R_4, R_9, R_{10}, R_{11} and R_{12} independently represent hydrogen, C_{1-4} alkyl, C_{2-4} alkenyl, C_{3-6} cycloalkyl, halogen, C_{1-4} haloalkyl, nitro, amino, C_{2-4} acylamino, C_{1-4} alkyl or dialkylamino, hydroxyl, C_{1-4} alkoxy, C_{1-4} alkylthio, a group of the formula $-SO_2N(R^x)_2$ or SO_2R^x where R^x is C_{1-4} alkyl, C_{1-4} acyloxy, or optionally substituted phenyl, optionally substituted phenoxy ;

R_7 and R_8 independently represent hydrogen, C_{1-4} alkyl or C_{1-4} acyl; and

R_5', R_5", R_6' and R_6" independently represent hydrogen, C_{1-4} alkyl, C_{2-4} alkenyl, C_{3-6} cycloalkyl, halogen, C_{1-4} haloalkyl, nitro, amino, C_{2-4} acylamino, hydroxyl, C_{1-4} alkoxy or C_{1-4} alkylthio a group of the formula $-SO_2N(R^x)_2$ or SO_2R^x where R^x is C_{1-4} alkyl, C_{1-4} acyloxy, or optionally substituted phenyl.

[0036] In particular, the inventors have discovered that colchicine [N-[(7S)-1,2,3,10-tetramethoxy-9-oxo-5,6,7,9-tetrahydrobenzo[α]heptalen-7-yl]acetamide] may treat or prevent cardiovascular events in patients with atherosclerotic vascular disease such as coronary heart disease.

[0037] Certain compounds of formula (I), and methods for their synthesis are described in the following publications, the contents of which are incorporated by reference:

> Kouroupis, Pavlos; Hansen, Hans-Jurgen, *From Colchicine and Some of Its Derivatives to 1,2,3,9,10-Pentamethoxybenzo[a]heptalenes,* Helvetica Chimica Acta; Vol. 78; (1995); p. 1247 – 1277.

Sun, Li; McPhail, Andrew T.; Hamel, Ernest; Lin, Chii M.; Hastie, Susan B.; et al.
Antitumor Agents. 139. Synthesis and Biological Evaluation of Thiocolchicine Analogs 5,6-Dihydro-6(S)-(acyloxy)- and 5,6- Dihydro-6(S)-(aroyloxy)methyl-1,2,3-trimethoxy-9-(methylthio)-8H-cyclohepta[a]naphthalen-8-ones as Novel Cytotoxic and Antimitotic Agents, Journal of Medicinal Chemistry; **Vol.** 36(5); (1993); p. 544 - 551

Kouroupis, Pavlos; Kessler, Jacqueline; Hansen, Hans-Juergen, *10-Alkyl-10-demethylcolchicines,* Helvetica Chimica Acta; Vol. 79; (1996); p. 208 – 212.

Chang, Dong-Jo; Jung, Jong-Wha; An, Hongchan; Suh, Young-Ger; Yoon, Eun-Young; Lee, Geon-Bong; Kim, Soon-Ok; Kim, Wan- Joo; Kim, Young-Myeon, *Design, synthesis and identification of novel colchicine-derived immunosuppressant,* Bioorganic and Medicinal Chemistry Letters; Vol.19(15); (2009); p. 4416 – 4420.

Kozaka, Takashi; Nakagawa-Goto, Kyoko; Shi, Qian; Lai, Chin-Yu; Brossi, Arnold; Lee, Kuo-Hsiung; Hamel, Ernest; Bastow, Kenneth F., *Antitumor agents 273. Design and synthesis of N-alkyl-thiocolchicinoids as potential antitumor agents,* Bioorganic and Medicinal Chemistry Letters; vol. 20(14); (2010); p. 4091 – 4094.

Danieli, Bruno; Giardini, Alessandra; Lesma, Giordano; Passarella, Daniele; Peretto, Bruno; Sacchetti, Alessandro; Silvani, Alessandra; Pratesi, Graziella; Zunino, Franco, *Thiocolchicine-Podophyllotoxin Conjugates: Dynamic Libraries Based on Disulfide Exchange Reaction,* Journal of Organic Chemistry; Vol. 71: 7; (2006); p. 2848 – 2853.

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Bensel, Nicolas; Lagnoux, David; Niggli, Verena; Wartmann, Markus; Reymond, Jean-Louis
New C(4)-Functionalized Colchicine Derivatives by a Versatile Multicomponent Electrophilic Aromatic Substitution Helvetica Chimica Acta; Vol. 87(9); (2004); p. 2266 – 2272

Malysheva, Yulia B.; Fedorov, Alexey Yu.; Combes, Sebastien; Allegro, Diane; Peyrot, Vincent; Knochel, Paul;
Gavryushin, Andrei E., *Synthesis and biological evaluation of novel anticancer bivalent colchicine-tubulizine hybrids* Bioorganic and Medicinal Chemistry; Vol. 20(14); (2012); p. 4271 – 4278.

Kouroupis, Pavlos; Linden, Anthony; Hansen, Hans-Juergen, *Synthesis of 4-Acetylcolchicine Helvetica,* Chimica Acta; Vol.79, (1996); p. 203 – 207

Bensel, Nicolas; Lagnoux, David; Niggli, Verena; Wartmann, Markus; Reymond, Jean-Louis
New C(4)-Functionalized Colchicine Derivatives by a Versatile Multicomponent Electrophilic Aromatic Substitution Helvetica Chimica Acta; Vol. 87(9); (2004); p. 2266 – 2272.

Chang, Dong-Jo; Jung, Jong-Wha; An, Hongchan; Suh, Young-Ger; Yoon, Eun-Young; Lee, Geon-Bong; Kim, Soon-Ok; Kim, Wan- Joo; Kim, Young-Myeon, *Design, synthesis and identification of novel colchicine-derived immunosuppressant,* Bioorganic and Medicinal Chemistry Letters; vol. 19; nb. 15; (2009); p. 4416 – 4420.

Hufford, Charles D.; Capraro, Hans-Georg; Brossi, Arnold. *(13)C- and (1)H-NMR. Assignments for Colchicine Derivatives,* Helvetica Chimica Acta; Vol. 63(1); (1980); p. 50 – 56.

Nicolaou, K. C.; Valiulin, Roman A.; Pokorski, Jonathan K.; Chang, Vicki; Chen, Jason S., *Bio-inspired synthesis and biological evaluation of a colchicine-related compound library,* Bioorganic and Medicinal Chemistry Letters; vol. 22; nb. 11; (2012); p. 3776 – 3780.

Patil, Shivaputra A.; Wang, Jin; Li, Xiaochen S.; Chen, Jianjun; Hosni-Ahmed, Amira; Patil, Renukadevi; Li, Wei; Miller, Duane D.; Jones, Terreia S.; Seibel, William L. *New substituted 4H-chromenes as anticancer agents*
Bioorganic and Medicinal Chemistry Letters; vol. 22; nb. 13; (2012); p. 4458 – 446.

Nielsen, Kurt; Manchanda, Rajesh *Deuterium-enriched colchicines, Thiocolchicine and derivatives thereof; Methods of preparation and use thereof, P*atent: US2011/178180; (2011); (A1).

Bartusik, Dorota; Tomanek, Boguslaw; Fallone, Gino; Lattova, Erika; Perreault, Helene; Tuszynski, Jack, *Derivatives of thiocolchicine and its applications to CEM cells treatment using 19F Magnetic Resonance ex vivo* Bioorganic Chemistry; vol. 38; nb. 1; (2010); p. 1 – 6.

Alali, Feras Q.; Qandil, Amjad; Gharaibeh, Ahmad A.; Ghawanmeh, Abdullah; Tawaha, Khaled; Burgess, Jason P.; Sy, Arlene; Nakanishi, Yuka; Kroll, David J.; Oberlies, Nicholas H. Colchicinoids from Colchicum crocifolium Boiss. (Colchicaceae) Natural Product Research; vol. 24(2); (2010); p. 152 – 159.

Boyer, Franois-Didier; Dubois, Joelle; Thoret, Sylviane; Dau, Marie-Elise Tran Huu; Hanna, Issam, *Synthesis and tubulin-binding properties of new allocolchicinoids Bioorganic Chemistry*; vol. 38(4); (2010); p. 149 – 158.

Yang, Baiyuan; Zhu, Zhiqing C.; Goodson, Holly V.; Miller, Marvin J. *Syntheses and biological evaluation of ring-C modified colchicine analogs, Bioorganic and Medicinal Chemistry Letters*; Vol. 20(12); (2010); p. 3831 – 3833.

Stefely, Jonathan A.; Miller, Patricia A.; Peterson, Rebecca J.; Moraski, Garrett C.; Miller, Marvin J.; Palchaudhuri, Rahul; Hergenrother, Paul J., *N-((1-benzyl-1H-1,2,3-triazol-4-yl)methyl)arylamide as a new scaffold that provides rapid access to antimicrotubule agents: synthesis and evaluation of antiproliferative activity against select cancer cell lines*, Journal of Medicinal Chemistry; Vol. 53(8); (2010); p. 3389 – 3395.

Kozaka, Takashi; Nakagawa-Goto, Kyoko; Shi, Qian; Lai, Chin-Yu; Brossi, Arnold; Lee, Kuo-Hsiung; Hamel, Ernest; Bastow, Kenneth F. Antitumor agents 273. *Design and synthesis of N-alkyl-thiocolchicinoids as potential antitumor agents*, Bioorganic and Medicinal Chemistry Letters; Vol. 20.(14); (2010); p. 4091 – 4094.

Johansson, Emma M. V.; Darbre, Tamis; Reymond, Jean-Louis; Dubois, Joelle, *Glycopeptide dendrimer colchicine conjugates targeting cancer cells,* Bioorganic and Medicinal Chemistry; Vol.18(17); (2010); p. 6589 – 6597.

Dietrich, Andrea; Mueller, Thomas; Schobert, Rainer; Biersack, Bernhard; Effenberger, Katharina; Knauer, Sebastian
4-(3-Halo/amino-4,5-dimethoxyphenyl)-5-aryloxazoles and-N-methylimidazoles that are cytotoxic against combretastatin a resistant tumor cells and vascular disrupting in a cisplatin resistant germ cell tumor model
Journal of Medicinal Chemistry, Vol. 53(18); (2010); p. 6595 – 6602.

Nicolaus, Norman; Neudoerfl, Joerg-Martin; Schmalz, Hans-Guenther; Zapke, Janet; Oschkinat, Hartmut; Riesterer, Philipp; Prokop, Aram, *Azides derived from colchicine and their use in library synthesis: A practical entry to new bioactive derivatives of an old natural drug,* ChemMedChem; vol. 5(5) (2010); p. 661 – 665.

Sharma, Shubhada; Ravindra, Rudravajhala; Blanden, Adam R.; Bane, Susan; Poliks, Barbara; Chiauzzi, Colby
Characterization of the colchicine binding site on avian tubulin isotype βVI, Biochemistry; vol. 49(13); (2010); p. 2932 – 2942.

Indena S.p.A."*Process for the glycosidation of colchicine and thiocolchicine*" Patent: EP2128170; (2009); (A1).

Sun, Tong; Nielsen, Kurt; Watson, Shawn; Hilfiker, Rolf; Sieber, Andreas, *Colchicine Solid-State forms: Methods of Making and Methods of Use Thereof*, Patent: US2009/312430; (2009); (A1).

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The efficacy of new colchicine derivatives and viability of the T-Lymphoblastoid cells in three-dimensional culture using 19F MRI and HPLC-UV ex vivo, Bioorganic Chemistry; vol. 37(6); (2009); p. 193 – 201.

Chang, Dong-Jo; Jung, Jong-Wha; An, Hongchan; Suh, Young-Ger; Yoon, Eun-Young; Lee, Geon-Bong; Kim, Soon-Ok; Kim, Wan- Joo; Kim, Young-

Myeong, *Design, synthesis and identification of novel colchicine-derived immunosuppressant*, Bioorganic and Medicinal Chemistry Letters; vol. 19(15); (2009); p. 4416 – 4420.

ALBERTA HEALTH SERVICES; Novel Colchicine Derivatives, Methods and Uses Thereof, Patent: WO2011/22805; (2011); (A1)

MUTUAL PHARMACEUTICAL COMPANY, INC.; MANCHANDA, Rajesh, Thiocolchicine Derivatives, method of making and method of use thereof, Patent: WO2010/138670; (2010); (A2)

[0038] These publications disclose a large number of compounds derived from colchicine, not all of which fall within the scope of formula (I). Compounds outside the scope of formula (I), yet derived from colchicine and described in the aforementioned publications, are collectively referred to herein as "known colchicine derivatives".

[0039] The compounds of formula (I) and the known colchicine derivatives contain at least one asymmetric carbon atom. The methods of the present invention include the use of isolated optical isomers and/or mixtures of such.

[0040] The term C1-4 alkyl as used herein means a straight or branched chain alkyl group containing from 1 to 4 carbon atoms, i.e. methyl, ethyl, isopropyl, n-propyl, s-butyl, isobutyl and n-butyl.

[0041] The term C1-4 haloalkyl means the abovementioned alkyl groups substituted by one or more halogen atoms, e.g. trifluoromethyl.

[0042] The term C1-4 alkoxy and C1-4 alkylthio refer to the abovementioned alkyl groups attached through an oxygen or sulphur atom respectively to the relevant ring.

[0043] The term C2-4 alkenyl refers to groups such as vinyl, allyl and butenyl.

[0044] The term amino indicates a group of formula –NH2 and also substituted amino groups such as mono-C1-4 alkylamino and di-C1-4 alkyl amino groups.

[0045] The term C2-4 acyl amino means an amino group substituted by a C2-4 acyl group such as acetyl.

[0046] The term C1-4 alkanoyl refers to groups such as formyl or acetyl.

[0047] The term C3-8 cycloalkyl means a saturated ring having from 3 to 8 carbon atoms in the ring, such as cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl or cyclooctyl.

[0048] The term optionally substituted phenyl as used herein means a phenyl group unsubstituted or substituted by one or more groups such as halogen, trifluoromethyl, methyl, methoxy or nitro.

[0049] The term optionally substituted phenoxy as used herein means a phenoxy group unsubstituted or substituted by one or more groups such as halogen, trifluoromethyl, methyl, methoxy or nitro.

[0050] Therefore, the present invention provides a method for the prevention or treatment of a cardiovascular event in a subject comprising the step of: administering a therapeutically effective amount of a compound of formula (I), a known colchicine derivative and/or a salt thereof.

[0051] Preferably, the subject has atherosclerotic vascular disease, more preferably coronary disease, even more preferably clinically stable coronary disease.

[0052] Therefore, the invention further provides a method for the prevention or treatment of a cardiovascular event in a subject with atherosclerotic vascular disease comprising the step of: administering a therapeutically effective amount of a compound of formula (I), a known colchicine derivative and/or a salt thereof.

[0053] The invention further provides a method for the prevention or treatment of a cardiovascular event in a subject comprising the step of: administering a therapeutically effective amount of a compound of formula (I), a known colchicine derivative and/or a salt thereof, wherein the subject has a coronary disease prior to administration of the therapeutically effective amount of a compound of formula (I), a known colchicine derivative and/or a salt thereof. Preferably the coronary disease is a stable coronary disease.

[0054] The method may include the further step of co-administering a second agent for the treatment and/or prevention of a cardiovascular event in a subject. For example, the composition delivered in the method may further include an agent for

anti-platelet therapy. Such anti-platelet therapy agents include: Irreversible cyclooxygenase inhibitors (such as Aspirin); Adenosine diphosphate (ADP) receptor inhibitors (such as Clopidogrel (Plavix®), Prasugrel (Effient®), Ticagrelor (Brilinta®), Ticlopidine (Ticlid®), Cangrelor); Phosphodiesterase inhibitors (such as Cilostazol (Pletal®)); Glycoprotein IIB/IIIA inhibitors (such as Abciximab (ReoPro®), Eptifibatide (Integrilin®), Tirofiban (Aggrastat®)); Adenosine reuptake inhibitors (such as Dipyridamole (Persantine®)); Thromboxane inhibitors including Thromboxane synthase inhibitors and Thromboxane receptor antagonists (such as Terutroban).

[0055] Additionally, the composition delivered in the method may include one or more statins. Statins that may be used in the composition of the present invention include: simvastatin, atorvastatin, fluvastatin, lovastatin, pitavastatin, pravastatin, and rosuvastatin.-

[0056] The additional statin and/or anti-platelet agent may be administered at the same time as the compound of formula (I), a known colchicine derivative and/or a salt thereof, for example as tablets or capsules taken at the same time as each other; within an hour of each other; within 2 hours, 4 hours, 6 hours, 8 hours or 12 hours of each other; or within a day of each other. Alternatively, the additional statin and/or anti-platelet agent may be in the same dosage form (for example the same tablet or capsule) as the compound of formula (I), a known colchicine derivative and/or a salt thereof.

[0057] The invention therefore provides a method for the prevention or treatment of a cardiovascular event in a subject with atherosclerotic vascular disease comprising the step of: administering a therapeutically effective amount of a compound of formula (I), a known colchicine derivative and/or a salt thereof and one or more additional agents selected from the list comprising: a statin or an anti-platelet agent.

[0058] Preferably the atherosclerotic vascular disease is a coronary disease, which may be a clinically stable coronary disease or an unstable coronary disease.

[0059] In one form of the invention, the methods comprise the administration of a compound of formula (I).

[0060] In one form of the invention, the methods comprise the administration of a compound selected from the group of compounds described in one or more of the publications listed above as defining known colchicine derivatives.

[0061] In a preferred form of the invention, the compound of formula (I) has one or more of the following features:

R_1, R_2, R_3, R_4, R_9, R_{10}, R_{11} and R_{12} independently represent hydrogen, C_{1-4} alkyl, C_{2-4} alkenyl, C_{3-6} cycloalkyl, halogen, C_{1-4} haloalkyl, nitro, amino, C_{2-4} acylamino, hydroxyl, C_{1-4} alkoxy, C_{1-4} alkylthio, a group of the formula $-SO_2N(R^x)_2$ or SO_2R^x where R^x is C_{1-4} alky;

R_5', R_5", R_6' and R_6" independently represent hydrogen, C_{1-4} alkyl, C_{2-4} alkenyl, C_{3-6} cycloalkyl, halogen, C_{1-4} haloalkyl, nitro, amino, C_{2-4} acylamino, hydroxyl, C_{1-4} alkoxy or C_{1-4} alkylthio a group of the formula $-SO_2N(R^x)_2$ or SO_2R^x where R^x is C_{1-4} alkyl.

[0062] In a preferred form of the invention, the compound of formula (I) has one or more of the following features:

a. At least one of R_1, R_2 and R_3 is C_{1-4} alkoxy or C_{1-4} alkylthio;

b. At least one of R_7 and R_8 is C_{2-4} acyl;

c. R_{10} is C_{1-4} alkoxy or C_{1-4} alkylthio

[0063] In a preferred form of the invention, the compound of formula (I) has two or more of the above-mentioned features.

[0064] In a preferred form of the invention, the compound of formula (I) has each of the abovementioned features.

[0065] In a more preferred form of the invention, the compound of formula (I) has the following feature:

d. Each of R_4, R_5', R_5", R_6', R_6" R_{11}, R_{12} is H.

[0066] In a more preferred form of the invention, the compound of formula (I) has the following feature:

e. one of R_7 and R_8 is H, and the other is C_{2-4} acyl.

[0067] Thus, in a highly preferred form of the invention, the compound of formula (I) has each of the following features:

a. At least one of R_1, R_2 and R_3 is C_{1-4} alkoxy or C_{1-4} alkylthio;

b. At least one of R_7 and R_8 is C_{2-4} acyl;

c. R_{10} is C_{1-4} alkoxy or C_{1-4} alkylthio;

d. Each of R_4, R_5', R_5", R_6', R_6" R_{11}, R_{12} is independently H;

e. One of R_7 and R_8 is H, and the other C_{2-4} acyl.

[0068] Generally, C_{1-4} alkoxy is preferred over C_{1-4} alkylthio.

[0069] Generally, C_{1-2} alkoxy is preferred over C_{3-4} alkoxy.

[0070] In a preferred form of the invention, the compound of formula (I) is selected from the group of compounds defined by the following features:

R_1, R_2, R_3, and, R_{10}, R_{11} independently represent C_{1-4} alkoxy or C_{1-4} alkylthio;

R_7 and R_8 independently represent hydrogen or C_{2-4} acyl; and

R_4, R_5', R_5", R_6' and R_6" independently represent hydrogen or C_{1-4} alkyl.

[0071] Preferably, R_1, R_2, R_3, and, R_{10}, R_{11} independently represent C_{1-4} alkoxy.

[0072] Preferably still, each of R_1, R_2, R_3, and, R_{10}, R_{11} represent C_{1-4} alkoxy.

[0073] Preferably R_4, R_5', R_5", R_6' and R_6" independently represent hydrogen.

[0074] Preferably still, each of R_4, R_5', R_5", R_6' and R_6" represent hydrogen.

[0075] In a highly preferred form of the invention, the compound of formula (I) has the following features:

each of R_1, R_2, R_3, and, R_{10}, R_{11} represent C_1 alkoxy;

each of R_4, R_5', R_5", R_6' and R_6" represent H;

R_7 represents H; and

R_8 represents C_2 acyl;

such that the compound of formula (I) is colchicine.

[0076] Compounds of formula (I) of the invention are useful in both free base or acid addition salt forms. The acid addition salts are preferably the pharmaceutically acceptable, non-toxic addition salts with suitable acids, such as those with inorganic acids, for example hydrochloric hydrobromic, nitric, sulfuric and phosphoric acids, or with organic acids, such as organic carboxylic acids, for example glycolic, maleic, hydroxymaleic, fumaric, malic, tartaric, citric, salicylic, o-acetoxybenzoic, nicotinic or isonicotinic acid, or organic sulfonic acids for example methanesulfonic, ethane sulfonic, 2-hydroxyethanesulfonic, toluene- *p*-sulfonic or naphthalene-2-sulfonic acid.

[0077] Without wishing to be bound by any one theory, we believe the activity of a compound of formula (I), a known colchicine derivative and/or a salt thereof in relation to the prevention of vascular events in patients with coronary disease may be due to the inhibition of neutrophil function, leading to a reduction in the risk of plaque instability and thus the risk of *de novo* vascular events due to disruption of native atherosclerotic plaques in patients with atherosclerotic vascular disease such as coronary disease. For example, the colchicine may be preventing activation and amplification of the [cholesterol] crystal induced inflammation within atherosclerotic plaques and thereby acting to slow the progression of atherosclerosis and promote the stability of atherosclerotic plaques.

[0078] There is therefore provided a method for reducing or preventing cholesterol crystal induced inflammation within atherosclerotic plaques in a subject, comprising the step of

administering a dosage of 0.5 mg or 0.6 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof.

[0079] Preferably the subject with atherosclerotic plaques has atherosclerotic vascular disease, more preferably a stable or unstable coronary disease.

[0080] Preferably the composition administered to reduce or prevent cholesterol crystal induced inflammation within atherosclerotic plaques further comprises one or more additional agents selected from the list comprising: a statin and/or an anti-platelet agent.

[0081] Preferably, the method of treatment of the present invention results in the treatment or prevention of one or more of the following cardiovascular events: acute coronary syndrome (including ischemic chest pain, acute myocardial infarction, unstable angina); cardiac arrest; or stroke such as non-cardio-embolic ischemic stroke.

[0082] Generally, the terms “treat”, "treating" and "treatment" and derivatives used herein have the meaning to affect a subject, tissue or cell to produce a desired pharmacological and/or physiological effect. The treatment may be therapeutic in terms of: preventing progression of the coronary disease or other atherosclerotic vascular disease and cardiovascular events; or causing a partial or complete cure and/or regression of the coronary disease or other atherosclerotic vascular disease and cardiovascular events.

[0083] "Preventing" or "prevention" and derivative terms relate to the partial or complete prevention or at least delaying the onset of the development of coronary disease or other atherosclerotic vascular disease and cardiovascular events or the symptoms thereof in a subject who: has not yet been diagnosed with coronary disease or other atherosclerotic vascular disease or had a cardiovascular event; has had coronary disease and may be in remission and wishes to prevent re-occurrence of the coronary disease and/or cardiovascular event; or has been diagnosed as being at risk of developing coronary disease or other atherosclerotic vascular disease and having a cardiovascular event.

[0084] The invention further provides for the use of a compound of formula (I), a known colchicine derivative and/or a salt thereof in the preparation of a medicament for the treatment or prevention of a cardiovascular event.

[0085] The invention also provides for the use of a therapeutically effective amount of a compound of formula (I), a known colchicine derivative and/or a salt thereof in

the preparation of a medicament for the prevention or treatment of a cardiovascular event in a subject with atherosclerotic vascular disease.

[0086] Preferably the atherosclerotic vascular disease is a clinically stable coronary disease or unstable coronary disease.

[0087] There is also provided the use of a therapeutically effective amount of a compound of formula (I), a known colchicine derivative and/or a salt thereof in the preparation of a medicament for reducing or preventing cholesterol crystal induced inflammation within atherosclerotic plaques in a subject.

[0088] The invention further provides for the use of a therapeutically effective amount of a compound of formula (I) in the preparation of a medicament for the prevention or treatment of a cardiovascular event in a subject.

[0089] In another form of the invention, there is provided the use of a therapeutically effective amount of a compound selected from the group of compounds described in one or more of the publications listed above as defining known colchicine derivatives in the preparation of a medicament for the prevention or treatment of a cardiovascular event in a subject.

[0090] Preferably, the medicament discussed above comprises between 0.01 and 1 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof; between 0.05 and 0.95 mg, between 0.1 and 0.9 mg, between 0.2 and 0.8 mg, or between 0.4 and 0.7 mg. More preferably, it comprises between 0.5 mg and 0.6 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof, most preferably either 0.5 mg or 0.6 mg.

[0091] The present invention further provides a composition for the prevention or treatment of a cardiovascular event in a subject, the composition comprising a therapeutically effective amount of a compound of formula (I), a known colchicine derivative and/or a salt thereof and one or more pharmaceutically acceptable additives, excipients carriers and/or diluents.

[0092] The present invention further provides a composition for reducing or preventing cholesterol crystal induced inflammation within atherosclerotic plaques in

a subject, the composition comprising a therapeutically effective amount of a compound of formula (I), a known colchicine derivative and/or a salt thereof and one or more pharmaceutically acceptable additives, excipients carriers and/or diluents.

[0093] Preferably, the composition comprising a compound of formula (I), a known colchicine derivative and/or a salt thereof comprises between 0.01 and 1 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof; between 0.05 and 0.95 mg, between 0.1 and 0.9 mg, between 0.2 and 0.8 mg, or between 0.4 and 0.7 mg. More preferably, it comprises between 0.5 mg and 0.6 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof, most preferably either 0.5 mg or 0.6 mg.

[0094] The exact amount of the a compound of formula (I), a known colchicine derivative and/or a salt thereof in the composition will of course, depend on the route of delivery, the nature of the coronary heart disease or other atherosclerotic vascular disease, the therapeutically effective amount of colchicine required and the general nature and health of the subject to whom the composition is delivered.

[0095] Preferably the concentration of the a compound of formula (I), a known colchicine derivative and/or a salt thereof in the composition will be of sufficient strength (qs) to provide a therapeutically effective dose to the target cells. Such therapy may be directed to the treatment or prevention of a cardiovascular event in a subject. More preferably, the therapeutically effective dose is directed to the treatment or prevention of a cardiovascular event in a subject who has atherosclerotic vascular disease such as stable or unstable coronary disease.

[0096] The compositions of the present invention, comprising a compound of formula (I), a known colchicine derivative and/or a salt thereof, are preferably adapted to be delivered to the subject in need more than once daily, once daily or less often. For example, if the composition is adapted for oral delivery, the composition is preferably administered once a day. However, it is contemplated that the composition can be administered more frequently than this (for example, two or three times a day) or less often (for example every second day, every third day, once a week). Alternatively, if the composition comprising a compound of formula (I), a known colchicine derivative and/or a salt thereof is in the form of an injectable

formulation, it is preferable that the composition be adapted for delivery once a week, or once a month.

[0097] The compositions may further comprise and one or more additional agents selected from the list comprising: a statin and/or an anti-platelet agent.

[0098] As used herein, the term "therapeutically effective amount" means an amount of a compound of formula (I), a known colchicine derivative and/or a salt thereof effective to yield a desired therapeutic response, for example to prevent or treat a cardiovascular event in a subject. The specific therapeutically effective amount will of course vary with such factors as the particular condition being treated, the physical condition and clinical history of the subject, the type of animal being treated, the duration of the treatment, the nature of concurrent therapy (if any), the specific formulations employed and the structure of the composition.

[0099] The term “pharmaceutically”, “physiologically”, or “veterinary acceptable” as used herein refers to pharmaceutically active agents, physiologically active agents, veterinary active agents, or inert ingredients which are suitable for use in oral formulations or formulations designed for contact with the skin of animals, including humans, without undue toxicity, incompatibility, instability, irritation, allergic response, and the like, commensurate with a reasonable benefit/risk ratio.

[00100] Additives, excipients carriers and diluents for use in the compositions of the present invention include, without limitation: water, saline, ethanol, dextrose, glycerol, glycerol and polyhydric alcohols, milk protein, vitamins, animal and vegetable oils, polyethylene glycols, lactose, dextrose, sucrose sorbitol, mannitol and other sugars, starches, gum acacia, calcium phosphates, alginate, tragacanth, gelatine, calcium silicate, cellulose and its derivatives such as microcrystalline cellulose and methyl cellulose, polyvinylpyrrolidone, water syrup, methyl and propylhydroxybenzoates, talc, magnesium carbonate, titanium dioxide, magnesium stearate and mineral oil or combinations thereof.

[00101] The compositions can additionally include lubricating agents, dispersion media, pH buffering agents, wetting agents, emulsifying and suspending agents, solvents, preserving agents, sweetening agents or flavouring agents, antifoaming agents, polymers, antioxidants, chelating agents, viscomodulators, tonicifiers,

flavorants, colorants, odorants, opacifiers, suspending agents, binders, fillers, plasticizers, lubricants, absorption-promoting agents and mixtures thereof. Preservatives include antimicrobial, antibacterial and antifungal agents, anti-oxidants, chelating agents and inert gases. The particular selection of constituent that can be included in the compositions described herein will generally depend on the type of preparation.

[00102] In the preferred embodiments, the composition is formulated to enable ready location and retention of the compound of formula (I), a known colchicine derivative and/or a salt thereof in the area required to deliver the therapeutic effect while at the same time not significantly interfering with the compound's efficacy. It will be understood, therefore, that the therapeutically effective composition may be formulated differently based on the area of treatment and how the composition is to be administered.

[00103] There are a range of reference sources for the development of pharmaceutical compositions which may be referred to by the skilled person when developing formulations comprising colchicine, such as "Remington's Pharmaceutical Sciences", 21st Edition (2009), Mack Publishing Company, Easton, Pennsylvania, USA, all the contents of which are incorporated herein.

[00104] A composition comprising a compound of formula (I), a known colchicine derivative and/or a salt thereof may be administered using standard procedures, for example: orally, topically, parenterally, intraorbitally, ophthalmically, intraventricularly, intracranially, intracapsularly, intraspinally, intracisternally, intraperitoneally, buccally, rectally, vaginally, intranasally, or by aerosol administration and/or inhalation spray or via an implanted reservoir.

[00105] In a preferred embodiment the compound of formula (I), a known colchicine derivative and/or a salt thereof is administered internally for the treatment or prevention of a cardiovascular event in a subject. For example, the compound may be delivered by oral routes in the form of a tablet, capsule, liquid dose, gel or powder; by injection e.g. into the blood stream, muscle tissue or directly into an organ such as the heart; by sublingual, buccal, rectal or intravaginal delivery; or by inhalation.

[00106] Pharmaceutically acceptable carriers, adjuvants and vehicles that may be used in oral, parenteral, sublingual, buccal, rectal or intravaginal or inhaled compositions may include: ion exchangers; alumina; aluminum stearate; lecithin; self-emulsifying drug delivery systems such as alpha- tocopherol polyethylene glycol 1000 succinate, or other similar polymeric delivery matrices or systems such as nanoparticles; serum proteins such as human serum albumin; buffer substances such as phosphates; glycine; sorbic acid; potassium sorbate; partial glyceride mixtures of saturated vegetable fatty acids; water; salts or electrolytes, such as protamine sulfate, disodium hydrogen phosphate, potassium hydrogen phosphate, sodium chloride, zinc salts; colloidal silica; magnesium trisilicate; polyvinyl pyrrolidone; cellulose-based substances; polyethylene glycol; sodium carboxymethylcellulose; polyacrylates; polyethylene-polyoxypropylene-block polymers; and wool fat.

[00107] The composition of the present invention comprising a compound of formula (I), a known colchicine derivative and/or a salt thereof can further contain one or more additives, provided that they do not detrimentally affect the therapeutic effect afforded by the compound of formula (I), a known colchicine derivative and/or a salt thereof. In one embodiment, the additive is a colorant. In alternative embodiments, the additive is a preservative such as a mould inhibitor or an anti-oxidant, a fragrance, or a stabiliser. The additional additives may also be agents that render the composition an emulsion, a micro-emulsion or a nano-emulsion.

[00108] In a preferred embodiment, the compound of formula (I), a known colchicine derivative and/or a salt thereof is delivered via an oral route. The colchicine may therefore be in the form of a tablet, capsule, gel or liquid composition. If the compound of formula (I), a known colchicine derivative and/or a salt thereof is in the form of a tablet, the tablet may further comprise fillers such as: lactose (milk sugar), microcrystalline cellulose, corn starch, sugars (including sucrose, mannitol, sorbitol, fructose, and dextrose), whey and yeast; and/or binders such as: povidone, xanthan gum and Carbopol. Additional ingredients may be in the form of: disintergrants such as crospovidone, croscarmellose sodium, and gellan gum; coatings such as shellac; lubricants such as magnesium stearate, stearic acid, sodium stearyl fumarate and hydrogenated vegetable oil; colorants such as titanium dioxide and iron oxides;

flavours (in chewable tablets); and plasticizers. Most preferably, the compound of formula (I), a known colchicine derivative and/or a salt thereof is administered in the form of a tablet comprising colchicine, magnesium stearate, lactose, maize starch and povidone. Preferably, the tablet, capsule, gel or liquid composition comprises between 0.01 and 1 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof; between 0.05 and 0.95 mg, between 0.1 and 0.9 mg, between 0.2 and 0.8 mg, or between 0.4 and 0.7 mg. More preferably, it comprises between 0.5 mg and 0.6 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof, most preferably either 0.5 mg or 0.6 mg.

[00109] Alternatively, the compound of formula (I), a known colchicine derivative and/or a salt thereof may be delivered via sublingual, buccal, rectal or intravaginal delivery, for example by administration of a tablet, capsule, gel, powder or spray.

[00110] In another embodiment, the compound of formula (I), a known colchicine derivative and/or a salt thereof is delivered parenterally, preferably by injection, for example subcutaneously or intramuscularly. However, delivery may also be intra-arterially or intraperitoneally for the treatment or prevention of a cardiovascular event in a subject. The composition may be in the form of a sterile injectable preparation, for example, as a sterile injectable suspension for the treatment or prevention of a cardiovascular event in a subject. This suspension may be formulated according to techniques known in the art using suitable dispersing agents, surfactants, and suspending agents (e.g. Tween 80). The sterile injectable preparation may also be a sterile injectable solution or suspension in a non-toxic parenterally- acceptable diluent or solvent (e.g. 1, 2-propanediol). Acceptable vehicles and solvents may include mannitol, water, Ringers solution and isotonic sodium chloride solution with buffer. Furthermore, sterile, fixed oils may be employed as a solvent or a suspending medium. For this purpose, any bland fixed oil may be employed including mono- or diglycerides. Fatty acids, such as oleic acid and its glyceride derivatives, and natural pharmaceutically acceptable oils, such as polyoxyethylated olive oil or castor oil, may also be used in the preparation of injectables. Preferably, the injectable composition comprises between 0.01 and 1 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof; between 0.05 and 0.95 mg, between 0.1 and 0.9 mg, between

0.2 and 0.8 mg, or between 0.4 and 0.7 mg. More preferably, it comprises between 0.5 mg and 0.6 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof, most preferably either 0.5 mg or 0.6 mg.

[00111] The composition may further comprise a second agent for the treatment and/or prevention of a cardiovascular event in a subject. For example, the composition may further include an agent for in anti-platelet therapy. Such anti-platelet therapy agents include: Irreversible cyclooxygenase inhibitors (such as Aspirin); Adenosine diphosphate (ADP) receptor inhibitors (such as Clopidogrel (Plavix®), Prasugrel (Effient®), Ticagrelor (Brilinta®), Ticlopidine (Ticlid®), Cangrelor); Phosphodiesterase inhibitors (such as Cilostazol (Pletal®)); Glycoprotein IIB/IIIA inhibitors (such as Abciximab (ReoPro®), Eptifibatide (Integrilin®), Tirofiban (Aggrastat®)); Adenosine reuptake inhibitors (such as Dipyridamole (Persantine®)); Thromboxane inhibitors including Thromboxane synthase inhibitors and Thromboxane receptor antagonists (such as Terutroban).,

[00112] Additionally, the composition may include one or more statins. Statins that may be used in the composition of the present invention include: simvastatin, atorvastatin, fluvastatin, lovastatin, pitavastatin, pravastatin, and rosuvastatin.–

[00113] The present invention also provides a regimen for the treatment or prevention of a cardiovascular event in a subject, the regimen comprising the step of:

administering a dosage of 0.5 mg or 0.6 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof once or more per day.

[00114] The present invention also provides a regimen for reducing or preventing cholesterol crystal induced inflammation within atherosclerotic plaques in a subject, the regimen comprising the step of:

administering a dosage of 0.5 mg or 0.6 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof once or more per day.

[00115] Alternatively, the regimen may involve administering the compound of formula (I), a known colchicine derivative and/or a salt thereof every second day, every third day, every fourth day, every fifth day, every sixth day or once a week.

[00116] Preferably, the subject being administered the regimen has atherosclerotic vascular disease, preferably a stable coronary disease.

[00117] The regimen may include the additional step of co-administering one or more additional agents selected from the list comprising: a statin and/or an anti-platelet agent. The one or more additional agents may also be administered once per day.

[00118] Methods for synthesising compounds of formula (I) and/or known colchicine derivatives may be found in the following publications, the contents of which are hereby incorporated by reference.

Substitution at R_1, R_2, R_3, R_4.

1. Synthesis of colchicine derivatives containing an methoxyl:

Chang, Dong-Jo; Jung, Jong-Wha; An, Hongchan; Suh, Young-Ger; Yoon, Eun-Young; Lee, Geon-Bong; Kim, Soon-Ok; Kim, Wan- Joo; Kim, Young-Myeon, *Design, synthesis and identification of novel colchicine-derived immunosuppressant,* Bioorganic and Medicinal Chemistry Letters; vol. 19; nb. 15; (2009); p. 4416 – 4420.

Hufford, Charles D.; Capraro, Hans-Georg; Brossi, Arnold. *(13)C- and (1)H-NMR. Assignments for Colchicine Derivatives,* Helvetica Chimica Acta; Vol. 63(1); (1980); p. 50 – 56.

2. Synthesis of colchicine derivatives having substituent at R_4:

Bensel, Nicolas; Lagnoux, David; Niggli, Verena; Wartmann, Markus; Reymond, Jean-Louis
New C(4)-Functionalized Colchicine Derivatives by a Versatile Multicomponent Electrophilic Aromatic Substitution Helvetica Chimica Acta; Vol. 87(9); (2004); p. 2266 – 2272.

3. Synthesis of colchicine derivative containing a containing an acetyl functional group at R_4:

Kouroupis, Pavlos; Linden, Anthony; Hansen, Hans-Juergen, *Synthesis of 4-Acetylcolchicine Helvetica,* Chimica Acta; Vol.79, (1996); p. 203 – 207:

Substitution at R_8 or R_7

1. Synthesis of colchicine derivatives containing an azide group:

Malysheva, Yulia B.; Fedorov, Alexey Yu.; Combes, Sebastien; Allegro, Diane; Peyrot, Vincent; Knochel, Paul; Gavryushin, Andrei E., *Synthesis and biological*

evaluation of novel anticancer bivalent colchicine-tubulizine hybrids Bioorganic and Medicinal Chemistry; Vol. 20(14); (2012); p. 4271 – 4278.

2. Synthesis of colchicine derivatives containing an amide group:

Bensel, Nicolas; Lagnoux, David; Niggli, Verena; Wartmann, Markus; Reymond, Jean-Louis
New C(4)-Functionalized Colchicine Derivatives by a Versatile Multicomponent Electrophilic Aromatic Substitution Helvetica Chimica Acta; Vol. 87(9); (2004); p. 2266 – 2272

Substitution at R_{10}

1. Synthesis of colchicine derivative containing a thio group.

Kozaka, Takashi; Nakagawa-Goto, Kyoko; Shi, Qian; Lai, Chin-Yu; Brossi, Arnold; Lee, Kuo-Hsiung; Hamel, Ernest; Bastow, Kenneth F., *Antitumor agents 273. Design and synthesis of N-alkyl-thiocolchicinoids as potential antitumor agents,* Bioorganic and Medicinal Chemistry Letters; vol. 20(14); (2010); p. 4091 – 4094.

Danieli, Bruno; Giardini, Alessandra; Lesma, Giordano; Passarella, Daniele; Peretto, Bruno; Sacchetti, Alessandro; Silvani, Alessandra; Pratesi, Graziella; Zunino, Franco, *Thiocolchicine-Podophyllotoxin Conjugates: Dynamic Libraries Based on Disulfide Exchange Reaction*, Journal of Organic Chemistry; Vol. 71: 7; (2006); p. 2848 – 2853.

Quinn, Frank R.; Neiman, Zohar; Beisler, John A. *Toxicity Quantitative Structure-Activity Relationships of Colchicines Journal of Medicinal Chemistry*; Vol. 24(5); (1981); p. 636 - 639

2. Synthesis of colchicine derivative containing an haloalkyl functional group.

Chang, Dong-Jo; Jung, Jong-Wha; An, Hongchan; Suh, Young-Ger; Yoon, Eun-Young; Lee, Geon-Bong; Kim, Soon-Ok; Kim, Wan- Joo; Kim, Young-Myeon, *Design, synthesis and identification of novel colchicine-derived immunosuppressant,* Bioorganic and Medicinal Chemistry Letters; Vol.19(15); (2009); p. 4416 – 4420.

3. Synthesis of colchicine derivative containing an alkoxy group.

Kouroupis, Pavlos; Kessler, Jacqueline; Hansen, Hans-Juergen, *10-Alkyl-10-demethylcolchicines,* Helvetica Chimica Acta; Vol. 79; (1996); p. 208 – 212.

4. Synthesis of colchicine derivative containing an hydroxyl group.

Kouroupis, Pavlos; Hansen, Hans-Jurgen, *From Colchicine and Some of Its Derivatives to 1,2,3,9,10-Pentamethoxybenzo[a]heptalenes,* Helvetica Chimica Acta; Vol. 78; (1995); p. 1247 – 1277.

Sun, Li; McPhail, Andrew T.; Hamel, Ernest; Lin, Chii M.; Hastie, Susan B.; et al.

Antitumor Agents. 139. Synthesis and Biological Evaluation of Thiocolchicine Analogs 5,6-Dihydro-6(S)-(acyloxy)- and 5,6- Dihydro-6(S)-(aroyloxy)methyl-1,2,3-trimethoxy-9-(methylthio)-8H-cyclohepta[a]naphthalen-8-ones as Novel Cytotoxic and Antimitotic Agents, Journal of Medicinal Chemistry; Vol. 36(5); (1993); p. 544 - 551.

EXAMPLES

[00119] The following examples are provided to further illustrate several embodiments of the invention.

Example 1

[00120] A prospective randomized observer blinded end-point trial was conducted to determine whether adding 0.5mg/day of colchicine to standard secondary prevention therapies including aspirin and high dose statins reduces the risk of cardiovascular events in patients with objectively diagnosed and clinically stable coronary disease.

Methods

[00121] Study Conduct and Design: The LoDoCo Trial was conducted under the auspices of the Heart Research Institute of Western Australia. It was designed by the principal investigators, registered with the Australian Clinical Trial Registry [12610000293066], and received ethics approval from the Human Research Ethics Committee at Sir Charles Gairdner Hospital Perth Western Australia in July 2008. There was no external funding source.

[00122] We employed a PROBE [Prospective Randomized, Open, Blinded End-point] design [8] Eligible consenting patients with established coronary disease presenting for routine clinical review were randomized to receive colchicine 0.5mg/day or no colchicine without any other change to their medical therapy. All outcomes were evaluated by an experienced adjudicator blinded to the treatment allocation.

[00123] Study Size and Eligibility: It was planned to recruit a study population that would include 250 patients

randomized to the control group and 250 patients randomized to treatment who were tolerant of colchicine for at least 4 weeks after the date of their randomization.

[00124] Patients were eligible for inclusion if they met each of the following criteria: 1] angiographically proven coronary disease; 2] aged 35 to 85 years; 3] clinically stable for at least 6 months, 4] no major competing co-morbidities or contra-indication to colchicine therapy, 5] considered to be compliant with therapy and attending routine cardiology follow up appointments, and 6] willing to be consented and randomized into the study. Patients with a history of bypass surgery were only eligible if they had undergone bypass surgery more than 10 years before, or had angiographic evidence of graft failure or had undergone stenting since their bypass surgery. All patients signed informed consent before randomization.

[00125] Randomization: The randomization sequence was computer generated, kept concealed from the investigators at all times and was managed by a research assistant who had no involvement in the evaluation or management of study patients. Once the assistant received the consent form, the patients' demographic data were entered into the data base and the investigators and patients were advised in writing of the treatment group to which the patient had been assigned.

[00126] Despite electing to use the lowest dose of colchicine available, it was anticipated that a number of patients would withdraw from therapy early after randomisation due to gastrointestinal side effects. In order to ensure that the requisite number of patients in the treatment arm were actually tolerant of treatment, the protocol allowed for the research assistant to assign a newly recruited patient to treatment if a patient discontinued colchicine due to side effects in the first month. Patients who were intolerant to therapy remained in the study, and were followed in the usual manner and included in the primary intention to treat analysis.

[00127] Intervention: Patients randomized to active treatment were given a prescription for colchicine 0.5 mg daily by their referring cardiologist. The drug was dispensed by their usual chemist, and if

requested, patients were reimbursed for the cost of these scripts. All other treatments were continued as usual.

[00128] Follow-up and definition of clinical outcomes: Patient compliance with treatment and outcome data were collected at routine follow up visits and at the time of any unplanned hospital admission.

[00129] An acute coronary syndrome (ACS) was defined as either [a] Acute Myocardial Infarction (AMI), as evidenced by acute ischemic chest pain associated with a rise in serum troponin above the upper limit of normal [9] or [b] Unstable Angina (UA), as evidenced by a recent acceleration of the patients angina unassociated with a rise in serum troponin but associated with angiographic evidence of a change in the patient's coronary anatomy. (Unstable Angina Braunwald classification types IB and IIB) [10]. The ACS was characterized as being stent-related if there was evidence of significant in-stent stenosis or acute stent thrombosis. Out of Hospital Cardiac Arrest was defined as either a sudden death as evidenced on the patients' death certificate, or a non-fatal out of hospital cardiac arrest, defined as a recovery from sudden collapse associated with documented asystole, ventricular tachycardia or ventricular fibrillation. Non-cardio-embolic ischemic stroke was defined as CT or MRI proven ischemic stroke adjudged by the treating neurologist as not being due to atrial fibrillation or intra-cranial hemorrhage.

[00130] The primary efficacy outcome was the composite, ACS, fatal or non-fatal out of hospital cardiac arrest or non-cardio-embolic ischemic stroke.

[00131] Secondary outcomes were [a] individual components of the primary outcome, and [b] the components of ACS unrelated to stent disease.

[00132] Timelines: The pre-specified study duration was a minimum follow up of two years in all patients. Accordingly the study was closed on May 31, 2012. During May, all living patients were contacted by phone to collect compliance and

outcome data from the last date of follow-up. Final outcome data were available in all patients and no patients were lost to follow up.

[00133] Statistical Power: Assuming that the control group had a combined event rate [ACS, out of hospital cardiac arrest or non cardio-embolic-ischemic stroke] of 8% [11], an accrual interval of 2 years and a follow-up after the accrual interval of 2 years, the planned sample size provided >80% power to detect a hazard ratio of <0.50 based on a two sided significance level of 5%.

[00134] Data analysis: Summary statistics, including mean and standard deviation were calculated for all baseline characteristics by treatment arm. All time to event outcomes were calculated in days by subtracting the date of randomisation from either: (1) the date of event or death; or (2) the trial termination date for those patients not experiencing the defined event.

[00135] As pre-specified, the primary efficacy analysis was based on the intention-to-treat principle. The intention-to-treat analysis included all randomized subjects and all events during the time from randomization to the trial termination. Trial termination date was fixed as May 31, 2012. A secondary pre-specified on-treatment analysis was also performed, based on patients who were both tolerant and compliant to therapy beyond the first month of randomization. All events during the time from randomisation until non-compliance with colchicine treatment regimen were included in this analysis.

[00136] The time-to-first-event for all outcomes is presented using a Kaplan–Meier plot.

[00137] The primary efficacy outcome was analysed using a cox proportional hazards model including treatment group coded as control or colchicine. The secondary outcomes were analysed similarly. In addition, the primary analysis was stratified by gender, age, diagnosis of diabetes, past myocardial infarction, unstable angina, coronary bypass surgery, coronary angioplasty, and therapy with aspirin, clopidogrel or both, high dose statin therapy (defined as a dose of statin equivalent to atorvastatin of 40mg or more), beta blockers, calcium blockers and ACE inhibitors.

Results

[00138] Study Population: Between August 2008 and May 2010, 901 patients with stable coronary disease attending for routine out-patient cardiology review were assessed for eligibility for the study. Of these, 297 [33%] did not meet the entry criteria, 72 [8%] declined to participate and 532 [59%] were enrolled into the study, 250 of whom were randomized to the control group and 282 to treatment. Of those randomized to treatment 32 [11%] reported early intolerance, due to gastrointestinal side effects, and 7 patients subsequently reported that they chose not start therapy (Figure 1). All 532 randomized patients were followed for the duration of the study period which ranged from a minimum of 24 to a maximum of 44 months. Median follow up was 36 months.

[00139] Baseline characteristics according to randomized treatment groups are shown in Table.1. Both groups were well matched for important clinical characteristics although more patients in the colchicine group were taking calcium channel blockers and less were taking beta-blocker therapy. Almost all patients in each group were taking anti-platelet therapy and high dose statin therapy.

Table 1: Study Population

	Control n [%]	**Treatment** n [%]
Total	250	282
Mean Age	67 ± 9.2	66 ± 9.6
Males	222 [89]	251 [89]
Diabetic	69 [28]	92 [33]
Smoker	14 [6]	10 [4]
Past AMI or UA	61 [24]	64 [23]
CABG	39 [16]	62 [22]
PTCA	138 [55]	169 [60]
Aspirin and/or Plavix	235 [94]	262 [93]
DAPT	24 [10]	38 [13]
High Dose Statins	235 [94]	271 [96]
BB[1]	178 [71]	176 [62]
CBB[2]	25 [10]	52 [18]
ACE	150 [60]	155 [55]

[1]$p<0.05$ [2]$p<0.01$ for the comparison of the distributions between treatment and control

Past AMI or UA History of myocardial infarction or unstable angina

CABG	Coronary Artery Bypass Surgery
PTCA	History of Percutaneous Coronary Angioplasty
DAPT	Dual anti-platelet therapy [Aspirin and Clopidogrel]
BB	Beta-blocker therapy,
CCB	Calcium Chanel Blocker therapy
ACE	ACE inhibitor therapy

[00140] Late discontinuations: 30 patients ceased colchicine therapy after a mean period of 2.36 years. Therapy was ceased due to an unrelated inter-current illness in 11 patients, by choice in 5, and for a variety of possible drug related effects in 14 patients [4.9%] as described in Table 2.

Table 2: Withdrawals from therapy

	n [%]
Early Withdrawals	32 [11]
Late Withdrawals*	30 [11]
Unrelated inter-current illness	11 [3.9]
Patient Choice	5 [1.8]
Perceived Side effects	
Intestinal upset	7 [2.5]
Myalgia	2 [0.90]
Myositis	1 [<0.5]
Rash	1 [<0.5]
Alopecia	1 [<0.5]
Itch	1 [<0.5]
Peripheral Neuritis	1 [<0.5]

* Withdrawals after 30 days, Average time to withdrawal 2.36 years

[00141] Outcomes; A primary outcome occurred in 55/532 patients, including 15/282 [5.3%] patients assigned to colchicine treatment, and 40/250 [16%] patients assigned to the control group [hazard ratio 0.33, 95% CI; 0.18-0.59; $p<0.001$, number needed to treat 11]. A sensitivity analysis was performed for the primary outcome, adjusting for the usage of calcium channel blockers and beta blocker therapy. These results were consistent with the primary analysis.

[00142] The time to first clinical event in each group by treatment is shown in Figure 2. The effect of colchicine on the primary outcome was evident early and the benefits of colchicine continued to accrue throughout the follow up period. Results of the primary analysis were consistent in all subgroups examined (Figure 3); There was no evidence of differential treatment effects based on any of the clinical or therapeutic variables.

[00143] The reduction in the primary outcome was largely driven by the reduction in the number of patients presenting with an ACS, [13/282 [4.6%] vs 34/250 [13.4%], hazard ratio 0.33; 95% CI; 0.18-0.63; p<0.001]. Out of hospital cardiac arrest and non-cardio-embolic ischemic stroke were infrequent but were also reduced in the treatment group (Table 3).

Table 3: Primary Outcome and its Components

	Control [n=250] n [%]	**Treatment [n=282]** n [%]	**HR 95% CI**	**p value**
Primary Outcome	40 [16]	15 [5.3]	0.33; 0.18-0.59	<0.001
Components of Primary Outcome				
Acute Coronary Syndrome	34 [13.6]	13 [4.6]	0.33; 0.18-0.63	<0.001
OOH Cardiac Arrest	2 [0.8]	1 [0.35][1]	0.47; 0.04-5.15	0.534
Non-Cardio-Embolic Stroke	4 [1.6]	1 [0.35]	0.23; 0.03-2.03	0.184
Components of ACS				
Stent Related	4 [1.6]	4 [1.4]	NS	
Non-Stent Related	30 [12]	9 [3.2]	0.26; 0.12-0.55	<0.001
Non-Stent Related AMI	14 [5.6]	4 [1.6]	0.25; 0.08-0.76	0.014
Non-Stent Related UA	16 [12]	5 [2.4]	0.27; 0.10-0.75	0.011

OOH Out of Hospital
ACS Acute Coronary Syndrome
AMI Acute Myocardial Infarction
UA Unstable Angina

[1] Non-Fatal

[00144] Of the 47 patients who presented with an ACS, the event was stent related in 8 [17%] [2 in each group had evidence of acute stent thrombosis and 2 in each group had evidence of significant in-stent stenosis]. Further analysis confirmed that patients randomized to treatment were less likely to present with an ACS unrelated to stent disease (9/282 [3.2%] vs 30/250 [12%] hazard ratio 0.26, 95% CI; 0.12-0.55; p<0.001), be it associated with an AMI (4/282 [1.4%] vs 14/250 [5.6%] hazard ratio 0.25, 95% CI; 0.08-0.76; p=0.014) or UA (5/282 [1.8%] vs 16/250 [6.4%] hazard ratio 0.27, 95% CI; 0.10-0.75; p=0.011). (Figure 4, Table 3)

[00145] Of 39 patients randomized to treatment who did not receive therapy beyond the first month due to early intolerance or non-compliance, 4 [10%] presented with an ACS due to acute stent thrombosis (n=1) and UA (n=3). Patients who were both compliant and tolerant to therapy beyond the first month of randomization had significantly fewer events than the control patients (11/243 [4.5%] vs 40/250 [16%] hazard ratio 0.29, 95% CI; 0.15-0.56; p<0.001). The results of all on-treatment analyses were consistent with those based upon the intention to treat analyses (Table 4).

Table 4: Primary Outcome and its Components [On-Treatment Analysis]

	Control [n=250]	**Treatment [n=243]**	**HR 95% CI**	**p value**
		n [%]	n [%]	
Primary Outcome	40 [16]	11 [5.3]	0.29 (0.15, 0.56)	<0.001
Components of Primary Outcome				
Acute Coronary Syndrome	34 [13.6]	9 [4.6]	0.28 (0.13, 0.58)	<0.001

OOH Cardiac Arrest	2 [0.8]	1 [0.35][1]	0.55 (0.05, 6.03) 0.622
Non-Cardio-Embolic Stroke	4 [1.6]	1 [0.35]	0.27 (0.03, 2.42) 0.242
Components of ACS			
Stent Related	4 [1.6]	3 [1.4]	NS
Non-Stent Related	30 [12]	6 [3.2]	0.21 (0.09, 0.50) <0.001
Non-Stent Related AMI	14 [5.6]	4 [1.6]	0.30 (0.10, 0.91) 0.033
Non-Stent Related UA	16 [12]	2 [2.4]	0.13 (0.03, 0.57) 0.007

OOH Out of Hospital
ACS Acute Coronary Syndrome
AMI Acute Myocardial Infarction
UA Unstable Angina

[1] Non-Fatal

[00146] Ten patients in the control group died compared with 4 patients in the colchicine group. Of the 10 controls, 5 died of presumed cardiac cause; 2 following an out-of-hospital cardiac arrest, 2 from cardiogenic shock following myocardial infarction, and 1 following bypass surgery. All 4 patients in the colchicine group died of non-cardiac causes.

[00147] The LoDoCo trial demonstrates that the addition of colchicine 0.5mg/day to standard therapy in patients with stable coronary disease significantly reduces the risk of a cardiovascular event, including an ACS, out of hospital cardiac arrest and non-cardio-embolic ischemic stroke. The benefits of colchicine were achieved on a background of widespread use of effective secondary prevention strategies, including high dose statins, as evidenced by the low event rate in the control group. The effect of adding colchicine became evident early, continued to accrue over time and was largely driven by a reduction in ACS unrelated to stent disease.

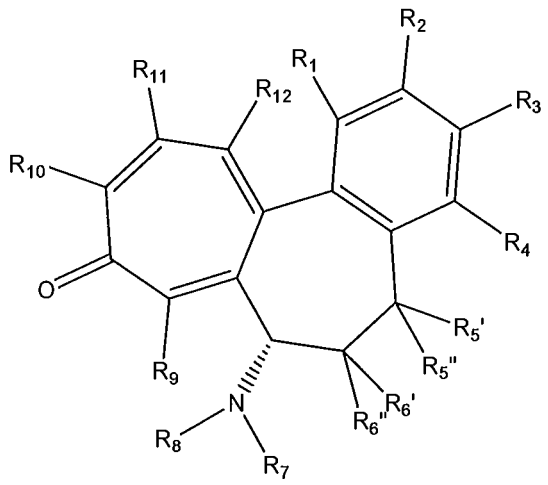
[00148] Numerous variations and modifications will suggest themselves to persons skilled in the relevant art, in addition to those already described, without departing from the basic inventive concepts. All such variations and modifications are to be considered within the scope of the present invention, the nature of which is to be determined from the foregoing description.

CLAIMS

1. A method for the treatment or prevention of a cardiovascular event in a subject with atherosclerotic vascular disease comprising the step of:

a) administering a therapeutically effective amount of a compound of formula (I), a known colchicine derivative and/or a salt thereof

Formula (I)



wherein:

R_1, R_2, R_3, R_4, R_9, R_{10}, R_{11} and R_{12} independently represent hydrogen, C_{1-4} alkyl, C_{2-4} alkenyl, C_{3-6} cycloalkyl, halogen, C_{1-4} haloalkyl, nitro, amino, C_{2-4} acylamino, C_{1-4} alkyl or dialkylamino, hydroxyl, C_{1-4} alkoxy, C_{1-4} alkylthio, a group of the formula $-SO_2N(R^x)_2$ or SO_2R^x where R^x is C_{1-4} alkyl, C_{1-4} acyloxy, or optionally substituted phenyl, optionally substituted phenoxy ;

R_7 and R_8 independently represent hydrogen, C_{1-4} alkyl or C_{1-4} acyl; and

R_5', R_5", R_6' and R_6" independently represent hydrogen, C_{1-4} alkyl, C_{2-4} alkenyl, C_{3-6} cycloalkyl, halogen, C_{1-4} haloalkyl, nitro, amino, C_{2-4} acylamino, hydroxyl, C_{1-4} alkoxy or C_{1-4} alkylthio a group of the formula $-SO_2N(R^x)_2$ or SO_2R^x where R^x is C_{1-4} alkyl, C_{1-4} acyloxy, or optionally substituted phenyl.

2. Use of a compound of formula (I), a known colchicine derivative and/or a salt thereof in the preparation of a medicament for the treatment or prevention of a cardiovascular event in a subject with atherosclerotic vascular disease.

3. A composition for the prevention or treatment of a cardiovascular event in a subject with atherosclerotic vascular disease, the composition comprising a therapeutically effective amount of a compound of formula (I), a known colchicine derivative and/or a salt thereof and one or more pharmaceutically acceptable additives, excipients carriers and/or diluents.

4. The composition of claim 3 comprising between 0.05 and 0.95 mg, between 0.1 and 0.9 mg, between 0.2 and 0.8 mg, or between 0.4 and 0.7 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof.

5. The composition of claim 4 comprising between 0.5 mg and 0.6 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof.

6. The composition of claim 4 comprising 0.5 mg or 0.6 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof.

7. The method of claim 1 wherein the compound of formula (I), a known colchicine derivative and/or a salt thereof is administered once or more per day.

8. A method for reducing or preventing cholesterol crystal induced inflammation within atherosclerotic plaques in a subject, comprising the step of

    administering a dosage of 0.5 mg or 0.6 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof.

9. The method of claim 8 wherein the subject has atherosclerotic vascular disease.

10. A regimen for the treatment or prevention of a cardiovascular event in a subject, the regimen comprising the step of:

    administering a dosage of 0.5 mg or 0.6 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof once per day.

11.A regimen for reducing or preventing cholesterol crystal induced inflammation within atherosclerotic plaques in a subject, the regimen comprising the step of:

administering a dosage of 0.5 mg or 0.6 mg of a compound of formula (I), a known colchicine derivative and/or a salt thereof once per day.

12.The regimen of claim 10 or 11 wherein the subject has atherosclerotic vascular disease.

13.The method of claim 1 or 9, use of claim 2, composition of claim 3 or regimen of claim 12 wherein the atherosclerotic vascular disease is a coronary disease.

14.The method of claim 1 or 8, use of claim 2, composition of claim 3 or regimen of claim 12 wherein the cardiovascular event is chosen from the list comprising: acute coronary syndrome (including ischemic chest pain, acute myocardial infarction, unstable angina); cardiac arrest; or stroke including non-cardio-embolic ischemic stroke.

15.The method of claim 1 or 8, use of claim 2, composition of claim 3 or regimen of claim 10 or 11 wherein the composition or medicament further comprises one or more additional agents selected from the list comprising: a statin and/or an anti-platelet agent.

16.The method, use, composition or regimen of claim 13 wherein the coronary disease is a clinically stable coronary disease.