Insulin Pumpers Bubbles Survey – 2008

In response to the requests sent out to the Insulin Pumpers lists in spring 2008, a total of 396 responses were received – many thanks to all.

1. Basics

First a summary of the pump information collected:
Since some pumpers provided information on more than one pump, the survey includes a grand total of 737 pumps. The following table shows how the pumps are divided between Animas, Cozmo, Disetronic, Minimed, Omni, Spirit, and other pumps. The 'other' category included some historic pumps from the dawn of pumping as well as some more recent pumps, but there were too few reports on these devices to contribute in any meaningful way to the analysis of bubble problems.

Pump	# pumps	% of all pumps
ANIMAS	129	17.5%
COZMO	64	8.7%
DISETRONIC	66	9.0%
MINIMED	443	60.1%
OMNI	9	1.2%
SPIRIT	18	2.4%
Other	8	1.1%
Total	737	100.0%

The following tables summarize answers to the key questions about bubbles:

"Do you have any problems with air bubbles while filling the pump?"

	# answers	% answers
always	47	6.4%
often	87	11.8%
sometimes	90	12.2%
occasionally	165	22.4%
rarely	342	46.4%
don't remember	6	0.8%
Total	737	100.0%

"Do you have cause for concern about air bubbles in the tubing during use?"

	# answers	% answers
always	19	2.6%
often	42	5.7%
sometimes	76	10.3%
occasionally	106	14.4%
rarely	487	66.1%
don't remember	7	0.9%
Total	737	100.0%

Almost 70% of the pump experiences (507 out of a total of 737) reported only occasional or rare problems with air bubbles while filling the pump, though a sizeable minority (134, constituting 18.2%) do have problems with air bubbles often or even always when filling the pump. Likewise, more than 80% of the pump experiences (593 out of a total of 737) report only occasional or rare problems with air bubbles in the tubing during pump use, though a small unfortunate minority (61, constituting 8.3%) often or always have problems with air bubbles during pump use.

2. Incidence of bubbles and make/model of pump

	Do you have any problems with air bubbles while filling the pump?				Do you have cause for concern about air bubbles in the tubing during use?			
Pump	always or often	sometimes	occasionally or rarely	Total	always or often	sometimes	occasionally or rarely	Total
ANIMAS – all	16 (12%)	10 (7.8%)	103 (79.8%)	129	5 (3.9%)	13 (10.3%)	108 (83.7%)	129
COZMO	8 (12.5%)	14 (21.9%)	42 (65.6%)	64	10 (15.6%)	2 (3.1%)	52 (81.2%)	64
Disetronic – all	7 (10.6%)	14 (21.2%)	45 (68.2%)	66	4 (6.1%)	6 (9.1%)	56 (84.8%)	66
Minimed - all	95 (21.4%)	52 (11.8%)	292 (65.9%)	443	37 (8.4%)	55 (12.5%)	348 (78.7%)	442
OMNI	0 (0%)	0 (0.0%)	9 (100%)	9	0 (0%)	0 (0.0%)	9 (100%)	9
SPIRIT	5 (27.8%)	0 (0.0%)	12 (66.7%)	18	3 (16.7%)	0 (0.0%)	15 (83.3%)	18

The percentage of pumpers reporting only rare or occasional problems with bubbles during filling is about 80% for Animas, 66% Cozmo, 68% Disetronic, 66% Minimed, 100% Omni, and 67% Spirit. Corresponding results for bubbles during use showed only rare or occasional problems at about 86% for Animas, 81% Cozmo, 85% Disetronic, 79% Minimed, 100% Omni, and 83% Spirit. These results don't appear to reveal a great deal of difference between pumps either when filling or during use, though Animas and Omni pumps look very good. However since only 9 Omni pumpers participated in the survey, and they had used the Omni only for 1-4 months, it is too soon to draw conclusions about Omni from this survey.

Since Animas, Disetronic and Minimed included a range of pumps, a further analysis was performed, examining each model separately. Pumps used by fewer than 9 users are not reported on in this table:

	Do you have any problems with air bubbles while filling the pump?				Do you have cause for concern about air bubbles in the tubing during use?			
	always or often	sometimes	occasionally or rarely	total	always or often	sometimes	occasionally or rarely	total
ANIMASR1000	3 (30%)	1 (10%)	6 (60%)	10	1 (9%)	3 (27%)	7 (64%)	11
ANIMASIR1000	1 (8%)	3 (23%)	9 (69%)	13	1 (8%)	0 (0%)	12 (92%)	13
ANIMASIR1200	4 (14%)	4 (14%)	20 (71%)	28	0 (0%)	2 (7%)	25 (93%)	27
ANIMASIR1250	4 (9%)	1 (2%)	38 (88%)	43	3 (7%)	5 (12%)	35 (81%)	43
ANIMASIR2020	4 (12%)	1 (3%)	29 (85 %)	34	0 (0%)	3 (9%)	29 (91%)	32
COZMO	8 (12%)	14 (22%)	42 (66%)	64	10 (16%)	2 (3%)	52 (81%)	64
HTRONPLUSV100	4 (21%)	4 (21%)	11 (58%)	19	1 (5%)	3 (16%)	15 (79%)	19
HTRONV100	2 (17%)	3 (25%)	7 (58%)	12	0 (0%)	2 (17%)	10 (83%)	12
DTRON	0 (0%)	2 (22%)	7 (78%)	9	1 (11%)	0 (0%)	8 (89%)	9
DTRONP	1 (4%)	5 (19%)	20 (77%)	26	2 (8%)	1 (4%)	23 (88%)	26
MM504	3 (20%)	2 (13%)	10 (67%)	15	2 (13%)	4 (27%)	9 (60%)	15
MM506	1 (9%)	2 (18%)	8 (73%)	11	1 (9%)	2 (18%)	8 (73%)	11
MM507	6 (26%)	5 (22%)	12 (52%)	23	1 (4%)	9 (39%)	13 (57%)	23
MM507C	4 (17%)	2 (8%)	18 (75%)	24	1 (4%)	1 (4%)	22 (92%)	24
MM508	23 (27%)	9 (11%)	53 (62%)	85	6 (7%)	12 (14%)	69 (79%)	87
MM511	10 (23%)	7 (16%)	26 (61%)	43	4 (9%)	8 (19%)	31 (72%)	43
MM512	4 (10%)	4 (10%)	30 (79%)	38	3 (8%)	1 (3%)	34 (89%)	38
MM712	5 (19%)	2 (7%)	20 (74%)	27	2 (7%)	1 (4%)	24 (89%)	27
MM515	2 (7%)	5 (19%)	20 (74%)	27	1 (4%)	2 (7%)	24 (89%)	27
MM715	5 (19%)	2 (7%)	20 (74%)	27	2 (7%)	5 (19%)	20 (74%)	27
MM522	15 (29%)	7 (14%)	29 (57%)	51	6 (12%)	6 (12%)	39 (76%)	51
MM722	14 (22%)	4 (6%)	45 (71%)	63	7 (11%)	2 (3%)	53 (86%)	62
OMNI	0 (0%)	0 (0%)	9 (100%)	9	0 (0%)	0 (0%)	9 (100%)	9
SPIRIT	5 (28%)	0 (0%)	12 (67%)	18	3 (17%)	0 (0%)	15 (83%)	18

Now the picture changes, with greater differences emerging between pumps. The results in this table are colour coded, with pumps showing least problems during filling and in use (≥ 80% users reported problems with bubbles only occasionally or rarely) indicated in deep blue, pumps with slightly more problems (70-80% users reported bubbles only occasionally or rarely) in pale blue, pumps with more problems (60-70% users reported bubbles only occasionally or rarely) in pale yellow, and pumps with the most problems (<60% users reported bubbles only occasionally or rarely) in orange.
The good news from this table is that most of the pumps with the worst bubble problems are earlier models that are no longer being supplied, and probably not much in use any more, with the exception of the Minimed Paradigm 522 which is reported to have relatively frequent problems during filling. However, it is worth remembering that even with this pump, and indeed with all pumps, more than 50%, i.e. the majority, of users reported only rare or occasional problems with bubbles both during filling and in use.

3. Incidence of bubbles and type of insulin used

	Do you have any problems with air bubbles	Do you have cause for concern about air

	while filling the pump?				bubbles in the tubing during use?			
	always or often	sometimes	occasionally or rarely	Total	always or often	sometimes	occasionally or rarely	Total
Humalog	79 (19.7%)	45 (11.2%)	278 (69.2%)	402	33 (8.2%)	37 (9.2%)	334 (82.7%)	404
Novorapid	40 (17.2%)	32 (13.7%)	161 (69.1%)	233	22 (9.6%)	21 (9.1%)	187 (81.3%)	230
Apidra	1 (5.6%)	0 (0.0%)	17 (94.4%)	18	1 (5.6%)	2 (11.1%)	15 (83.3%)	18
Regular	10 (18.9%)	6 (11.3%)	37 (69.8%)	53	3 (5.7%)	12 (22.6%)	38 (71.7%)	53
Other	4 (25.0%)	7 (43.8%)	5 (31.3%)	16	2 (12.5%)	4 (25.0%)	10 (62.5%)	16

Bubble problems both in filling the cartridge and during use seem to differ little between the different insulins used. Apidra seems to have slightly less incidence of problems than the other insulins, but it is difficult to be certain with data from only 18 Apidra users.
304 out of 396 responders had only used one type of insulin. So only the other 92 pumpers could report on direct comparisons between different insulins. Of these 92, 59 said that the different insulins they used were the same for bubble problems, 27 said Humalog had the most bubbles, 3 said Novorapid had the most bubbles, and 3 said another unspecified insulin had most bubbles. 20 said Novorapid had the least bubbles, 4 said Humalog had least bubbles, 2 said Apidra, 2 Regular, 5 other. It would appear from this that there is a perception that Novorapid has less bubble problems than Humalog, but such a difference is not confirmed in the reports of bubble problems from users of Humalog and Novorapid in general according to the table above.

4. **Incidence of bubbles and total daily dose of insulin**

	Do you have any problems with air bubbles while filling the pump?				Do you have cause for concern about air bubbles in the tubing during use?			
Daily units insulin	always or often	sometimes	occasionally or rarely	Total	always or often	sometimes	occasionally or rarely	Total
Less than 20	4 (15.4%)	5 (19.2%)	17 (65.4%)	26	4 (16.0%)	2 (8.0%)	19 (76.0%)	25
20-30	21 (21.9%)	9 (9.4%)	66 (68.8%)	96	8 (8.3%)	9 (9.4%)	79 (82.3%)	96
30-40	19 (18.3%)	15 (14.4%)	70 (67.3%)	104	8 (7.8%)	8 (7.8%)	87 (84.5%)	103
40-50	15 (22.7%)	8 (12.1%)	43 (65.2%)	66	11 (16.7%)	4 (6.1%)	51 (77.3%)	66
50-60	7 (16.7%)	1 (2.4%)	34 (81.0%)	42	1 (2.4%)	3 (7.1%)	38 (90.5%)	42
More than 60	8 (13.6%)	2 (3.4%)	49 (83.1%)	59	3 (5.2%)	2 (3.4%)	53 (91.4%)	58

Percentages of users experiencing problems only occasionally or rarely when filling the pump were in the range 64-69% for those using less than 50units daily, while for pumpers using more than 50 units insulin daily, over 80% of them only experience problems when filling the pump occasionally or rarely. Likewise, percentage of users experiencing problems only occasionally or rarely during pump use appear to be lower the less insulin used: in the range of 73-84% for those using less than 50units, and 90% for those using more than 50 units insulin daily.
This suggests a slight tendency for people who use large daily amounts of insulin (more than 50 units a day) to have less frequent problems with bubbles both when filling the pump and when using it, as compared to people using smaller daily amounts of insulin. This effect appeared to be independent of model of pump used. And it is worth noting here that it is not only children who use very small amounts of insulin, insulin requirements are very diverse and there are many adults, and not necessarily only particularly small people, who only require small amounts of insulin. One might speculate that pumpers who use large amounts of insulin have more practice filling pumps since they have to do so very often. Or, given the current advice to change the cartridge with every infusion set change (though it is hard to know how widely this guideline is indeed followed), it could be that people who use smaller amounts of insulin do not fill their cartridges to their full capacity, and that in this situation air bubbles are more likely. Or perhaps that the relatively small amounts of insulin missed due to the presence of some air bubbles might be less significant relative to large amounts used, so that those who use large amounts of insulin may be less likely to investigate and recognize bubble problems.

5. **Incidence of bubbles and length of tubing**

Of the 397 pump experiences where tubing length was specified, 162 used long (approx. 43"/110cm), 53 used medium (approx. 31"/80cm), 173 used short (approx. 24"/61cm). Very few people have used more than one length of tubing, and of those who have, most (more than 80%) believed that length of tubing did not impact on bubble problems.

	Do you have any problems with air bubbles while filling the pump?				Do you have cause for concern about air bubbles in the tubing during use?			
	always or often	sometimes	occasionally or rarely	total	always or often	sometimes	occasionally or rarely	total
Long	28 (17.3%)	13 (8.0%)	121 (74.7%)	162	14 (8.6%)	11 (6.8%)	137 (84.6%)	162
Medium	16 (30.2%)	8 (15.1%)	29 (54.7%)	53	6 (11.3%)	8 (15.1%)	39 (73.6%)	53
Short	30 (17.4%)	20 (11.6%)	122 (70.9%)	172	15 (8.9%)	9 (5.3%)	145 (85.8%)	169
Total	74 (18.7%)	41 (10.4%)	280 (70.9%)	397	35 (8.9%)	28 (7.1%)	329 (83.9%)	384

Analyzing reports of bubbles according to length of tubing used, it would appear, strangely enough, that using the medium length tubing gives rise to more problems than short or long tubing both when filling the pump and during use.

6. Techniques for avoiding and eliminating bubbles

Here is a list of tricks and techniques that have been suggested as helpful in avoiding bubbles. Below are tables for each proposed technique showing (a) how many pumpers actually use these techniques, (b) for those pumpers who have used more than one option, which they believed to be better, and (c) level of bubble problems reported by people who use each of the technique options.

i. Filling cartridge with insulin straight from refrigerator OR insulin at room temperature?

	Have you filled cartridge with insulin straight from refrigerator?		Have you filled cartridge with insulin at room temperature?	
	Number	Percent	Number	Percent
always	83	11.3%	281	38.1%
often	80	10.9%	236	32.0%
sometimes	172	23.3%	85	11.5%
rarely	168	22.8%	49	6.6%
never	234	31.8%	86	11.7%
Total	737	100.0%	737	100.0%

Most pumps are mostly filled with insulin at room temperature. Not surprisingly many people are not entirely consistent about always filling their pump in their preferred way, but 70% report always or often using insulin at room temperature, while only 22% report always or often using insulin straight from the refrigerator.

Which technique is better?	Number	Percent
Straight from refrigerator	11	2.5%
Room temperature	306	69.5%
same	123	28.0%
Total	440	100.0%

Of 440 pump experiences reporting that both options were used, many of these pumpers (306, 69.5%) believed that it is better to fill the pump with insulin at room temperature, and while some people (123, 28%) thought it makes no difference, only very few (11, 2.5%) believed it is better to fill the pump with insulin straight from the refrigerator.

Taking a less direct approach to this issue, the following two tables show the extent of problems with bubbles experienced by pumpers who always chose one option:

From fridge	Do you have any problems with air bubbles while filling the pump?				Do you have cause for concern about air bubbles in the tubing during use?			
	always or often	sometimes	occasionally or rarely	Total	always or often	sometimes	occasionally or rarely	Total
always	10 (12.2%)	9 (11.0%)	63 (76.8%)	82	5 (6.1%)	3 (3.7%)	74 (90.2%)	82
never	41 (17.6%)	18 (7.7%)	174 (74.7%)	233	20 (8.5%)	20 (8.5%)	194 (82.9%)	234

Room temperature	Do you have any problems with air bubbles while filling the pump?				Do you have cause for concern about air bubbles in the tubing during use?			
	always or often	sometimes	occasionally or rarely	Total	always or often	sometimes	occasionally or rarely	Total
always	57 (20.4%)	22 (7.9%)	200 (71.7%)	279	28 (10.0%)	25 (9.0%)	226 (81.0%)	279
never	9 (10.6%)	8 (9.4%)	68 (80.0%)	85	5 (5.9%)	7 (8.2%)	73 (85.9%)	85

Thus there appears to be very little if any difference between filling the pump with insulin at room temperature rather than directly from the refrigerator. If anything, contrary to the stated belief of the majority, it seems that those who fill the pump with insulin directly from the refrigerator reported just slightly less problems with bubbles during filling and use.

ii. Injecting air into vial before drawing up insulin OR drawing up insulin without injecting air first?

	Have you injected air into vial?		Have you drawn up insulin without injecting air first?	
	Frequency	Percent	Frequency	Percent
always	565	76.7	19	2.6
often	77	10.4	11	1.5
sometimes	24	3.3	46	6.2
rarely	12	1.6	165	22.4
never	59	8.0	496	67.3
Total	737	100.0	737	100.0

Most pumpers consistently inject air into the insulin vial when filling the pump. So few consistently fill the pump without injecting air into the vial that it is difficult to draw conclusions about the benefits or otherwise.

Which technique is better?	Frequency	Percent
Injecting air	210	73.2%
No air	17	5.9%
same	60	20.9%
Total	287	100.0%

However of those 287 pumpers who have filled cartridges both with and without injecting air for the same pump, most (210, 73.2%) believed that it is better to inject air when filling the pump, and while some (60, 20.9%) thought it makes no difference, only very few (17, 5.9%) believed it is better not to inject air.

	Do you have any problems with air bubbles while filling the pump?				Do you have cause for concern about air bubbles in the tubing during use?			
Air fill	always or often	sometimes	occasionally or rarely	Total	always or often	sometimes	occasionally or rarely	Total
always	105 (18.6%)	70 (12.4%)	385 (68.1%)	565	40 (7.1%)	60 (10.6%)	458 (81.1%)	565
never	6 (10.2%)	5 (8.5%)	48 (81.4%)	59	2 (3.4%)	6 (10.2%)	51 (86.4%)	59

Again surprisingly, those few people who never inject air into the vial when filling the pump report fewer problems with air bubbles than those who always inject air into the vial.

iii. Do you fill the cartridge from an insulin penfill or from a vial?

	Have you filled cartridge from penfills?		Have you filled cartridge from vials?	
	Frequency	Percent	Frequency	Percent
always	15	2.0	473	64.2
often	3	0.4	38	5.2
sometimes	28	3.8	6	0.8
rarely	39	5.3	3	0.4
never	652	88.5	217	29.4
Total	737	100	737	100

A large majority always fill from vials, and rarely or never fill from penfills.

Which technique is better?	Frequency	Percent
penfill	11	13.4%
vial	52	63.4%
same	19	23.2%
Total	82	100.0%

Of the few pumpers who have used both vials and penfills, most (52, 63.4%) believe that filling from vials is better.

	Do you have any problems with air bubbles while filling the pump?				Do you have cause for concern about air bubbles in the tubing during use?			
From penfill	always or often	sometimes	occasionally or rarely	Total	always or often	sometimes	occasionally or rarely	Total
always	1 (6.7%)	1 (6.7%)	13 (86.7%)	15	1 (6.7%)	0 (0.0%)	14 (93.3%)	15
never	122 (18.9%)	79 (12.2%)	445 (68.9%)	646	57 (8.8%)	67 (10.4%)	523 (80.8%)	647
Total	134 (18.3%)	90 (12.3%)	507 (69.4%)	731	61 (8.4%)	76 (10.4%)	593 (81.2%)	730

From vial	Do you have any problems with air bubbles while filling the pump?				Do you have cause for concern about air bubbles in the tubing during use?			
	always or often	sometimes	occasionally or rarely	Total	always or often	sometimes	occasionally or rarely	Total
always	91 (19.4%)	65 (13.9%)	313 (66.7%)	469	38 (8.0%)	50 (10.6%)	381 (80.5%)	473
never	36 (16.7%)	16 (7.4%)	163 (75.8%)	215	20 (9.2%)	22 (10.1%)	174 (80.2%)	217
Total	134 (18.3%)	90 (12.3%)	507 (69.4%)	731	61 (8.3%)	76 (10.3%)	593 (80.5%)	737

Once again, despite the prevailing belief that it is better to fill the pump from an insulin vial than from a penfill, there appears to be a slight tendency for fewer bubbles when filling from a penfill.

iv. Do you fill the cartridge slowly or fast?

	Have you filled cartridge slowly?<		Have you filled cartridge fast?	
	Frequency	Percent	Frequency	Percent
always	300	40.7	10	1.4
often	202	27.4	31	4.2
sometimes	135	18.3	154	20.9
rarely	13	1.8	221	30.0
never	87	11.8	321	43.6
Total	737	100	737	100

Most people generally fill the cartridge slowly rather than fast.

Which technique is better?	Frequency	Percent
slow fill	323	80.3
fast fill	21	5.2
same	58	14.4
Total	402	100

Of those who have tried both slow and fast fill, a large majority believe that filling the cartridge slowly is better.

slowfill	Do you have any problems with air bubbles while filling the pump?				Do you have cause for concern about air bubbles in the tubing during use?			
	always or often	sometimes	occasionally or rarely	total	always or often	sometimes	occasionally or rarely	total
always	59 (19.9%)	40 (13.5%)	198 (66.7%)	297	29 (9.8%)	30 (10.1%)	237 (80.1%)	296
never	8 (9.3%)	6 (7.0%)	72 (83.7%)	86	9 (10.3%)	3 (3.4%)	75 (86.2%)	87
total	134 (18.3%)	90 (12.3%)	507 (69.4%)	731	61 (8.4%)	76 (10.4%)	593 (81.2%)	730

fastfill	Do you have any problems with air bubbles while filling the pump?				Do you have cause for concern about air bubbles in the tubing during use?			
	always or often	sometimes	occasionally or rarely	total	always or often	sometimes	occasionally or rarely	total
always	1 (10.0%)	0 (0.0%)	9 (90.0%)	10	0 (0.0%)	0 (0.0%)	10 (100.0%)	10
never	62 (19.6%)	36 (11.4%)	219 (69.1%)	317	38 (12.0%)	23 (7.3%)	256 (80.8%)	317
All	134 (18.3%)	90 (12.3%)	507 (69.4%)	731	61 (8.4%)	76 (10.4%)	593 (81.2%)	730

While these tables indicate that, contrary to prevailing belief, filling the cartridge fast might give rise to somewhat fewer bubble problems than filling slowly, there are so few pumpers who fill the cartridge fast that this data doesn't enable one to draw conclusions about this.

v. Do you fill cartridge in advance, and leaving it standing in or out of refrigerator for hours before connecting to pump OR connect cartridge immediately?

	Have you left cartridge standing?		Have you connected cartridge immediately?	
	Frequency	Percent	Frequency	Percent
always	46	6.2	349	47.4
often	57	7.7	106	14.4
sometimes	85	11.5	68	9.2
rarely	85	11.5	57	7.7
never	464	63.0	157	21.3
Total	737	100	737	100

Most people generally connect the cartridge immediately and don't leave it standing first for bubbles to rise and be eliminated.

Which technique is better?	Frequency	Percent
leaving cartridge standing	84	39.8
immediate filling	30	14.2
same	97	46.0
Total	211	100

Of those people who have tried leaving the cartridge standing as well as immediate filling, more (84, almost 40%) believed that leaving the cartridge standing is better, with only 30, 14%) claiming that immediate filling is preferable, while many (97, 46%) thought it makes no difference.

Advance fill	Do you have any problems with air bubbles while filling the pump?				Do you have cause for concern about air bubbles in the tubing during use?			
	always or often	sometimes	occasionally or rarely	Total	always or often	sometimes	occasionally or rarely	Total
always	12 (26.1%)	4 (8.7%)	30 (65.2%)	46	4 (8.7%)	6 (13.0%)	36 (78.3%)	46
never	70 (15.2%)	53 (11.5%)	337 (73.3%)	460	36 (7.8%)	48 (10.4%)	376 (81.7%)	460
All	134 (18.3%)	90 (12.3%)	507 (69.4%)	731	61 (8.4%)	76 (10.4%)	593 (81.2%)	730

Immediate fill	Do you have any problems with air bubbles while filling the pump?				Do you have cause for concern about air bubbles in the tubing during use?			
	always or often	sometimes	occasionally or rarely	Total	always or often	sometimes	occasionally or rarely	Total
always	60 (17.3%)	38 (11.0%)	248 (71.7%)	346	28 (8.1%)	37 (10.7%)	280 (81.2%)	345
never	15 (9.6%)	18 (11.5%)	123 (78.8%)	156	9 (5.7%)	12 (7.6%)	136 (86.6%)	157
All	134 (18.3%)	90 (12.3%)	507 (69.4%)	731	61 (8.4%)	76 (10.4%)	593 (81.2%)	730

There appears to be no significant difference between the level of bubble problems experienced by those who leave the cartridge standing as compared to those who use it immediately after filling.

vi. Priming standard amount for infusion set OR priming generously?

	Have you given a standard prime?		Have you given a generous prime?	
	Frequency	Percent	Frequency	Percent
always	366	49.7	102	13.8
often	104	14.1	69	9.4
sometimes	63	8.5	91	12.3
rarely	55	7.5	103	14.0
never	149	20.2	372	50.5
Total	737	100	737	100

Most people generally do a standard prime rather than priming extra insulin in a 'generous' prime.

Which technique is better?	Frequency	Percent
standard prime	32	12.1
generous prime	142	53.6
same	91	34.3
Total	265	100

Of the 265 people who have tried both standard and generous prime, most (142, 54%) believe that the generous prime gives rise to fewer problems with bubbles.

	Do you have any problems with air bubbles while filling the pump?				Do you have cause for concern about air bubbles in the tubing during use?			
Standard prime	always or often	sometimes	occasionally or rarely	Total	always or often	sometimes	occasionally or rarely	Total
always	68 (18.8%)	44 (12.2%)	250 (69.1%)	362	32 (8.8%)	33 (9.1%)	297 (82.0%)	362
never	26 (17.6%)	18 (12.2%)	104 (70.3%)	148	13 (8.7%)	13 (8.7%)	123 (82.6%)	149
All	134 (18.3%)	90 (12.3%)	507 (69.4%)	731	61 (8.4%)	76 (10.4%)	593 (81.2%)	730

	Do you have any problems with air bubbles while filling the pump?				Do you have cause for concern about air bubbles in the tubing during use?			
Generous prime	always or often	sometimes	occasionally or rarely	Total	always or often	sometimes	occasionally or rarely	Total
always	26 (25.7%)	14 (13.9%)	61 (60.4%)	101	13 (12.7%)	11 (10.8%)	78 (76.5%)	102
never	64 (17.4%)	45 (12.2%)	259 (70.4%)	368	27 (7.3%)	31 (8.4%)	310 (84.2%)	368
All	134 (18.3%)	90 (12.3%)	507 (69.4%)	731	61 (8.4%)	76 (10.4%)	593 (81.2%)	730

There appears to be no significant difference between the level of bubble problems experienced by those who do a standard prime as compared to those who prime generously.

vii. Wearing pump with cartridge facing up OR with cartridge facing down (cartridge vertical with connection from cartridge to tubing down, so bubbles rise and don't enter tubing) OR sideways (cartridge horizontal) OR just anyhow without attention to direction

	Have you worn pump facing up?		Have you worn pump facing down?		Have you worn pump sideways?		Have you worn pump just anyhow?	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
always	202	27.4	37	5.0	67	9.1	116	15.7
often	121	16.4	26	3.5	96	13.0	42	5.7
sometimes	164	22.3	117	15.9	167	22.7	126	17.1
rarely	37	5.0	79	10.7	88	11.9	67	9.1
never	213	28.9	478	64.9	319	43.3	386	52.4
Total	737	100	737	100	737	100	737	100

Not many people consistently wear the pump facing in one particular orientation, and there is no evidence that any particular orientation results in fewer problems with bubbles either when filling the pump or during use.

Other issues:

Vision: there is no consistent evidence that vision has a significant impact on bubble problems, though it should be born in mind that relatively few people with poor vision filled in the questionnaire – perhaps not surprising.

Age also seems to have no bearing on incidence of bubbles either during filling or in use.

Summary

In this survey investigating factors that might influence the incidence of problems with air bubbles when filling insulin pumps and during pump use, the only factors which appeared to be important were the model of pump and the daily insulin dose.

Some pumps did appear to be associated with more problems with bubbles both when filling the cartridge and during pump use. While most of the 'worst' pumps from this point of view were older pumps no longer being supplied, one or two current pumps are included. It might be worth checking these findings on a larger number of subjects and investigating the design issues that contribute to this problem.

In addition pumpers using a larger daily insulin dose experience fewer problems with bubbles. Reasons for this might include the following: (i) that pumpers who use large amounts of insulin have more practice filling pumps since they have to do so very often, (ii) given the current advice to change the cartridge with every infusion set change, it could be that people who use smaller amounts of insulin do not fill their cartridges to their full capacity, and that in this situation air bubbles are more likely, (iii) perhaps the relatively small amounts of insulin missed due to the presence of some air bubbles might be less significant relative to large amounts used, so that those who use large amounts of insulin may be less likely to investigate and recognize bubble problems. These issues require further investigation. While total daily dose depends on the individual's insulin requirements, if injecting larger volumes were found to significantly reduce problems with bubbles, one might consider the benefits for those who use smaller insulin doses to fill the pump with diluted insulin (currently not so widely available however), thus increasing the volume though not the dose of insulin used.

There is no evidence that any of the various 'tricks' (temperature of insulin, injecting air into vial, filling cartridge from penfills, filling cartridge slowly, filling cartridge in advance, and leaving it standing before connecting to pump, priming generously, wearing pump in a specific orientation) which many pumpers swear by impact consistently or significantly on the incidence of bubbles.