Transdermal Method and Patch for Nausea

[1] This application claims the priority of US Application 11/380,268, filed April 26, 2006, US Application 60/682,251, filed May 18, 2005, US Application 60/702,744, filed July 27, 2005, and US Application 60/759,381, filed January 17, 2006.

[2] The present invention relates to a transdermal device and method for the treatment of nausea and vomiting, and more particularly to a transdermal method, composition, and device containing a 5-HT_3 receptor antagonist for the treatment of nausea and vomiting for a sustained period of time.

[3] Most patients undergoing anticancer treatment either by chemotherapy or radiation suffer from side effects of the treatment such as nausea and vomiting, a common complaint by patients. To prevent or minimize these side effects of anticancer treatments, antagonists of 5-hydroxytryptamine subtype 3 (hereinafter referred to as `serotonin`) such as ondansetron, granisetron, tropisetron, dolasetron, hydrodolasetron, azasetron, ramosetron, lerisetron, indisetron, itasetron, palonosetron, lamosetron, allosetron and mixtures thereof, known as serotonin receptor antagonists or 5-HT_3 receptor antagonists, have been widely administered, either parenterally or orally, on multiple days.

[4] Nausea and vomiting may also occur due to other reasons, such as for example, post-operatively, from motion sickness, or as a side effect of other drugs taken by a patient. Examples of drugs which may cause nausea and vomiting as side effects are certain antibacterial and antiviral agents, glucose-level-controlling bioactive agents, such as insulin and amylin or their natural and synthetic analogs, α-glucodase inhibitors, sulfonylurea, meglitinide, thiazolidinediones, biguanide, dual PPARα/γ agonists, PPARγ agonists, and insulin secretagogues.

[5] In any situation where a patient is suffering from nausea and vomiting, oral administration of an antiemetic agent is challenging and creates more discomfort for the patient. Intravenous (IV) or intramuscular (IM) administration is generally impractical for home use. Oral, IM, and IV dosages must be given to the patient in multiple doses over time to achieve continuous antiemetic benefits, although these administration routes provide fluctuating plasma levels of the antiemetic agent. Additionally, since nausea and vomiting are challenging to reverse, antiemetic agents are most effective if given prophylactically.

[6] To cope with these problems, there has been an attempt to formulate a composition of an antiemetic agent in the form of patches so that the antiemetic agent can be administered transdermally.

[7] Attempts to develop a transdermally administered antiemetic agent have raised other problems. For example, some penetration enhancers used in transdermal compositions, (e.g., terpenes), induce skin irritation. Alcohols, which are often needed to solubilize the antiemetic agent for transdermal applications, are also irritating to the skin. Also, because of rapid depletion of the alcohol, sustained delivery over a period greater than a few hours is difficult to achieve. When a transdermal composition consisting of a solution with a low viscosity is used, the blood level of the drug may easily drop below the effective level thus lessening the desired pharmacological effect.

[8] Other efforts to administer antiemetic agents transdermally have included complicated application devices or techniques such as supplemental energy to enhance the transdermal penetration of the drug. Current art describing transdermal antiemetic treatments often focuses on mimicking oral or IV agents to achieve therapeutic plasma levels. Typical delivery of such agents has been attempted with the salt form of the drug to maintain the stability of the active agent. However, salt forms of antiemetic agents have relatively low transdermal permeabilities, and it is difficult to achieve therapeutic plasma levels over a sustained period. Use of the free base form is typically not considered since it could be irritating or considered to be unstable in the dosage form.

[9] Thus, it is desirable to provide a transdermal composition of an antiemetic agent which is simple to use, nonirritating to the skin and which may be left in place on the skin for 24 hours, two days, three days or more for continuously and effectively preventing, ameliorating or treating nausea and vomiting. Moreover, with modest but functionally significant concentrations of active and permeation enhancer, it is nonetheless possible using the current teachings to formulate a patch that delivers antiemetic agent over a very substantial time period, and even maintain delivery as measured at the blood level well after removal of the composition.

[10] Extended delivery to the blood has been reported, but using transdermal delivery devices that lacked permeation enhancer. See, WO 2004/069141. With the present invention, remarkably sustained delivery is achieved with the presence of functionally significant concentrations of permeation enhancer. The lack of permeation enhancer is taught in the '141 application to limit instability and irritation. These same

benefits are achieved using the teachings of the current invention, but using modest but functionally significant concentrations of permeation enhancer.

Summary

[10a] In a first aspect, there is provided the use of a composition comprising:

i. an antiemetically effective amount of a 5-HT_3 receptor antagonist;

ii. a permeation enhancing amount of permeation enhancer comprising 0.5% to 15% by weight of the skin-contacting layer; and

iii. an adhesive,

in the manufacture of a medicament for the treatment of acute, delayed or anticipatory emesis for a sustained period in an individual, wherein said medicament is to be applied to a portion of intact skin or mucosa on the individual for 24 hours or more ; and wherein a plasma concentration of the 5-HT_3 receptor antagonist in a therapeutically effective range is provided for period of time from an onset time to 12 hours or more after the composition is removed.

[10b] In a second aspect, there is provided a composition for transdermal administration of an antiemetic comprising:

a skin-contacting composition comprising:

i. an antiemetically effective amount of a 5-HT_3 receptor antagonist;

ii. a permeation enhancing amount of permeation enhancer comprising 0.5% to 15% by weight of the skin-contacting layer; and

iii. an adhesive,

wherein, when applied to a portion of intact skin on an individual for 24 hours and then removed, the composition provides the individual with a plasma concentration of the 5-HT_3 receptor antagonist in a therapeutically effective range for period of time from an onset time to 12 hours or more after the composition is removed.

[10c] In a third aspect, there is provided a device tor transdermal prevention, amelioration or treatment of nausea and vomiting in an individual which comprises a patch comprising:

a. support layer; and

b. a skin-contacting layer comprising:

i. an antiemetically effective amount of a 5-HT_3 receptor antagonist;

ii. a permeation enhancing amount of permeation enhancer comprising 0.5% to 15% by weight of the skin-contacting layer; and

iii. an adhesive,

wherein, when applied to a portion of intact skin on an individual for 24 hours and then removed, the device provides the individual with a plasma concentration of the 5- HT_3 receptor antagonist in a therapeutically effective range for period of time from an onset time to 12 hours or more after the device is removed.

[10d] In a fourth aspect, there is provided a kit comprising the device as disclosed above, and a dosage form comprising an antiemetically effective amount of a corticosteroid.

[10e] In a fifth aspect, there is provided a kit comprising the device as disclosed above, and a dosage form comprising antiemetic agent(s) in forms adapted for oral administration or injection.

[11] Provided in one embodiment is a method of treating acute, delayed or anticipatory emesis for a sustained period in an individual, the method comprising: applying to a portion of intact skin or mucosa on the individual for 24 hours or more a composition comprising:

i. an antiemetically effective amount of a 5-HT3 receptor antagonist;

ii. a permeation enhancing amount of permeation enhancer comprising 0.5% to 15% by weight of the skin-contacting layer; and

iii. an adhesive,

wherein a plasma concentration of the 5-HT3 receptor antagonist in a therapeutically effective range is provided for period of time from an onset time to 12 hours or more after the composition is removed. In certain embodiments, 12 or more hours after removing the composition, one applies a second said composition, wherein a plasma concentration of the 5-HT3 receptor antagonist in a therapeutically effective range is provided for period of time from an onset time to 12 hours or more after the second said composition is removed.

[12] In certain embodiments, the 5-HT3 receptor antagonist is administered in conjunction with another antiemetic agent, or the same agent in a separate form of administration.

[13] Additionally provided is a composition for transdermal administration of an antiemetic comprising: a skin-contacting composition comprising:

i. an antiemetically effective amount of a 5-HT3 receptor antagonist;

ii. a permeation enhancing amount of permeation enhancer comprising 0.5% to 15% by weight of the skin-contacting layer; and

iii. an adhesive,

wherein, when applied to a portion of intact skin on an individual for 24 hours (or more) and then removed, the composition provides the individual with a plasma concentration of the 5-HT3 receptor antagonist in a therapeutically effective range for period of time from an onset time to 12 hours or more after the composition is removed.

[14] Further provided is a device for transdermal prevention, amelioration or treatment of nausea and vomiting in an individual which comprises a patch comprising: (a) a support layer; and (b) a skin-contacting layer comprising:

i. an antiemetically effective amount of a 5-HT3 receptor antagonist;

ii. a permeation enhancing amount of permeation enhancer comprising 0.5% to 15% by weight of the skin-contacting layer; and

iii. an adhesive,

wherein, when applied to a portion of intact skin on an individual for 24 hours (or more) and then removed, the device provides the individual with a plasma concentration of the 5-HT3 receptor antagonist in a therapeutically effective range for period of time from an onset time to 12 hours or more after the device is removed.

Brief Description of the Drawings

[15] Figure 1 is a graph of the *in vitro* flux of granisetron through human cadaver skin using an embodiment of a device of the present invention.

[16] Figure 2 is a graph of the *in vitro* cumulative delivery of granisetron through human cadaver skin using an embodiment of a device of the present invention.

[17] Figures 3 shows a pharmacokinetic profile obtained using a device of the invention.

Detailed Description of the Invention

[18] As used herein, the term "5-HT_3 receptor antagonist" refers to any of a class of drugs which act as 5-hydroxytryptamine receptor antagonists to provide an anti-nausea and anti-vomiting effect in individuals.

[19] As used herein, the term "antiemetic" refers to the prevention, amelioration or treatment of nausea and vomiting in individuals.

[20] As used herein, the term "antiemetic agent" refers to a drug or material that is used to prevent, ameliorate or treat nausea and vomiting in individuals .

[21] As used herein, the term "antiemetically effective amount" refers to the dose or blood level (depending on the context) of an antiemetic agent that provides relief from (including amelioration of) nausea and vomiting in an individual. In the case of blood levels, the level that, if appropriately sustained, provides relief from (including amelioration of) nausea and vomiting in an individual. The amount is an amount that

can be expected to be effective in segment(s) of a targeted patient/subject population, and can be such an amount divided by a reasonable number of delivery devices or vehicles.

[22] As used herein, the term "individual" refers to a living mammal and includes, without limitation, humans and other primates, livestock and sports animals such as cattle, pigs and horses, and pets such as cats and dogs.

[23] As used herein, the term "onset time" refers to the time after application of the transdermal device or composition to an individual until an antiemetically effective amount is obtained in the individual's blood.

[24] As used herein, the term "permeation enhancement" refers to an increase in the permeability of skin to a therapeutic agent in the presence of permeation enhancer(s) as compared to permeability of skin to the same therapeutic agent in the absence of a permeation enhancer(s).

[25] As used herein, the term "permeation enhancer" refers to an agent or a mixture of agents which acts to increase the permeability of the skin to therapeutic agents.

[26] As used herein, the term "permeation-enhancing amount" refers to an amount of a permeation enhancer which provides permeation enhancement throughout a substantial portion of the administration period.

[27] As used herein, the phrase "portion of intact skin" refers to a defined area of intact unbroken skin or mucosal tissue. That area will usually be in the range of about 5 cm^2 to about 100 cm^2.

[28] As used herein the term "salt" refers to, but is not limited to, pharmaceutically acceptable organic or inorganic salts. Typical inorganic salts include hydrogen halides such as hydrochlorides, carbonates, phosphates, sulfates, hydrogen sulfates, hydrobromides, nitrates, and sulfides. Organic salts include, but are not limited to, acid addition salts including salts of monocarboxylic and polycarboxylic acids such as acetic acid, malic acid, maleic acid, propionic acid, succinic acid, fumaric acid, citric acid, benzoic acid, cinnamic acid, tartaric acid, and the like.

[29] As used herein, the phrase "sustained time period" refers to about 24 hours or more and will typically intend a period in the range of about 48 or 72 hours to 168 hours.

[30] As used herein, the term "transdermal" refers to both percutaneous and transmucosal administration, i.e., passage of a drug, such as an antiemetic agent through a body surface or membrane such as intact unbroken skin or intact unbroken mucosal tissue into the systemic circulation.

[31] As used herein, the phrase "transdermal device wear time," or "patch wear time" refers to the interval of time during which a transdermal device is maintained in place on a portion of an individual's skin or mucosa.

[32] As used herein, the term "percutaneously absorbable" refers to the ability of a drug to pass through a body surface or membrane such as intact unbroken skin or mucosal tissue into the circulation system when formulated in a transdermal device of the invention.

[33] As used herein, the term "acute nausea and vomiting" relates to nausea and vomiting in an individual lasting up to 24 hours after the individual receives chemotherapy, radiation, or drug treatment. It may also relate to post-operative nausea and vomiting and to nausea and vomiting resulting from motion sickness.

[34] As used herein, the term "delayed nausea and vomiting" relates to nausea and vomiting in an individual occurring up to five (5) days after the individual receives chemotherapy, radiation, postoperatively or post drug treatment.

[35] As used herein, the term "anticipatory nausea and vomiting" relates to a conditioned response in an individual after the individual receives chemotherapy, radiation, or drug treatment if the individual expects to experience nausea and vomiting as a result of the treatment or if the individual experienced nausea and vomiting as a result of previous treatments. Anticipatory nausea and vomiting may also be experienced post-operatively or as a result of motion sickness.

[36] As used herein, the term "skin-contacting layer" is a layer of a transdermal device for contacting skin or mucosa.

[37] As used herein, "flux rate" means the rate as modeled from applications of the device to human cadaver skin.

[38] The present invention relates to methods of preventing, ameliorating or treating nausea and vomiting for a sustained time period by the transdermal administration of antiemetic agents. The antiemetic agents used in the present invention are, in the transdermal device, the free base form of 5-HT_3 receptor antagonists, examples of which include ondansetron, granisetron, tropisetron, dolasetron, hydrodolasetron, azasetron, ramosetron, lerisetron, indisetron, itasetron, palonosetron, lamosetron, allosetron and mixtures thereof. It will be recognized that after administration the antagonists will form similar salts or metabolites as are formed given other means of administration or the

administration of salt forms. The present invention also relates to devices and compositions for use with the method of the invention.

[39] The method of the present invention is effective in the prevention, amelioration or treatment of nausea and vomiting due to chemotherapy, radiation therapy, other drug therapy, motion sickness, or post-operative reaction. Because this method involves the transdermal administration of an antiemetic agent over the course of days, it is effective in preventing, ameliorating or treating nausea and vomiting for an extended time. Additional benefits of the present invention include improved patient compliance, since the method involves the placement of a transdermal device, which in some embodiments is left in place for 2, 3, 4, 5, 6, 7 days or more; patient protection from nausea and vomiting from the time the device is applied until it is removed, or for extended periods, such as 6, 9, 12, 18 or 24 hours or more, after it is removed; increased patient confidence to leave the hospital or doctor's office after chemotherapy, knowing that the device will prevent or reduce nausea and vomiting. Additionally, the device can maintain blood levels of the antiemetic agent in a therapeutically effective range until it is removed. In some embodiments, after wearing the device for 24 hours or more (or 36 hours or more, or 48 hours or more, or 72 hours or more), blood levels are maintained in therapeutically effective range for an extended period after removal, such as 6, 9, 12, 18 or 24 hours or more. Since the device delivers the antiemetic agent at a controlled rate, there is no initial spike in plasma concentration as when the agent is administered, for example, by IV; therefore, the method reduces side effects, such as headache and constipation, sometimes experienced with other forms of administration.

[40] In certain embodiments, therapeutically effective blood levels of 5-HT_3 receptor antagonist are obtained within 24 hours of application, 18 hours of application, 12 hours of application, or within 9 hours, or within 8 hours, or within 7 hours, or within 6 hours. Such onset periods will vary with the 5-HT_3 receptor antagonist and the particular skin-contacting layer formulation.

[41] In certain embodiments, the patch provides a flux rate of 1 $\mu g/cm^2/hr$ or more (such as between 1 and 25 $\mu g/cm^2/hr$) of the 5-HT_3 receptor antagonist for, after an onset period, 24 hours or more, 48 hours or more, or 72 hours or more, or 96 hours or more, or 120 hours or more, or 144 hours or more, or 168 hours or more. In certain embodiments, the patch provides a flux rate of 2 $\mu g/cm^2/hr$ or more (such as between 2 and 10 $\mu g/cm^2/hr$) of the 5-HT_3 receptor antagonist for, after an onset period, 24 hours or more,

48 hours or more, or 72 hours or more, or 96 hours or more, or 120 hours or more, or 144 hours or more, or 168 hours or more.

[42] In certain embodiments, the patch delivers between 10 μg/day (microgram/day) or more (such as 10 to 10,000 μg/day) of the 5-HT3 receptor antagonist to the individual for, from an onset time to 24 hours or more, 48 hours or more, or 72 hours or more, or 96 hours or more, or 120 hours or more, or 144 hours or more, or 168 hours or more. In certain embodiments, the patch delivers between 20 μg/day (microgram/day) or more, or 50 μg/day or more, 100 μg/day or more, 200 μg/day or more, 500 μg/day or more, 1,000 μg/day or more, 2,000 μg/day or more, 4,000 μg/day or more, 6,000 μg/day or more, of the 5-HT3 receptor antagonist to the individual for, from an onset time to 24 hours or more, 48 hours or more, or 72 hours or more, or 96 hours or more, or 120 hours or more, or 144 hours or more, or 168 hours or more. It will be recognized that the amount sought to be delivered will vary with the 5-HT3 receptor antagonist. For example, with ondansentron amounts may need to be higher than for granisetron.

[43] The permeation enhancer used in the device of the present invention can act to increase the permeability of the skin to the 5-HT_3 receptor antagonist in the skin-contacting layer. In general, the higher the amount of permeation enhancer, the greater the increase in the skin's permeability; however, at higher amounts of permeation enhancer, cold flow of the adhesive can also occur, making it necessary to remove the transdermal patch prematurely. "Cold flow" is the phenomenon of lateral flow of the reservoir material from under its backing layer or the like. Also at higher amounts of permeation enhancer, the 5-HT_3 receptor antagonist may crystallize out of the matrix, thus limiting its permeability. Therefore, it is desirable to use an amount of permeation enhancer which will reliably enhance the drug's permeability while still limiting or preventing adhesive cold flow and drug crystallization. In one embodiment of the device of the present invention, the permeation enhancer in an amount of 15% or less (or about 14% or less, or about 13% or less, or about 12% or less, or about 11% or less, or about 10% or less, or about 9% or less) of the weight of the skin-contacting layer (or composition) to enhance the permeability of the drug without causing significant adhesive cold flow or drug crystallization. The permeation enhancer is present in a permeation-enhancing amount. The permeation enhancer can be present, for example, in an amount of about 0.5% or more (or about 1% or more, or about 2% or more, or about

3% or more, or about 4% or more, or about 5% or more, or about 7% or more) of the weight of the skin-contacting layer (or composition)

[44] The amount of 5-HT_3 receptor antagonist can be varied, for example, from about one of the lower limits described below (with the limit exclusive or inclusive of the endpoint), or from to one of the upper limits (exclusive or inclusive). The lower limits are, based on the weight of the skin contacting layer or the composition, 0.1%, 0.2%, 0.5%, 1%, 2%, 3%, or 4%. The upper limits are, based on the weight of the skin contacting layer or the composition, 15%, 14%, 13%, 12%, 11%, 10%, 9%, 8% 7% or 6%. Again, these amounts may additionally vary with the particular 5-HT3 receptor antagonist.

[45] One embodiment of the device of the present invention is a transdermal patch for application to the skin or mucosa of an individual. The patch has a skin or mucosa-contacting layer ("skin-contacting layer" for simplicity) laminated or otherwise attached to a support layer. Typically, the skin-contacting layer is covered by a removable release liner before use to protect the skin-contacting surface and keep it clean until it is applied to the skin or mucosa.

[46] The support layer acts as a support for the skin-contacting layer and provides a barrier layer that prevents loss of the drug in the skin-contacting layer to the environment. The material chosen for such support should be compatible with the adhesive, drug, and permeation enhancer, and should be minimally permeable to any components of the patch. The support can be opaque to protect components of the matrix patch from degradation from exposure to ultraviolet light. Further, the support should be capable of binding to and supporting the adhesive layer, yet should be pliable to accommodate the movements of a person using the patch. Suitable materials for the carrier include metal foils, metalized polyfoils, composite foils or films containing polyester such as polyester terephthalate, polyester or aluminized polyester, polytetrafluoroethylene, polyether block amide copolymers, polyethylene methyl methacrylate block copolymers, polyurethanes, polyvinylidene chloride, nylon, silicone elastomers, rubber-based polyisobutylene, styrene, styrene-butadiene and styrene-isoprene copolymers, polyethylene, and polypropylene. A thickness of about 0.0005 to 0.01 inch can, for example, be used. The release liner can be made of the same materials as the carrier, or other suitable films coated with an appropriate release surface.

[47] If present, the permeation enhancer is typically a fatty acid ester of fatty acyl chain length C_{12}-C_{18}. The alcohol component of the ester is typically C1-C6, or C2-C4, such as for example isopropanol.

[48] The patch can further comprise various additives in addition to the adhesive, antiemetic, and permeation enhancer. These additives are generally those pharmaceutically acceptable ingredients that are known in the art of drug delivery and, more particularly, in the art of transdermal drug delivery. Nonlimiting examples of additive ingredients include diluents, excipients, emollients, plasticizers, skin irritation reducing agents (which can also include agents that reduce irritation to mucosa), carriers, and mixtures of these. For example, suitable diluents can include mineral oil, low molecular weight polymers, plasticizers, and the like. Many transdermal drug delivery formulations have a tendency to cause irritation after prolonged exposure to the skin or mucosa, thus addition of an irritation reducing agent aids in achieving a composition that is better tolerated by the skin or mucosa.

[49] For delivery of the antiemetic agent according to an embodiment of the present invention, a patch device containing an adhesive, a 5-HT3 receptor antagonist, and a permeation enhancer is brought in contact with the skin or mucosa at a selected portion of intact skin or mucosa and is held in place by the adhesive.

[50] In certain embodiments, the transdermal composition (prior to application to a patient) is essentially free of water. In certain embodiments, the transdermal composition is essentially free of tetraglycol (also known as glycofurol or tetrahydrofurfurylpolyethilenglycole). In certain embodiments, the transdermal composition is essentially free of a hydrophilic organic solvent, including essentially free of ethanol, isopropanol, butanol, benzyl alcohol, propylene glycol, glycerin, polyethylene glycol having a molecular weight of 600 or less, diethylene glycol monoethyl ether, triacetin, N-methylpyrrolidone, 2-pyrrolidone, dimethyl sulfoxide, decylmethyl sulfoxide, dioxane, lactone or mixtures thereof. For the purposes of the preceding proviso, "hydrophilic organic solvent" does not include fatty acid esters of fatty acyl chain length C12-C18. It will be understood that nominal amounts of such components, when the transdermal composition is essentially free thereof, may be present in amounts consistent with process parameters, but are not present in amounts having a material effect on function, handling, storage, or some factor material to the effective use or marketing of a transdermal device.

[51] In another embodiment the present invention provides a method for the prevention, amelioration or treatment of nausea and vomiting due to chemotherapy, radiation therapy, other drug therapy, motion sickness, or post-operative reaction by the transdermal administration of a 5-HT_3 receptor antagonist combined with the administration (e.g., oral, injection (such as IV, IP, IM, SC), transdermal, buccal, rectal) of another antiemetic agent (e.g., a corticosteroid), or the same 5-HT_3 receptor antagonist administered by separate administration route. A second administration form can be administered by a separate dosing schedule, as appropriate for the given dosage form.

[52] Concurrent administration of 5-HT_3 receptor antagonists and corticosteroids for the treatment of nausea and vomiting is known. For example, US 5,929,059 (Sanger et al.) discloses a method of treatment and/or prophylaxis of nausea and vomiting, which comprises administering to a human or animal subject, granisetron and steroid such as dexamethasone or a pharmaceutically acceptable salt or ester thereof. Sanger et al. further disclose that these two ingredients may be administered orally, rectally, parenterally, or buccally, with oral administration being preferred.

[53] However, as earlier described herein, oral administration of anti-emetic compounds can be challenging and may lead to greater discomfort for the patient. Additionally, oral, IV, IM, rectal, and buccal administration of active ingredients produce fluctuation in plasma levels of the active ingredients. Therefore, it would be advantageous to transdermally administer a 5-HT_3 receptor antagonist, thus preventing, ameliorating, or treating nausea and vomiting, and then to administer an antiemetically effective amount of an antiemetic corticosteroid, which can enhance the antiemetic properties of the 5-HT_3 receptor antagonist. The antiemetic corticosteroid administration can be started at the same time as the beginning of the transdermal administration of the 5-HT_3 receptor antagonist or after the 5-HT_3 receptor antagonist has been transdermally administered for one hour or more, 12 hours or more, or 24 hours or more. Administrations can be maintained for 12 hours or more, or 24 hours or more, 48 hours or more, 72 hours or more, 96 hours or more, 120 hours or more, 144 hours or more, or 168 hours or more. The corticosteroid administration may occur as a single dosage or additional dosages may be administered at selected intervals. Useful routes of administration include, for example, oral or parenteral routes.

[54] Antiemetic corticosteroids suitable for use in this embodiment of the invention can include, for example, dexamethasone, methylprednisolone, prednisolone, their

physiologically acceptable salts or esters, or combinations thereof. Dexamethasone may be administered as dexamethasone alcohol or in the form of a pharmaceutically acceptable salt or ester. Suitable salts and esters include the acetate, isonicotinate, phenylpropionate, pivalate, t-butyl acetate, trioxaundecanoate, disodium metasulphabenzoate and disodium phosphate.

[55] A dose of steroid such as dexamethasone for use according to the method of this embodiment of the invention can, for example, be in the range of 0.5 to 20 mg per dosage unit. The unit doses may be administered from 1 to 4 times per day. However, the exact dose will depend on the route of administration and the condition being treated, and it will be appreciated that it may be necessary to make routine variations to the dosage depending on the age and weight of the patient, as well as the nature and severity of the condition being treated.

[56] Compositions for oral administration of dexamethasone, such as tablets and capsules, may be prepared by conventional means with pharmaceutically acceptable excipients such as binding agents (e.g. pregelatinized maize starch, polyvinylpyrrolidone or hydroxypropyl methylcellulose); fillers (e.g. lactose, microcrystalline cellulose or calcium hydrogen phosphate); lubricant (e.g. magnesium stearate, talc or silica); disintegrants (e.g. potato starch or sodium starch glycollate); or wetting agent (e.g. sodium lauryl sulphate). Tablets may be coated by methods well known in the art. Liquid preparations for oral administration may take the form of, for example, solutions, syrups or suspensions, or they may be presented as a dry product for constitution with water or other suitable vehicle before use. Such liquid preparations may be prepared by conventional means with pharmaceutically acceptable additives such as suspending agents (e.g. sorbitol syrup, cellulose derivatives or hydrogenated edible fats); emulsifying agents (e.g. lecithin or acacia); non-aqueous vehicles (e.g. almond oil, oily esters, ethyl alcohol or fractionated vegetable oils); and preservatives (e.g. methyl or propyl-p-hydroxybenzoates or sorbic acid). The preparations may also contain buffer salts, flavoring, coloring and sweetening agents as appropriate.

[57] Preparations for oral administration of the corticosteroid may be suitably formulated to give controlled release of the active ingredient.

[58] For parenteral administration the compositions may be presented in a form suitable for bolus injection or continuous infusion. Formulations for injection may be presented in unit dosage form e.g. in syringes, ampoules or in multi-dose containers,

with an added preservative. The compositions may take such forms as suspensions, solutions or emulsions in oily or aqueous vehicles, and may contain formulatory agents such as suspending, stabilizing and/or dispersing agents. Alternatively, the active ingredients may be in powder form for constitution with a suitable vehicle, e.g. sterile pyrogen-free water, before use.

[59] In certain embodiments of this invention a transdermal patch with a skin-contacting layer comprising:

i. an antiemetically effective amount of a free base of a 5-HT_3 receptor antagonist;

ii. a permeation-enhancing amount of a permeation enhancer selected from the group consisting of isopropyl myristate, isopropyl palmitate or fatty acid esters of fatty acyl chain length C12-C18; and

iii. an adhesive selected from the group consisting of acrylics (including alkyl acrylics), vinyl acetates, natural and synthetic rubbers, ethylenevinylacetate copolymers, polysiloxanes, polyacrylates, polyurethanes, plasticized polyether block amide copolymers, plasticized styrene-butadiene rubber block copolymers, and mixtures thereof;

is applied to the skin or mucosa of an individual in need of anti-emetic treatment or prevention. Subsequently, an antiemetically effective amount of a systemic corticosteroid is orally administered to the individual to enhance the antiemetic effectiveness of the 5-HT3 receptor antagonist.

[60] In a further embodiment, the transdermal device is provided together with a systemic corticosteroid, such as dexamethasone, in the form of a kit.

[61] In another embodiment the present invention provides a method for the prevention, amelioration or (including amelioration of succeeding symptoms following prophylactic administration) or treatment of nausea and vomiting due to chemotherapy, radiation therapy, other drug therapy, motion sickness, or post-operative reaction by the transdermal administration of a 5-HT_3 receptor antagonist combined with the oral or administration by injection of antiemetic agent(s). The antiemetic agent can be selected from the group consisting of 5-HT_3 receptor antagonists, cannabinoids, NK1 receptor antagonists, dopamine antagonists, corticosteroids, or any other known antiemetic agent. In certain embodiments, the antiemetic agent is administered to the individual at the same time that the transdermal device is applied to the individual's skin. In other

embodiments, other antiemetic agent(s) are administered with a timing selected to provide an initial delivery to plasma during the lag phase of the transdermal administration.

[62] In one embodiment the transdermal device is provided with an antiemetic agent in the form of a kit. In a further embodiment, the kit comprises labeling describing administering the antiemetic agent to the individual at about the same time that the transdermal device is applied to the individual's skin. Examples of the second component include a dosage form comprising the same or a separate antiemetic agent as in the first transdermal device. The second dosage form can be, for example, for administration orally, by injection (such as IV, IP, IM, SC), transdermally, buccally, rectally, or the like.

[63] In another embodiment, the transdermal device is applied to the individual's skin up to, for example, 24 hours before the individual is to be subjected to an event that creates a risk of emesis. Such events include administration of a pharmaceutical compound that creates a risk of emesis, such as, for example, chemotherapeutic agents for anticancer therapy, and surgical or other medical procedures that create a risk of emesis. In a further embodiment, the transdermal device is applied to the individual's skin 0.5 or more hours (1 or more hours , or 2 or more hours, or 4 or more hours, or 8 or more hours, or 10 or more hours, or 12 or more hours) before the individual is to be subjected to an event that creates a risk of emesis.

[64] In other transdermal devices adapted to give long-term delivery of granisetron, such long term delivery is achieved by avoiding permeation enhancers. The current invention provides a device that includes such enhancer, but nonetheless provides long term delivery, while at the same time avoiding irritation and instability that can be associated with enhancers. Moreover, in certain embodiments the current device provides, on a device area-normalized basis, greater transdermal delivery to the plasma as measured by peak plasma levels or AUC (area under the curve) than a device that corresponds in all but the absence of permeation enhancer. In certain embodiments, such delivery is 1.5 times or more, or 1.7 times or more, or 2 times or more, as measured at 24, 48, 72, 96 or 120 hours after application of the device.

EXAMPLE 1: Preparation of Adhesive Mixture and Transdermal Delivery Device

Table 1

Composition	Formulation A	Formulation B
Patch Size	**15.0 cm^2**	**15.0 cm^2**
Estimated Target Daily Dose	**1.2 mg**	**1.2 mg**
	Dry %	**Dry %**
Styrene-butadiene rubber pressure sensitive adhesive	44.04	--
Acrylate-vinylacetate pressure sensitive adhesive	--	43.8
Isopropyl Myristate	3.01	4.07
Granisetron Base	3.05	3.05
Polyester Release liner	35.8	35.8
Polyester Backing	13.3	13.3

Components

[65] Formulation A and Formulation B were prepared using the amounts of each component as shown in Table 1 above.

[66] The styrene-butadiene rubber pressure sensitive adhesive used in the examples herein was DURO-TAK® 87-6173 adhesive, available from National Starch and Chemical in Bridgewater, NJ. The acrylate-vinylacetate pressure sensitive adhesive used in the examples herein was DURO-TAK® 87-2516 adhesive, available from National Starch and Chemical in Bridgewater, NJ. The isopropyl myristate used in the examples herein was of NF grade. The polyester release liner used in the examples herein is available from Loparex, Inc., and the polyester backing used in the examples herein is available from 3M as 2610F.

Procedure

[67] The granisetron base is dissolved in an appropriate solvent such as toluene and mixed with the selected adhesive. The isopropyl myristate is then added to the mixture and the contents are mixed until a homogeneous solution is achieved.

[68] The homogeneous solution is coated onto the siliconized surface of the polyester release liner to the desired thickness. The coated release liner is then passed through a drying oven until the solvents are evaporated. The dry adhesive-coated release

liner is removed from the oven and is then laminated with the polyester backing layer. The multi-layer laminate is cut by punching out units of the desired size and geometry for delivery of the desired target daily dose, or it may be wound into rolls for storage or transport to another location. The rolled laminate may then be unwound and cut by punching out units of the desired size and geometry. These punched units are then placed in individual pouches and sealed for later use as patches.

Irritation Data

[69] Formulation A was tested in a rabbit irritation test, a guinea pig sensitization test, a dog toxicokinetic and a human irritation test, and found non-irritating and non-toxic.

EXAMPLE 2: Test for Flux of Granisetron from the Transdermal Delivery Device

Procedure

[70] Heat-separated human cadaver skin was cut to the desired size and mounted on a Franz diffusion cell. The release liner was peeled away from a patch made according to Formulation B as described in EXAMPLE 1 above. The patch was placed on the skin and the patch and skin were clamped together. Receptor solution was added to the diffusion cell, and the assembly was maintained at 32°C. Aliquots of the receptor solution were taken at periodic time points (24 hours, 48 hours, 72 hours, 96 hours, and 120 hours). The concentration of the granisetron in the receptor solution was measured at each time point, and the flux rate from examples A and B was calculated. The resulting data is illustrated in Figure 1. Cumulative delivery of granisetron over the indicated time was likewise calculated from the concentration of granisetron in the receptor solution at each time point and is illustrated in Figure 2.

EXAMPLE 3: Stability of granisetron in illustrative examples

Table 2

Composition	Formulation C	Formulation D
	Dry %	Dry %
Styrene-butadiene rubber pressure sensitive adhesive	49.88%	-
Acrylate-vinylacetate pressure sensitive adhesive		43.77%
Isopropyl Myristate	-	5.09%
Granisetron Base*	1.02%	2.04%
Polyester Release liner	35.8%	35.8%
Polyester Backing	13.3%	13.3%

[71] Patches were made according to the procedure described in Example 1 above using the formulations shown in Table 2. The patches were then tested for granisetron stability using the method described below.

[72] Samples of the patches are stored at 50°C for up to 2 months. Stability of the product is assessed by testing periodically for granisetron content and the total amount of impurities using high performance liquid chromatography. The results are shown below in Table 3.

Table 3

Time	Granisetron Potency (%w/w)		Total impurities (% of granisetron)	
	Formulation C	Formulation D	Formulation C	Formulation D
T_o	99.9	99.5	0.05	0.25
1 month at 50°C	99.8	99.2	0.12	0.41
2 month at 50°C	99.6	98.4	0.19	0.81

[73] The data in Table 3 show that the granisetron remains stable for at least 2 months at 50°C in the composition of the example of the invention with little loss of granisetron potency and low amounts of impurities relative to the formulations at starting time T_o.

EXAMPLE 4: Samples for *in vivo* test

[74] Patches were made according to the method described above using the ingredients and respective amounts shown in Table 4.

Ingredient/Component	**Weight (mg/cm^2)**	**% Composition**	**Wt in finished product ($mg/25\ cm^2$ patch)**
Granisetron base	0.75	2.54	18.75
Isopropyl myristate	1.20	4.06	30.00
Acrylic adhesive	13.05	44.13	326.25
Total	15.00	50.73	375.00
Polyester backing	3.91	13.22	97.75
Release liner	10.66	36.05	266.50
Total weight	**29.57**	**100.00**	**739.25**

[75] The acrylic adhesive used in Example 4 was DURO-TAK® 87-2516, available from National Starch and Chemical in Bridgewater, NJ.

[76] A randomized crossover clinical study was conducted in 11 individuals who received either a transdermal patch or an IV solution of granisetron. Each 25 cm^2 patch was formulated to deliver 2 mg/day of granisetron. The 25 cm^2 patches of Example 4 were applied to the skin of individuals and left in place for 96 hours, at which time they were removed. This was followed by a 10 day wash-out period, after which the same individuals received granisetron IV in once-daily dosages of 2 mg/day Individuals who received the IV treatment in the first period received a transdermal patch in the cross over treatment. Blood plasma levels of granisetron for all of the individuals in the test were measured periodically during the 96 hour time that the patches were being worn and the IV dosages were being administered, and for an additional 2 days after the patches were removed and the IV administration discontinued.

[77] The results (Fig. 3A) indicated that the individuals receiving IV granisetron experienced sharp spikes in blood plasma levels of the granisetron after each daily dose

was administered and the blood plasma levels decreased very quickly. On the other hand, the blood plasma levels of granisetron in the individuals wearing the patches increased steadily and reached a plateau that was maintained until the patches were removed after 96 hours, at which time the blood plasma levels decreased slowly and steadily, while still remaining in the therapeutically effective range for more than 24 hours after the patches were removed. With granisetron, typical plasma levels were observed to be in the range of 0.1-25 ng/ml over the whole wear time and for two additional days following patch removal. Thus, the patch of this example provided a blood plasma level in a therapeutically effective range both for the entire patch wear time and for more than 24 hours after it was removed.

[78] Publications and references, including but not limited to patents and patent applications, cited in this specification are herein incorporated by reference in their entirety in the entire portion cited as if each individual publication or reference were specifically and individually indicated to be incorporated by reference herein as being fully set forth. Any patent application to which this application claims priority is also incorporated by reference herein in the manner described above for publications and references.

[79] While this invention has been described with an emphasis upon certain embodiments, it will be obvious to those of ordinary skill in the art that variations in the preferred devices and methods may be used and that it is intended that the invention may be practiced otherwise than as specifically described herein. Accordingly, this invention includes all modifications encompassed within the spirit and scope of the invention as defined by the claims that follow.

What is claimed:

1. The use of a composition comprising:

i. an antiemetically effective amount of a 5-HT_3 receptor antagonist;

ii. a permeation enhancing amount of permeation enhancer comprising 0.5% to 15% by weight of the skin-contacting layer; and

iii. an adhesive,

in the manufacture of a medicament for the treatment of acute, delayed or anticipatory emesis for a sustained period in an individual, wherein said medicament is to be applied to a portion of intact skin or mucosa on the individual for 24 hours or more ; and wherein a plasma concentration of the 5-HT_3 receptor antagonist in a therapeutically effective range is provided for period of time from an onset time to 12 hours or more after the composition is removed.

2. The use of claim 1, wherein, 12 or more hours after removing the composition, a second said composition is to be applied to a portion of intact skin or mucosa on the individual, wherein a plasma concentration of the 5-HT_3 receptor antagonist in a therapeutically effective range is provided for period of time from an onset time to 12 hours or more after the second said composition is removed.

3. The use of claim 1, wherein an antiemetically effective amount of a corticosteroid is further to be administered to the individual.

4. The use of claim 3, wherein the corticosteroid is to be administered transdermally.

5. The use of claim 3, wherein the corticosteroid is to be administered orally or by injection.

6. The use of claim 1, wherein an antiemetically effective amount of an antiemetic agent in a second dosage form is further to be administered to the individual.

7. The use of claim 1, wherein the serotonin 5-HT_3 receptor antagonist is selected from the group consisting of ondansetron, granisetron, tropisetron, dolasetron,

hydrodolasetron, azasetron, ramosetron, lerisetron, indisetron, itasetron, palonosetron, lamosetron, allosetron, and mixtures thereof.

8. The use of claim 1, wherein the 5-HT_3 receptor antagonist is granisetron.

9. The use of claim 8, wherein an antiemetically effective amount of a corticosteroid is further to be administered.

10. The use of claim 1, wherein the permeation enhancer consists essentially of 15% or less by weight of the skin-contacting layer of a fatty acid ester of fatty acyl chain length C_{12}-C_{18}, or mixtures thereof.

11. The use of claim 1, wherein the permeation enhancer consists essentially of 15% or less by weight of the skin-contacting layer of isopropyl myristate.

12. The use of claim 1, wherein in coordination with said application, a pharmaceutical or procedure that creates a risk of emesis is further to be administered to the individual.

13. The use of claim 12, wherein said application occurs prior to said enesis risk-creating administration.

14. A composition for transdermal administration of an antiemetic comprising:
a skin-contacting composition comprising:

i. an antiemetically effective amount of a 5-HT_3 receptor antagonist;
ii. a permeation enhancing amount of permeation enhancer comprising 0.5% to 15% by weight of the skin-contacting layer; and
iii. an adhesive,

wherein, when applied to a portion of intact skin on an individual for 24 hours and then removed, the composition provides the individual with a plasma concentration of the 5-HT_3 receptor antagonist in a therapeutically effective range for period of time from an onset time to 12 hours or more after the composition is removed.

15. A device tor transdermal prevention, amelioration or treatment of nausea and vomiting in an individual which comprises a patch comprising:

a. support layer; and

b. a skin-contacting layer comprising:

i. an antiemetically effective amount of a 5-HT_3 receptor antagonist;

ii. a permeation enhancing amount of permeation enhancer comprising 0.5% to 15% by weight of the skin-contacting layer; and

iii. an adhesive,

wherein, when applied to a portion of intact skin on an individual for 24 hours and then removed, the device provides the individual with a plasma concentration of the 5- HT_3 receptor antagonist in a therapeutically effective range for period of time from an onset time to 12 hours or more after the device is removed.

16. The device of claim 15, wherein, when applied to a portion of intact skin on an individual for 48 hours and then removed, the device provides the individual with a plasma concentration of the 5-HT_3 receptor antagonist in a therapeutically effective range for period of time from an onset time to 12 hours or more after the device is removed.

17. The device of claim 15, wherein, when applied to a portion of intact skin on an individual for 72 hours and then removed, the device provides the individual with a plasma concentration of the 5-HT_3 receptor antagonist in a therapeutically effective range for period of time from an onset time to 12 hours or more after the device is removed.

18. The device of claim 15, wherein, when applied to a portion of intact skin on an individual for 96 hours and then removed, the device provides the individual with a plasma concentration of the 5-HT_3 receptor antagonist in a therapeutically effective range for period of time from an onset time to 12 hours or more after the device is removed.

19. The device of claim 15, wherein the 5-HT_3 receptor antagonist is in free base form.

20. A kit comprising the device of claim 15, and a dosage form comprising an antiemetically effective amount of a corticosteroid.

21. The kit of claim 20, wherein the dosage form is for oral administration or injection of the corticosteroid.

22. The kit of claim 20, wherein the dosage form is for transdermal administration of the corticosteroid.

23. A kit comprising the device of claim 15, and a dosage form comprising antiemetic agent(s) in forms adapted for oral administration or injection.

24. The kit of claim 23, wherein the agent of the dosage form is a 5-HT_3 receptor antagonist, cannabinoid, NK1 receptor antagonist, dopamine antagonist, corticosteroid, or mixture thereof.

25. The device of claim 15, wherein the 5-HT_3 receptor antagonist is selected from the group consisting of ondansetron, granisetron, tropisetron, dolasetron, hydrodolasetron, azasetron, ramosetron, lerisetron, indisetron, itasetron, palonosetron, lamosetron, allosetron, and mixtures thereof.

26. The device of claim 15, wherein the 5-HT_3 receptor antagonist is granisetron.

27. The device of claim 26, wherein the antiemetically effective amount of granisetron comprises between 0.1% and 15% by weight of the skin-contacting layer.

28. The device of claim 15, wherein the permeation enhancer consists essentially of 15% or less by weight of the skin-contacting layer of a fatty acid ester of fatty acyl chain length C_{12}-C_{18}, or mixtures thereof.

29. The device of claim 15, wherein the permeation enhancer consists essentially of 15% or less by weight of the skin-contacting layer of isopropyl myristate.

30. The device of claim 15, further comprising packaging presenting labeling describing applying the device to an individual in conjunction with one or both of (a) administration to the individual of a pharmaceutical that creates a risk of emesis or (b) implementing on the individual an operative or other medical procedure that creates a risk of emesis.

31. The device of claim 30, wherein the labeling describes applying the device 30 minutes or more prior to the administration or implementing.

32. The device of claim 15, wherein the device, when applied to a portion of human cadaver skin for 168 hours or more, provides a flux rate of between 1 and 25 $\mu g/cm^2/hr$, the flux rate remaining between 1 and 25 $\mu g/cm^2/hr$ for 168 hours or more.

33. The device of claim 15, wherein the device, when applied to a portion of intact skin on an individual for 168 hours, delivers between 10 and 10,000 µg/day of the 5-HT3 receptor antagonist to the individual for each day after an onset period.

34. The device of claim 15, wherein the device, when applied to a portion of intact skin on an individual for a period from 24 hours to 144 hours and then removed, delivers between 10 and 10,000 µg/day of the 5-HT3 receptor antagonist to the individual for each day after an onset period through 12 hours after removal.