

## EXTENSION SET TO REDUCE EXTENSION TUBE KINKING

### BACKGROUND

[0001] Infusion therapy, a common healthcare procedure, may be facilitated by a vascular access device. Hospitalized, home care, and other patients receive fluids, pharmaceuticals, and blood products via a vascular access device inserted into the vascular system. Blood withdrawal is another common healthcare procedure that may be facilitated by a vascular access device.

[0002] A common type of catheter is an over-the-needle peripheral intravenous catheter (“PIVC”). As its name implies, the over-the-needle PIVC may be mounted over an introducer needle having a sharp distal tip. The PIVC and the introducer needle may be assembled so that the distal tip of the introducer needle extends beyond the distal tip of the PIVC with the bevel of the needle facing up away from skin of the patient. The PIVC and introducer needle are generally inserted at a shallow angle through the skin into vasculature of the patient.

[0003] In order to verify proper placement of the introducer needle and/or the PIVC in the vein, a user generally confirms that there is “flashback” of blood in a flashback chamber of a PIVC assembly. Once placement of the needle has been confirmed, a user may temporarily occlude flow in the vein and remove the introducer needle, leaving the PIVC in place within the vein. The PIVC may then be used for fluid infusion and/or blood withdrawal or collection.

[0004] Oftentimes the PIVC assembly may include an extension tube, which may be used to infuse fluid and/or withdraw blood at a site removed from an insertion site of the catheter. This may reduce a risk of disturbing the insertion site or dislodging the catheter from the vasculature of the patient.

[0005] In some instances, a three-way stop valve may be coupled to the extension tube. The three-way stop valve may facilitate infusion via multiple medical devices coupled to different

ports of the three-way stop valve. The three-way stop valve is often prone to growth of microorganisms due to the internal structure of the three-way stop valve and stagnate fluid within the three-way stop valve. The three-way stop valve or the extension tube may be secured to the patient, which may result in a bend in the extension tube and an increased likelihood of a kink in the extension tube. The kink may limit or prevent fluid flow through the catheter, inhibiting fluid infusion and blood withdrawal and endangering the patient.

[0006] The subject matter claimed herein is not limited to embodiments that solve any disadvantages or that operate only in environments such as those described above. Rather, this background is only provided to illustrate one example technology area where some implementations described herein may be practiced.

#### SUMMARY OF THE INVENTION

[0007] The present disclosure relates generally to intravenous catheter extension sets. In some embodiments, a vascular access system may include a catheter adapter and an extension set. In some embodiments, a catheter may extend distally from the catheter adapter. In some embodiments, the catheter may include a PIVC, a midline catheter, or a peripherally inserted central catheter (“PICC”).

[0008] In some embodiments, the extension set may include one or more of the following: a first end, a second end, an extension tube between the first end and the second end, and a brace. In some embodiments, the first end may include a first connector and/or the second end may include a second connector. In some embodiments, the first connector may be configured to couple to the catheter adapter. In some embodiments, the brace may be configured to hold the extension tube in a curved position, which may reduce a likelihood of kinking of the extension tube and dislodging the catheter from an insertion site.

[0009] In some embodiments, the brace may include a hub, which may include an arm. In some embodiments, the arm may include a coupling portion configured to couple to the extension tube. In some embodiments, the extension tube may be curved between the hub and the coupling portion.

[0010] In some embodiments, the arm of the brace may be rigid. In some embodiments, the coupling portion of the arm may include an opening, and the extension tube may pass through the opening. In some embodiments, the coupling portion of the arm may include a snap feature configured to hold the extension tube.

[0011] In some embodiments, the extension set may include one or more other extension tubes, which may extend distally from the hub. In some embodiments, the other extension tubes may each include a distal end and a proximal end. In some embodiments, the second connector may be coupled to the distal end of a particular extension tube of the other extension tubes. In some embodiments, the second connector of the extension set may include one or more ports.

[0012] In some embodiments, the vascular access system may further include one or more needleless connectors, which may be coupled to the second connector. In some embodiments, the first connector and/or the second connector may include a luer lock. In some embodiments, the first connector and/or the second connector may include a check valve.

[0013] In some embodiments, the vascular access system may include a housing, which may be disposed between the first connector and the extension tube. In some embodiments, the housing may reduce a likelihood of kinking of the extension tube and dislodging the catheter from an insertion site. In some embodiments, the housing may be U-shaped or V-shaped and a fluid pathway may extend through the housing. In some embodiments, the housing may include a

first end, a second end, and a fluid pathway extending through the first end and the second end.

In some embodiments, the first end of the housing may be coupled to the first connector.

**[0014]** In some embodiments, the distal end of the extension tube may be coupled to the second end of the housing. In some embodiments, the fluid pathway of the housing may be in fluid communication with a fluid pathway of the extension tube.

**[0015]** In some embodiments, the extension set may include one or more additional extension tubes, which may extend distally from the second end of the housing. In some embodiments, each of the additional extension tubes may include a distal end and a proximal end. In some embodiments, the second connector may be coupled to the distal end of one or more of the additional extension tubes.

**[0016]** It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are not restrictive of the invention, as claimed. It should be understood that the various embodiments are not limited to the arrangements and instrumentality shown in the drawings. It should also be understood that the embodiments may be combined, or that other embodiments may be utilized and that structural changes, unless so claimed, may be made without departing from the scope of the various embodiments of the present invention. The following detailed description is, therefore, not to be taken in a limiting sense.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0017]** Example embodiments will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

**[0018]** Figure 1 is an upper perspective view of a prior art vascular access system, illustrating a kinked extension tube, according to some embodiments;

[0019] Figure 2A is an upper perspective view of an example vascular access system, according to some embodiments;

[0020] Figure 2B is an upper perspective view of an example extension set of the vascular access system of Figure 2A, according to some embodiments;

[0021] Figure 2C is a lower perspective view of the extension set of Figure 2B, according to some embodiments;

[0022] Figure 2D is a cross-sectional view of the extension set of Figure 2B, according to some embodiments;

[0023] Figure 3A is a proximal end view of an example brace along the line 3A-3A of Figure 2B, according to some embodiments;

[0024] Figure 3B is a proximal end view of another example brace, according to some embodiments;

[0025] Figure 4A is an upper perspective view of another example extension set, according to some embodiments;

[0026] Figure 4B is an upper perspective view of another example extension set, according to some embodiments;

[0027] Figure 5A is an upper perspective view of the vascular access system of Figure 2A, according to some embodiments;

[0028] Figure 5B is an upper perspective view of another example extension set, according to some embodiments;

[0029] Figure 5C is a cross-sectional view of the extension set of Figure 5B, according to some embodiments;

[0030] Figure 6A is an upper perspective view of another example extension set, according to some embodiments; and

[0031] Figure 6B is an upper perspective view of another example extension set, according to some embodiments.

#### DESCRIPTION OF EMBODIMENTS

[0032] The present disclosure relates generally to intravenous catheter extension sets. Referring now to Figure 1, a prior art vascular access system 10 is illustrated. The prior art vascular access system 10 includes a catheter adapter 12 and a catheter 14 extending distally from the catheter adapter 12. The catheter adapter 12 includes a proximal end 16, a distal end 18, and a lumen extending therebetween. The catheter adapter 12 includes an injection port 20 in fluid communication with the lumen of the catheter adapter 12. To ensure that the catheter 14 remains in proper position, adhesive tape 15 is applied to the catheter adapter 12 to secure the catheter 14 within an insertion site where the catheter 14 is inserted through skin and into vasculature of a patient.

[0033] The prior art vascular access system 10 includes an extension set 22 coupled to the proximal end 16 of the catheter adapter 12. The extension set 22 includes an extension tube 24 that is coupled to a three-way valve 26. The three-way valve 26 enables more than one infusion device to be in fluid communication with the prior art vascular access system 10. The three-way valve 26 may be secured to the patient with adhesive tape 15. If the catheter adapter 12 and/or the three-way valve 26 are not adequately or appropriately secured with the adhesive tape 15, a kink 30 may form in the extension tube 24. The kink 30 may limit or prevent fluid flow through the catheter 14.

[0034] Referring now to Figure 2A-2D, in some embodiments, a vascular access system 32 may include an extension set 34 and a catheter assembly. In some embodiments, the extension set 34 may include one or more of the following: a first end 36, a second end 38, an extension tube 40 between the first end 36 and the second end 38, and a brace 42. In some embodiments, the first end 36 may include a first connector 44, which may be coupled to a catheter adapter 46 of the catheter assembly. In some embodiments, the brace 42 may be configured to hold the extension tube 40 in a curved position. Thus, in some embodiments, the brace 42 may reduce a likelihood of kinking of the extension tube 40. In some embodiments, the brace 42 may also reduce a risk of dislodging a catheter 48 from the insertion site.

[0035] In some embodiments, the extension set 34 may be used with any suitable catheter assembly. In some embodiments, the catheter assembly may include the BD VENFLON™ Pro Safety Shielded IV Catheter. In these and other embodiments, the catheter adapter 46 may include an injection port 47 in fluid communication with a lumen of the catheter adapter 46.

[0036] In some embodiments, the catheter assembly may include the catheter adapter 46 and the catheter 48 extending distally from the catheter adapter 46. In some embodiments, the catheter 48 may include a peripheral IV catheter (“PIVC”), a midline catheter, or a peripherally inserted central catheter (“PICC”). In some embodiments, the catheter adapter 46 may include a proximal end 50, a distal end 52, and the lumen extending therebetween.

[0037] In some embodiments, the second end 38 of the extension set 34 may include a second connector 54, which may be configured to couple to a medical device, such as, for example, an infusion or blood withdrawal device. In some embodiments, the first connector 44 and/or the second connector 54 may include a male or female luer connector or another suitable connector. In some embodiments, the first connector 44 and/or the second connector 54 may include a luer-

slip or luer-lock feature. In some embodiments, the first connector 44 may couple the extension set 34 to the proximal end 50 of the catheter adapter 46. In some embodiments, the extension set 34 may be removably coupled to the catheter adapter 46 via the first connector 44.

[0038] In some embodiments the first connector 44 and/or the second connector 54 may include a valve to prevent fluid from leaking out of the corresponding connector. In some embodiments, the valve 56 may include a one-way valve, a check valve, or another suitable valve.

[0039] In some embodiments, the extension set 34 may include one or more other extension tubes 60. In some embodiments, the other extension tubes 60 may each include a distal end 62 and a proximal end 64. In some embodiments, the second connector 54 may be coupled to the distal end 62 of a particular one of the other extension tubes 60.

[0040] In some embodiments, the second connector 54 may include one or more ports. In some embodiments, the second connector 54 may be configured to couple to a needleless connector 65. In some embodiments, one or more of the other extension tubes 60 may be coupled to a connector the same as or different from the second connector 54, which may facilitate coupling of the extension set 34 to various medical devices.

[0041] In some embodiments, the brace 42 may include a hub 66, which may include an arm 68 extending outwardly from a body of the hub 66. In some embodiments, an exterior of the hub 66 may include one or more surface features to improve gripping the hub 66 and the extension set 34. For example, the exterior of the hub 66 may include one or more protrusions. Additionally or alternatively, the exterior of the hub 66 may include one or more grooves. In some embodiments, the arm 68 may be monolithically formed as a single unit with a remaining portion of the hub 66.

**[0042]** In some embodiments, the other extension tubes 60 may extend from the hub 66. In some embodiments, the proximal ends 64 of the other extension tubes 60 may be coupled to the hub 66. For example, the proximal ends 64 of the other extension tubes 60 may be integrated with the hub 66. In some embodiments, the proximal ends 64 of the other extension tubes 60 may be removably coupled to the hub 66 via one or more connectors (not illustrated).

**[0043]** In some embodiments, the extension tube 40 may be coupled to the hub 66. In some embodiments, the extension tube 40 may include a first end 70 and a second end 72. In some embodiments, the second end 72 of the extension tube 40 may be coupled to the hub 66. For example, the second end 72 of the extension tube 40 may be integrated with the hub 66. In some embodiments, the second end 72 of the extension tube 40 may be removably coupled to the hub 66 via one or more connectors (not illustrated).

**[0044]** In some embodiments, the extension tube 40 may be elongated and extend through the hub 66 and couple directly to the second connector 54. In some embodiments, the hub 66 may include the second connector 54 and the extension tube 40 may terminate within the hub 66. In these and other embodiments, the vascular access system 32 may not include the other extension tubes 60.

**[0045]** In some embodiments, the hub 66 may include a lumen extending therethrough such that the second end 72 of the extension tube 40 may be in fluid communication with the other extension tubes 60. In some embodiments, a fluid pathway extending through the extension set 34 may include one or more of the following: the first connector 44, the extension tube 40, the hub 66, the other extension tubes 60, and the second connector 54.

**[0046]** In some embodiments, the arm 68 may include a coupling portion 74 configured to couple to the extension tube 40. In some embodiments, the extension tube 40 may be curved

between the hub 66 and the coupling portion 74. In some embodiments, the extension tube 40 may be integrated with the coupling portion 74 or removably coupled with the coupling portion 74.

[0047] In some embodiments, the brace 42 may be constructed of a rigid material. In some embodiments, the brace 42 may be constructed of plastic, such as, for example, polyethylene. In some embodiments, the brace 42 may be constructed from any suitable material including, for example, nylon, vinyl, polyurethane, etc. In some embodiments, the hub 66 may be constructed of a more rigid material than the arm 68. In some embodiments, the second end 72 of the extension tube 40 may be aligned with a longitudinal axis of the hub 66.

[0048] Referring now to Figure 3A, in some embodiments, the coupling portion 74 may include an enclosed opening 80 that extends through the arm 68, and the extension tube 40 may extend through the enclosed opening 80.

[0049] Referring now to Figure 3B, the coupling portion 74 may include a snap mechanism 76 or a fastener, which may couple the extension tube 40 to the arm 68. In some embodiments, the snap mechanism 76 and/or the fastener may facilitate removable coupling of the extension tube 40 to the arm 68. In some embodiments, the snap mechanism 76 may include an opening 77, which may include a diameter 78 less than an outer diameter of the extension tube 40 such that the extension tube 40 snaps within the opening 77. In some embodiments, the fastener (not illustrated) may include a clip, clasp, hook, strap, or other suitable fastener.

[0050] Referring now to Figures 4A, an extension set 81 is illustrated, according to some embodiments. In some embodiments, the extension set 81 may include or correspond to the extension set 34 described with respect to Figures 2-3. In some embodiments, the extension set 81 may include only one of the other extension tubes 60.

**[0051]** In some embodiments, the other extension tube 60 may include a clamp 82. In some embodiments, the clamp 82 may selectively close off the other extension tube 60 to prevent fluid from flowing through the other extension tube 60. It is understood that in some embodiments, one or more of the other extension tubes 60 described with respect to Figure 2 may include the clamp 82.

**[0052]** Referring now to Figure 4B, an extension set 83 is in some embodiments, the second connector 54 may include a Y-adapter 84 or another suitable connector. In some embodiments, a needleless connector 65 may be coupled to the Y-adapter 84. In some embodiments, the second connector 54 of the extension set 34 and/or the extension set 81 may include the Y-adapter 84.

**[0053]** Referring now to Figures 5A-5C, in some embodiments, the vascular access system 32 may include an extension set 85. In some embodiments, the extension set 85 may include or correspond to one or more of the extension set 34 described with respect to Figures 2-3, the extension set 81 described with respect to Figure 4A, and the extension set 81 described with respect to Figure 4B.

**[0054]** In some embodiments, the first end 36 of the extension set 85 may include the first connector 44, which may be coupled to the catheter adapter 46. In some embodiments, the second end 38 may include the second connector 54. In some embodiments, the extension tube 40 may be disposed between the first end 36 and the second end 38. In some embodiments, the extension set 85 may include a housing 86, which may be disposed between the first connector 44 and the extension tube 40. In some embodiments, the housing 86 may reduce a risk of kinking the extension tube 40 compared to if the extension tube 40 was coupled directly to the first connector 44.

**[0055]** In some embodiments, the housing 86 may include a first end 88 and a second end 90. In some embodiments, the first end 88 may be coupled to the first connector 44. In some embodiments, the housing 86 may be monolithically formed as a single unit with the first connector 44. In some embodiments, the first connector 44 may include a male or female luer connector or another suitable connector. In some embodiments, the first connector 44 may include a luer-slip or luer-lock feature. As mentioned, in some embodiments, the first connector 44 may include the valve 56 to prevent fluid from leaking out of the first connector 44. In some embodiments, the valve 56 may include a one-way valve, a check valve, or another suitable valve.

**[0056]** In some embodiments, the second end 90 may be coupled to the extension tube 40. In some embodiments, the housing 86 may be generally U-shaped or generally V-shaped. In some embodiments, a fluid pathway 92 may extend through the housing 86.

**[0057]** In some embodiments, the housing 86 may be constructed of plastic, such as, for example, polyethylene or another suitable plastic. In some embodiments, the housing 86 may be constructed of a rigid material. In some embodiments, the housing 86 may be constructed from any suitable material including, for example, nylon, vinyl, polyurethane, etc. In some embodiments, portions of the housing 86 may be constructed of flexible material or plastic and other portions may be constructed of a more rigid material.

**[0058]** In some embodiments, the housing 86 may be transparent or translucent. In some embodiments, the housing 86 may further include a support 87 extending between two arms forming a U-shape or a V-shape of the housing 86. In some embodiments, the support 87 may help retain the U-shape or the V-shape of the housing 86. In some embodiments, the housing 86 may not include the support 87.

[0059] In some embodiments, the distal end 62 of the extension tube 40 may be coupled to the second end 90 of the housing 86. In some embodiments, the proximal end 64 of the extension tube 40 may be coupled to the second connector 54. In some embodiments, the second connector 54 may be coupled to the needleless connector 65.

[0060] Referring now to Figure 6A, in some embodiments, an extension set 94 may include another extension tube 96, which may extend distally from the second end 90 of the housing 86. In some embodiments, the extension set 94 may include or correspond to one or more of the extension set 34 described with respect to Figures 2-3, the extension set 81 described with respect to Figure 4A, the extension set 83 described with respect to Figure 4B, and the extension set 85 described with respect to Figure 5.

[0061] In some embodiments, the other extension tube 96 may include a distal end 98, which may be coupled to the second end 90 of the housing 86. For example, the distal end 98 may be integrated with the second end 90 of the housing 86, as illustrated, for example, in Figure 6A. In some embodiments, the distal end 98 may be removably coupled to the second end 90 of the housing 86 via one or more connectors (not illustrated).

[0062] In some embodiments, the other extension tube 96 may include a proximal end 100, which may be coupled to another connector 99. In some embodiments, the other connector 99 may be the same as or different from the second connector 54.

[0063] Referring now to Figure 6B, another extension set 102 may include the Y-adapter 84 or another suitable connector. In some embodiments, the needleless connector 65 may be coupled to the Y-adapter 84. In some embodiments, the second connector 54 of the extension set 83 and/or the extension set 94 may include the Y-adapter 84. In some embodiments, the extension tube 40 and/or the other extension tube 96 may include the clamp 82.

[0064] All examples and conditional language recited herein are intended for pedagogical objects to aid the reader in understanding the invention and the concepts contributed by the inventor to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions. Although embodiments of the present inventions have been described in detail, it should be understood that the various changes, substitutions, and alterations could be made hereto without departing from the spirit and scope of the invention.

## CLAIMS

1. A vascular access system, comprising:  
a catheter adapter; and  
an extension set, comprising:  
a first end comprising a first connector coupled to the catheter adapter;  
a second end comprising a second connector;  
an extension tube disposed between the first end and the second end; and  
a brace configured to hold the extension tube in a curved position, wherein the extension set comprises the brace, wherein the brace comprises a hub, wherein the hub comprises an arm, wherein the arm comprises a coupling portion configured to couple to the extension tube, wherein the extension tube is curved between the hub and the coupling portion.
2. The vascular access system of claim 1, wherein the arm is rigid.
3. The vascular access system of claim 1, wherein the extension tube is a first extension tube, wherein the extension set comprises a second extension tube extending distally from the hub, wherein the second extension tube comprises a distal end and a proximal end, wherein the second connector is coupled to the distal end of the second extension tube.
4. The vascular access system of claim 1, further comprising a needleless connector coupled to the second connector.
5. The vascular access system of claim 1, wherein the first connector comprises a luer lock connector, wherein the luer lock connector comprises a check valve.
6. An extension set, comprising:  
a first end comprising a first connector coupled to the catheter adapter;

a second end comprising a second connector;  
an extension tube disposed between the first end and the second end; and  
a brace configured to hold the extension tube in a curved position,  
wherein the brace comprises a hub, wherein the hub comprises an arm, wherein the arm comprises a coupling portion configured to couple to the extension tube, wherein the extension tube is curved between the hub and the coupling portion.

7. The extension set of claim 6, wherein the coupling portion of the arm comprises an enclosed opening, wherein the extension tube extends through the enclosed opening.

8. The extension set of claim 6, wherein the coupling portion of the arm comprises a snap feature configured to hold the extension tube.

9. The extension set of claim 6, wherein the arm is rigid.

10. The extension set of claim 6, wherein the extension tube is a first extension tube, wherein the extension set comprises a second extension tube extending distally from the hub, wherein the second extension tube comprises a distal end and a proximal end, wherein the second connector is coupled to the distal end of the second extension tube.

11. The extension set of claim 6, further comprising a needleless connector coupled to the second connector.

12. The extension set of claim 6, wherein the first connector comprises a luer lock connector, wherein the luer lock connector comprises a check valve.

13. The extension set of claim 6, wherein the second connector comprises a multi-port connector.