CLAIMS

What is claimed is:

1. A wearable automatic injection device for injecting a therapeutic agent into a patient, the wearable automatic injection device comprising:

a housing having a patient contact portion securable to a patient;

a vessel in the housing for holding a therapeutic agent;

a bung disposed in the vessel;

a syringe needle fluidically couplable to the vessel;

an injection assembly moveably disposed in the housing having an injection needle for insertion into the patient and fluidically couplable with the syringe needle;

a fluid-based plunger actuation mechanism having a pressure element providing a hydraulic pressure to an incompressible working fluid held therein, and one or more fluid circuits to transport the incompressible working fluid from the pressure element into fluid communication with the bung to provide a force thereto to eject the therapeutic agent from the vessel; and

a delivery trigger that when activated releases the working fluid into fluid communication with the bung and generates a fluid pressure to advance the bung within the vessel.

2. The wearable automatic injection device of claim 1, wherein the plunger actuation mechanism further comprises:

a fluid conduit provided between the pressure element and the plunger.

3. The wearable automatic injection device of claim 2, wherein the plunger actuation mechanism further comprises:

a damping mechanism coupled to the vessel and the pressure element to regulate the ejection of the therapeutic agent from the vessel.

4. The wearable automatic injection device of claim 3, wherein the damping mechanism comprises a flow restrictor for maintaining the hydraulic pressure downstream of the flow restrictor toward the vessel at a lower pressure that the hydraulic pressure upstream of the flow restrictor toward the source of the working fluid.

5. The wearable automatic injection device of claim 4, wherein the pressure element is coupled to the flow restrictor using a tubing.

6. The wearable automatic injection device of claim 1, wherein the working fluid includes one of water or oil.

7. The wearable automatic injection device of claim 1, wherein the pressure element includes one of an elastic bladder, a master cylinder, or a spring-loaded syringe.

8. A wearable automatic injection device for injecting a therapeutic agent into a patient, the wearable automatic injection device comprising:

a housing having a patient contact portion securable to the patient;

a vessel in the housing for holding the therapeutic agent;

a bung disposed in the vessel;

a syringe needle fluidically couplable to the vessel;

an injection assembly moveably disposed in the housing having an injection needle for insertion into the patient and fluidically couplable with the syringe needle; and

a mechanical-based plunger actuation mechanism for actuating the bung within the vessel, wherein the plunger actuation mechanism comprises:

a biasing mechanism;

a fusee; and

a tether coupling the biasing mechanism to the fusee.

9. The wearable automatic injection device of claim 8, wherein the plunger actuation mechanism further comprises:

a damping mechanism coupled to the fusee for regulating the movement of the fusee; and

a gear train including one or more gears for coupling the fusee to the damping mechanism.

10. The wearable automatic injection device of claim 9, wherein the damping mechanism comprises a viscous damper.

11. The wearable automatic injection device of claim 9, wherein the damping mechanism comprises an escapement mechanism.

12. The wearable automatic injection device of claim 11, wherein the escapement mechanism is a swiss lever escapement.

13. The wearable automatic injection device of claim 11, wherein the escapement mechanism is a runaway escapement.

14. The wearable automatic injection device of any one of claims 1 or 8, wherein the vessel is moveably disposed within the housing, and further comprises a vessel actuator for automatically actuating the vessel from a first position in the pre-injection state to a second position in the injection state.

15. The wearable automatic injection device of any one of claims 1 or 8, further comprising:

a pierceable septum separating the syringe needle from the sterile fluid conduit in a pre-injection state, wherein the vessel moves in an injection state causing the syringe needle to pierce the septum and establishing fluid communication between the syringe needle and the injection needle.

16. The wearable automatic injection device of any one of claims 1 or 8, wherein the plunger actuation mechanism and the patient contact portion are non-sterile.

17. The wearable automatic injection device of any one of claims 1 or 8, wherein the housing is non-sterile.

18. The wearable automatic injection device of any one of claims 1 or 8, wherein the plunger actuation mechanism includes a flow restrictor to regulate a rate of delivery of the therapeutic agent into the patient.

19. The wearable automatic injection device of any one of claims 1 or 8, further comprising:

a needle locking mechanism for automatically locking the injection needle in a retracted position within the housing in a post-injection state.

20. The wearable automatic injection device of claim 19, wherein the needle locking mechanism comprises:

a barrier mechanism moveably disposed over an injection needle aperture in the housing;

wherein the injection needle aperture is open and allows the injection needle to protrude outside the housing when the barrier mechanism is in a first position; and

wherein the injection needle aperture is closed and prevents the injection needle from protruding outside the housing when the barrier mechanism is in a second position.

21. The wearable automatic injection device of claim 19, wherein the needle locking mechanism comprises:

a needle lock release mechanism responsive to retraction of the injection assembly from an extended position in the injection state to a retracted position in the post-injection state; and

a pivoting member coupled to the injection needle and to the needle lock release mechanism;

wherein activation of the needle lock release mechanism causes the pivoting member to pivot the injection needle away from an injection needle aperture in the housing.

22. The wearable automatic injection device of any one of claims 1 or 8, further comprising a transfer mechanism defining a sterile fluid conduit between the syringe needle and the injection needle.

23. The wearable automatic injection device of claim 22, wherein the transfer mechanism comprises an adapter coupled to the syringe needle and the injection needle establishing the sterile fluid conduit between the syringe needle and the injection needle.

24. The wearable automatic injection device of claim 23, wherein the first portion of the adapter substantially envelopes a distal end of the vessel.

25. The wearable automatic injection device of claim 22, wherein the sterile fluid conduit comprises raised wall portions extending along the edges of the centrally extending channel to constrain the therapeutic agent to the channel.

26. The wearable automatic injection device of any one of claims 1 or 8, wherein the wearable automatic injection device is operable without electrical power.

27. The wearable automatic injection device of any one of claims 1 or 8, wherein the therapeutic agent is delivered in a linear delivery profile at a constant linear flow rate.