6. The aspiration catheter system of any of claims 1-5, wherein at least one sidewall opening of the plurality of sidewall openings comprises a one-way valve configured to permit flow of fluid into the inner catheter lumen.

7. The aspiration catheter system of claim 6, wherein the one-way valve is configured to open in response to a differential pressure between the outer catheter lumen and the inner catheter lumen being greater than or equal to a predetermined threshold value.

8. The aspiration catheter system of claim 6 or claim 7, wherein the one-way valve comprises a duckbill valve, a slit valve, or a flexible flap positioned at the respective sidewall openings.

9. The aspiration catheter system of any of claims 1-8, wherein the distal-most sidewall opening of the plurality of sidewall openings is positioned between about 0.5 centimeters and about 10 centimeters proximal to the inner catheter distal opening.

10. The aspiration catheter system of any of claims 1-9, further comprising:

a fluid circulation system coupled to a proximal portion of the outer catheter and a proximal portion of the inner catheter,

wherein the fluid circulation system is configured to deliver fluid through the outer catheter lumen and receive fluid through the inner catheter lumen.

11. The aspiration catheter system of claim 10, wherein the fluid comprises saline.

12. The aspiration catheter system of any of claims 1-11, wherein the sidewall openings of the plurality of sidewall openings are circumferentially distributed around an outer perimeter of the inner catheter.

13. The aspiration catheter system of any of claims 1-12, wherein the sidewall openings of the plurality of sidewall openings are distributed axially along the inner catheter.