

## Appendix: Pumpers' comments

Special techniques for avoiding bubbles:

This question elicited many opinions ranging from those pumpers who are quite certain that bubbles are an inevitable bugbear associated with pumping to those who are equally certain that bubble problems are due to 'sloppy' technique for filling cartridges, and that if everyone were to follow a few simple rules, of which there are many different versions as pumpers who quote them, then everyone could, like them, be entirely free from bubbles. In this regard, it is worth mentioning that one pumper stated that since there is a double lumen tube, air will not go through from the cartridge to the tubing; this may have been true of a particular pump, but is not true for most pumps, so generally leaving air in the cartridge puts you at risk of air going through the tubing in place of insulin.

All techniques mentioned are listed here. If a particular technique works well for you, whether or not it sounds scientific or reasonable, that's great, and no disrespect to anyone's suggestions, however weird and wonderful they may sound, is intended in this report. However it must be noted that since some of the 'golden rules' (e.g. 2 and 3 below) are mutually incompatible, it is apparent that there are unfortunately no absolute rules which can free all insulin pumpers from all air bubbles. But in case this sounds gloomy, remember that many successful pumpers use none of these special 'tricks' and yet do not experience particular problems with bubbles.

All the suggestions received (with the exception of a very few that were unclear or not generally applicable) are listed below, but please note that except for the first suggestion which is a standard recommended procedure, all other suggestions are just suggestions, and they are listed here as interesting ideas which you may (or may not!) find helpful.

How to avoid air bubbles in cartridge and tubing during filling:

1. lubricate cartridge by pulling plunger in and out while rotating it before filling cartridge – (*NOTE*: this is generally recommended by the pump manufacturers as part of standard practice when filling all cartridges).
2. unscrew plunger and screw it back in again before starting to fill cartridge
3. never pull plunger beyond maximum fill point, since air is more likely to enter if you do
4. ensure that not only insulin but also all equipment is at room temperature (note that 'room temperature' can cover a wide range in different climates and in homes that are not temperature controlled at all times. Some have more problems when filling the pump in a cold room in winter.)
5. warm insulin to body temperature before filling vial (someone wrote "at least body temperature" – in fact warming insulin above body temperature is definitely not recommended)
6. keep the insulin vial in current use out of the refrigerator until it is finished (but note that with daily insulin doses varying at least from 15-100u, 'until the vial is finished' might be anything from 10 to over 60 days)
7. fill the cartridge with insulin directly from refrigerator but allow the filled cartridge to come to room temperature over several hours or days, and then prime before use
8. fill (very) slowly
9. repeatedly fill and part-empty, expelling insulin + bubbles, fill some more etc
10. avoid filling more than once
11. if there are many bubbles, empty cartridge back into vial and start filling again
12. inject air into vial – same/less/more volume than the insulin required
13. don't inject air into vial – because it may contaminate insulin
14. put second needle (with or without syringe attached) into insulin vial to avoid creating a vacuum/negative pressure in either the cartridge or the vial – cited in the name of the late great John Neale of whom many of us have very fond memories
15. don't try to use very end of nearly empty vial
16. always replace tubing and infusion set at the same time as cartridge (but others do not recommend doing this)

17. if you fill cartridge without using new tubing, beware of bubbles left in the tubing, though some successfully avoid problems by ensuring tubing is pre-filled
18. keep cartridge / pump vertical during entire filling process, including priming tubing
19. do not try to overfill cartridges
20. always overfill cartridge slightly, and then expel the extra insulin

Getting rid of air bubbles in cartridge during/after filling:

1. wait a few minutes for bubbles to collect and rise before expelling the air
2. tap/knock/flip/flick/thump/whack/thwap/shake cartridge with pen (some say only metal pen), pencil, lancet device, spoon, scissors, knife, back-scratcher or finger, or knock cartridge against some hard surface, so bubbles rise, then push them out into air or back into insulin vial or into tubing before connecting to pump
3. rotate or spin or swirl cartridge or perform a 'lasso' type motion with it in the air
4. hold pump (and the first part of the tubing) vertical while filling, priming etc to ensure that air bubbles get pushed out
5. leave filled cartridge for 1-2 hours or much longer (some fill next cartridge when replacing previous one, or some even fill 3-4 cartridges from 1 vial all at the same time), at room temperature or in refrigerator, to allow all air bubbles to leave before attaching to pump.
6. when attaching tubing to cartridge, use pliers to tighten the luer lock.
7. some swear by the need to expel bubbles while needle is still in the insulin vial, others when it is detached, still others only when the cartridge is already attached to the tubing.
8. use a syringe to remove air bubbles from cartridge
9. use bright lights and vision aids if necessary to check for bubbles

Keeping free from air bubbles during use:

1. keep pump vertical with cartridge facing down so that bubbles stay at the end of the cartridge furthest from the tubing, either all the time, or at least during bolus
2. after a day of wearing, take off, tap and prime again, as heat from body will cause more bubbles
3. if blood glucose levels are high, check pump and tubing for bubbles, and prime them out, though some say that bubbles only occur in tubing in first 12-24 hours after filling
4. some pumpers watch bubbles progressing along the tube and wait till they are near the infusion site before priming them away
5. always change cartridges and tubing after 48 hours or at most 72 hours.
6. do not use the last bit of insulin in the cartridge since any bubbles are likely to remain there
7. note that flaws in the tubing can sometimes appear to be bubbles

Cartridge/reservoir design issues:

1. in some pumps, air is seen coming in at the seals/gaskets/o-rings
2. shape (flat vs tapered shoulders) of certain cartridges makes it more difficult to expel bubbles
3. plastics used in certain reservoirs seem less/more likely to hold on to bubbles
4. occasionally one reservoir or a whole batch of reservoirs may have bubble problems
5. visibility, particularly around the neck of the cartridge is limited in some pump designs, so difficult to see if bubbles remain or not
6. in some pumps, the needle goes so far into the cartridge that some bubbles stay in the cartridge above the opening of the needle
7. some believe pre-filled cartridges would solve all bubble problems, but this was not necessarily found to be true, particularly when pre-filled cartridges were used straight from the refrigerator

Special issues: Altitude and flying:

Changes in altitude (and therefore pressure) can cause bubbles. One pumper writes, "I live at altitude.... when I fill at 5000 feet and then come to my home altitude of 7400 feet I end up

with more bubbles in the tubing and the cartridge." Likewise people have problems with bubbles when flying, possibly more so on long haul flights.

#### Summary

If all else fails, you might dream of one pumper's suggestion "Buy an OmniPod - no bubbles - no problem" – but remember that at the time this survey information was gathered there was not sufficient experience with the OmniPod to be certain about this. A less expensive suggestion was provided by another pumper who recommended "some cussing and much feline assistance" – but there again not everyone would agree – my cat doesn't cooperate though she no longer specializes in the sport of chasing the tubing as she did in her youth.