

What is Claimed:

1. A wearable drug delivery device comprising:
 - a main housing;
 - a container disposed in the main housing;
 - an insertion mechanism disposed in the main housing;
 - a fluid pathway connector defining a sterile fluid flowpath between the container and the insertion mechanism; and
 - the insertion mechanism including
 - a trocar or hollow delivery needle,
 - an insertion mechanism housing having a proximal end and a distal end,
 - a hub carrying the trocar or hollow delivery needle, the hub and being movable relative to the insertion mechanism housing between a first hub position adjacent to the proximal end of the insertion mechanism housing and a second hub position adjacent to the distal end of the insertion mechanism housing,
 - a power source configured to generate rotational motion, and
 - a motion conversion mechanism operatively connecting the power source and the hub, and configured to convert the rotational motion of the power source into linear motion of the hub.
2. The drug delivery device of claim 1, comprising a cannula guide removably connected to the hub, the cannula guide in fluid communication with the fluid pathway connector and movable relative to the insertion mechanism housing between a first cannula guide position adjacent to the proximal end of the insertion mechanism housing and a second cannula guide position adjacent to the distal end of the insertion mechanism housing.
3. The drug delivery device of claim 2, comprising a cannula having a hollow interior and being axially aligned with the trocar or hollow delivery needle, the cannula guide being configured to fluidly connect the hollow interior of the cannula and the fluid pathway connector.

4. The drug delivery device of claim 3, wherein the cannula guide is a manifold in fluid communication with the fluid pathway connector and movable relative to the insertion mechanism housing between a first manifold position adjacent to the proximal end of the insertion mechanism housing and a second manifold position adjacent to the distal end of the insertion mechanism housing.

5. The drug delivery device of any one of claims 1 to 4, wherein the motion conversion mechanism includes a pin and a yoke, the pin being slidably received in a slot formed in the yoke.

6. The drug delivery device of claim 5, wherein the pin is operatively connected to and receiving rotational motion from the power source, wherein rotation of the pin in a first rotational direction over a first arc causes the yoke to move linearly in a distal direction, and wherein rotation of the pin in the first rotational direction over a second arc causes the yoke to move linearly in a proximal direction.

7. The drug delivery device of claim 6, wherein the yoke is rigidly connected to or integrally formed with the hub such that the hub and yoke move together jointly.

8. The drug delivery device of claim 7, wherein the motion conversion mechanism includes a guide post extending through an aperture formed in the yoke, the yoke being movable relative to the guide post.

9. The drug delivery device of any one of claims 5 to 7, wherein the motion conversion mechanism includes a rotatable member rotatable about a rotational axis by the power source, wherein the pin extends from the rotatable member at a position offset from the rotational axis.

10. The drug delivery device of claim 2, wherein the hub has a first stroke in which the hub initially moves from the first hub position to the second hub position to extend the trocar or hollow needle from the insertion mechanism housing, and a second stroke in which the hub subsequently moves from the second hub position to the first hub position to retract the trocar or hollow needle into the insertion mechanism housing.

11. The drug delivery device of claim 10, wherein the hub carries the cannula guide from the first cannula guide position to the second cannula guide position during the first stroke.

12. The drug delivery device of claim 11, comprising a catch member connected to the insertion mechanism housing and configured to engage a proximally facing surface of the cannula guide when the cannula guide occupies the second cannula guide position.

13. The drug delivery of claim 12, wherein the hub is disconnected from the cannula guide by the catch member during the second stroke such that the catch member retains the cannula guide in the second cannula guide position while the hub returns to the first hub position.

14. The drug delivery device of claims 12 or 13, wherein the catch member is configured to elastically deform to allow the cannula guide to move into the second cannula guide position during the first stroke.

15. The drug delivery device of any one of claims 12 to 14, wherein the catch member includes a spring clip initially having an expanded configuration, the spring clip being compressed by the cannula guide during the first stroke and subsequently returning to the expanded configuration once the cannula guide reaches the second cannula guide position.

16. The drug delivery device of claim 9, comprising a lock member configured to selectively engage and prevent rotation of the rotatable member.

17. The drug delivery device of claim 16, wherein the rotatable member has an outer surface including a circular portion and a non-circular portion, the lock member being configured to slide along the circular portion during rotation of the rotatable member and prevent further rotation of the rotatable member when the lock member engages the non-circular portion.

18. An insertion mechanism for a drug delivery device, the insertion mechanism comprising:

a trocar or hollow delivery needle;

a housing having a proximal end and a distal end;

a hub carrying the trocar or hollow delivery needle, the hub being movable relative to the housing between a first hub position adjacent to the proximal end of the housing and a second hub position adjacent to the distal end of the housing;

a power source configured to generate rotational motion; and

a motion conversion mechanism operatively connecting the power source and the hub, and configured to convert the rotational motion of the power source into linear motion of the hub.

19. The insertion mechanism of claim 18, comprising a cannula guide removably connected to the hub, the cannula guide movable relative to the housing between a first cannula guide position adjacent to the proximal end of the housing and a second cannula guide position adjacent to the distal end of the housing.

20. The insertion mechanism of claim 19, comprising a cannula having a hollow interior and being axially aligned with the trocar or hollow delivery needle, the cannula guide being configured to fluidly connect the hollow interior of the cannula and a fluid pathway connector.

21. The insertion mechanism of claim 20, wherein the cannula guide is a manifold in fluid communication with the fluid pathway connector and movable relative to the housing between a first manifold position adjacent to the proximal end of the housing and a second manifold position adjacent to the distal end of the housing.

22. The insertion mechanism of any one of claims 18 to 21, wherein the motion conversion mechanism includes a pin and a yoke, the pin being slidably received in a slot formed in the yoke.

23. The insertion mechanism of claim 22, wherein the pin is operatively connected to and receiving rotational motion from the power source, wherein rotation of the pin in a first rotational direction over a first arc causes the yoke to move linearly in a distal direction, and wherein rotation of the pin in the first rotational direction over a second arc causes the yoke to move linearly in a proximal direction.

24. The insertion mechanism of claim 23, wherein the yoke is rigidly connected to or integrally formed with the hub such that the hub and yoke move together jointly.

25. The insertion mechanism of claim 24, wherein the motion conversion mechanism includes a guide post extending through an aperture formed in the yoke, the yoke being movable relative to the guide post.

26. The insertion mechanism of any one of claims 22 to 25, wherein the motion conversion mechanism includes a rotatable member rotatable about a rotational axis by the power source, wherein the pin extends from the rotatable member at a position offset from the rotational axis.

27. The insertion mechanism of claim 19, wherein the hub has a first stroke in which the hub initially moves from the first hub position to the second hub position to extend the trocar or hollow needle from the housing, and a second stroke in which the hub subsequently moves from the second hub position to the first hub position to retract the trocar or hollow needle into the housing.

28. The insertion mechanism of claim 27, wherein the hub carries the cannula guide from the first cannula guide position to the second cannula guide position during the first stroke.

29. The insertion mechanism of claim 28, comprising a catch member connected to the housing and configured to engage a proximally facing surface of the cannula guide when the cannula guide occupies the second cannula guide position.

30. The insertion mechanism of claim 29, wherein the hub is disconnected from the cannula guide by the catch member during the second stroke such that the catch member retains the cannula guide in the second cannula guide position while the hub returns to the first hub position.

31. The insertion mechanism of claim 29 or 30, wherein the catch member is configured to elastically deform to allow the cannula guide to move into the second cannula guide position during the first stroke.

32. The insertion mechanism of any one of claims 29 to 31, wherein the catch member includes a spring clip initially having an expanded configuration, the spring clip being compressed by the cannula guide during the first stroke and subsequently returning to the expanded configuration once the cannula guide reaches the second cannula guide position.

33. The insertion mechanism of claim 26, comprising a lock member configured to selectively engage and prevent rotation of the rotatable member.

34. The insertion mechanism of claim 33, the rotatable member having an outer surface including a circular portion and a non-circular portion, the lock member being configured to slide along the circular portion during rotation of the rotatable member and prevent further rotation of the rotatable member when the lock member engages the non-circular portion.

35. The insertion mechanism of claim 26 or 34, wherein the rotational power source is a torsion spring operatively coupled to the rotatable member, the torsion spring initially in an energized state.

36. A method comprising:

providing a wearable drug delivery device comprising a container, a drug disposed in the container, an insertion mechanism, and a fluid pathway connector defining a sterile fluid flow path between the container and the insertion mechanism, the insertion mechanism having an insertion mechanism housing, a hub, a trocar or hollow delivery needle secured to the hub, a power source configured to generate rotational motion, a motion conversion mechanism having a rotating member operatively connecting the power source and the hub, and configured to convert the rotational motion of the power source into linear motion of the hub;

disposing the wearable drug delivery device in contact with a patient's skin;

activating the power source to linearly move the hub and trocar or hollow delivery needle in a distal direction so that the trocar or hollow delivery needle penetrates the patient's skin;

retracting the trocar or hollow delivery needle from the patient by moving the hub in the a proximal direction;

expelling the drug from the container, through the fluid pathway connector for subcutaneous delivery to the patient.

37. The method of claim 36, wherein activating the power source includes linearly moving a cannula secured to the cannula guide in the distal direction so that the trocar or hollow delivery needle and the cannula penetrate the patient's skin, wherein the cannula guide is in fluid communication with the fluid pathway and is carried by the hub.

38. The method of claim 37, wherein retracting the trocar or hollow delivery needle includes disconnecting the hub from the cannula guide when the hub moves in the proximal direction to retract the trocar or hollow delivery needle from the patient.

39. The method of claim 37 or 38, wherein expelling the drug includes expelling the drug from the container, through the fluid pathway connector, and into the cannula for subcutaneous delivery to the patient.

40. The method of any one of claims 36 to 39, including activating the motion conversion mechanism, the rotating member of the motion conversion mechanism including a yoke and the rotatable member including a pin, the pin being slidably received in a slot formed in the yoke.

41. The method of claim 40, including rotating the rotatable member and the pin, the rotatable member operatively connecting the power source, wherein rotation of the rotatable member rotates the pin in a first rotational direction over a first arc causing the yoke to move linearly in the distal direction, and wherein rotation of the rotatable member rotates the pin in the first rotational direction over a second arc causing the yoke to move linearly in the proximal direction.

42. The method of any one of claims 40 or 41, including sliding the yoke by the motion conversion mechanism along a guide post, the guide post extending through an aperture formed in the yoke, the yoke being movable relative to the guide post.

43. The method of any one of claims 37 to 42, wherein activating the power source includes moving the hub during a first stroke from a first hub position adjacent to a proximal end of the insertion mechanism housing to a second hub position adjacent to a distal end of the insertion mechanism housing to extend the trocar or hollow needle from the insertion mechanism housing.

44. The method of claim 43, wherein retracting the trocar or hollow delivery needle includes moving the hub during a second stroke from the second hub position to the first hub position.

45. The method of claim 43 or 44, including carrying the cannula guide by the hub during the first stroke from a first cannula guide position adjacent to the proximal end of the

insertion mechanism housing to a second cannula guide position adjacent to the distal end of the insertion mechanism housing.

46. The method of claim 45, including engaging a proximally facing surface of the manifold by a catch member connected to the insertion mechanism housing when the cannula guide occupies the second cannula guide position.

47. The method of claim 46, wherein retracting the trocar or hollow delivery needle includes disconnecting the hub from the cannula guide by the catch member during the second stroke such that the catch member retains the cannula guide in the second cannula guide position while the hub returns to the first hub position.

48. The method of claim 46 or 47, wherein engaging a proximally facing surface of the cannula guide includes returning the catch member to an initial expanded configuration after first deforming as the cannula guide moves past the catch member in the distal direction.

49. The method of any one of claims 40 to 42, wherein activating the power source includes releasing an energized torsion spring operatively coupled to the rotatable member of the motion conversion mechanism.

50. The method of claim of any one of claims 40 to 42 and 49, further including engaging a portion of the rotatable member with an obstructing edge to prevent the rotatable member from rotating.

51. The method of claim 50, wherein engaging the portion of the rotatable member includes rotating a lock member towards the rotatable member before the hub moves in the proximal direction, the lock member having the obstructing edge and being configured to selectively engage and prevent rotation of the rotatable member.

52. The method of claim 50, wherein engaging the portion of the rotatable member includes engaging a non-circular portion of the rotatable member with the insertion mechanism housing comprising the obstructing edge, the non-circular portion engaging the obstructing edge after the hub moves in the proximal direction.