The accepted wisdom is that the greater the syringe size, the lower the pressure generated (Fearon, 2000), although this goes against an earlier belief that small syringes should be used in babies to avoid injuring them.

Indeed, a circular on implementing National Patient Safety Agency advice in Northern Ireland stated: ‘Smaller (less than 50ml) oral/enteral syringes exert a higher pressure, which can split the feeding tube’ (Northern Ireland Medicines Governance Team, 2007).

This circular followed the NPSA’s (2007) alert on safer measurement and administration of liquid medicines via oral and other enteral routes. It also built on the recommendations made by the NPSA (2005) in the guidelines for checking safe positioning of NG tubes.

The NPSA recommended using 50ml syringes in adults for aspiration and feeding, and 20ml or 50ml syringes for children. This seemed illogical, as the use of smaller syringes ought surely to be safer in larger patients. These recommendations remain unchanged.

The vacuum pressure created by larger syringes could cause trauma to the stomach if the lining were in contact with the tube tip. Potentially, positive pressure could erode the lining if fluid were to ‘jet’ on to delicate tissues. While there has been a huge impetus to ensure safety in this area of nursing, there is a lack of credible research. It is worrying that nursing still relies on what may well not be ‘best practice’ (Reising and Neal, 2005).

AIM

We aimed to provide evidence to support the use of appropriate syringes. This would mean care could be provided from an evidence base, rather than by following custom and practices.

LITERATURE REVIEW

We carried out a literature search on CINAHL, Medline and Google, covering the last 20 years, using the following terms: nasogastric tube; problems; paediatric; pediatric; children; syringe sizes. We found no research to support the ideas above. However, some articles clearly expressed that view (Reising and Neal, 2005; Cannaby et al, 2002).

Reising and Neal (2005) said: ‘Both Guenter and Lord, two experts in the field who associate tube rupture with syringe size, say a syringe of 30ml or greater is needed to prevent rupture; other experts come to the same conclusion. Two textbooks also support this premise. Although Lilly and Aucker recommend a 10–20ml syringe for flushing small-bore tubes, these smaller syringe sizes are believed to cause tube rupture because they generate considerable pressure. ‘We found no research on appropriate syringe size for flushing; the only recommendations we found were from sources that weren’t research-based.’

However, having stated this, Reising and Neal then recommended a minimum syringe size of 30ml.
We were surprised to read the literature postulating this, as it contradicts earlier teaching and is generally unsupported by credible data. We believe many articles make statements that are not supported by factual information. This suggests nursing is being practised without a reliable (or indeed any) evidence base.

It is important to question tenets that cannot be proven to advance care and safety, and we felt it was appropriate to investigate whether syringe size was a significant factor in pressure generation. We noted when emptying syringes that larger ones could be expelled far more forcefully so the pressure generated might be greater. This study aims to provide evidence to promote an informed debate and to enhance patient safety.

**METHOD**

The method used was simple. The same testers consistently applied the method for all types of syringes using the same equipment:
- Druck DPI 705 manometer (digital electronic);
- Penta female luer enteral feeding syringe (50ml);
- Medicina female luer enteral feeding syringes (10ml, 5ml, 2.5ml);
- Size 8ch feeding tube (Unomedical);
- Size 8ch Corflo (Merck Serono);
- Medicina enteral male adapter to allow connection of female luer syringes to the feeding tubes.

The manometer was calibrated to zero and set up with a connection to the syringes via the adapter. Measurements were recorded in mmHg for negative and positive pressures.

The setup was then modified by inserting an NG tube into the circuit – we wanted to ascertain the effect of a 40cm fine (8ch) bore tube or a 60cm fine (8ch) bore Corflo tube in diminishing or exacerbating pressures.

The experiment was repeated with the NG tube in place to allow for measurement of a number of pressures. Those recorded were:
- Aspiration to full volume of syringe (from zero) both with and without an NG tube;
- Aspiration to 2ml (from zero) both with and without an NG tube;
- Injection of 2ml of water by hand over 30 seconds.

To ensure reliability, we used the same syringe for tests on both tubes – and used only one tube of each type. Both researchers observed the test. The most extreme of three readings of each test are reported, since it is the extremes that might cause problems.

In 2005, we undertook similar work using Terumo syringes and syringe pumps. In 2007, the NPSA stipulated that IV syringes were to be replaced by enteral syringes. The earlier research will be used to indicate safety issues in long-line drug administration and we do not consider we can use it as proof of enteral syringe safety. We did note, however, that the IV syringe findings were very similar to those for enteral syringes and we feel this indicates that researcher bias was not a factor as there were close correlations in each study.

We replicated the original work in 2008 using enteral feeding syringes to ensure the experiment was NPSA compliant. All feeding tubes and syringes used in this study complied with the NPSA’s (2007) alert.

**RESULTS**

Table 1 outlines the results. Interestingly, the largest syringe created the highest negative pressures in nearly all situations – and, where it did not, there was a negligible difference. The pressure was greatest when aspirating syringes to their full volume – although clinically there is no indication for doing so.

The crucial test was comparing the aspiration of 2ml as this is the sort of aspiration needed to draw fluid for pH testing. Here, the largest syringe still gave a higher negative pressure via an NG tube of either type – although it was not considered to be significantly different. When the NG tube was used, there was a significant drop in negative pressure in all syringes, and they were all remarkably similar.

We considered that this mediating effect was due to Poiseuille’s law (resistance to flow rises through increasing the length and decreasing the radius of a tube) so if a longer and finer tube were used, the effect would be even greater. This is borne out by the results for the longer Corflo (Merck Serono) NG tube.

These figures appear to contradict the modern ethos that one should ‘attach a 50ml syringe to the end of the tube (the bigger the syringe, the lower the suction pressure), unless contraindicated by manufacturer’s instructions’ (Fearon, 2000, cited in NHS Quality Improvement Scotland, 2007).

**DISCUSSION**

Here, we analyse the findings scientifically and apply them to clinical practice.

For aspiration, the concept of vacuum is considered. This is based around the theorem of expansion.

Pressure is almost always measured relative to...
atmospheric pressure (1 atm = 1 bar = 14.5psi = 760mmHg) – this point is defined as zero. Vacuums can be measured with the starting point as being true zero, so everything from zero to 760mmHg is a total or partial vacuum compared with atmospheric pressure, or as a negative value starting at a hypothetical atmospheric pressure of 0mmHg going to an absolute vacuum of ~760mmHg. The following example uses absolute values.

Each syringe has some air or fluid in the luer connection at the tip but nowhere else if the plunger is fully home. The volume of this is identical for any size of syringe of the same brand.

By aspirating the plunger to its full marked volume from a fully depressed position, a vacuum is formed by pulling this dead space into either 20ml or 2.5ml. Using Boyle’s Law (P1V1 = P2V2) with P1 being atmospheric pressure (760mmHg), V1 the volume of the luer (0.05ml) and V2 the final volume of the syringe, P1 is found to be 1.99mmHg.

Using figures of absolute pressure below 760mmHg, the lower the P1 number, the greater the vacuum; the 20ml syringe generates a vacuum eight times greater than the 2.5ml.

The inescapable conclusion is that a smaller syringe will minimise vacuum trauma and reduce the risk of gastric suction biopsy.

The corollary is that if one is feeding the opposite will be true and that the best syringe to use is of a larger size. However, we explain why the science is flawed and does not account for real-life variability.

The general rule is to use the largest syringe possible for administration, as it is less likely to result in a harmful high pressure. This is almost entirely related to the diameter of the plunger; the larger the diameter, the more the pressure is spread over a bigger surface area.

There is a difference in plunger diameters of 2.5ml and 20ml Penta syringes. The 2.5ml plunger has a diameter of 8.8mm and the 20ml plunger 19mm. Converting this to area (πr²), the 2.5ml plunger has an area of 60.8mm² and the 20ml of 283.6mm². If a weight equivalent to 1kg was placed on each plunger, the 2.5ml syringe would generate a force of 1.63 bar (1,225mmHg or 23.7psi) but the 20ml would generate only 0.35 bar (258mmHg or 5psi).

However, applying this blunt fact to practice is misleading and causes trusts to waste money on expensive and oversized syringes.

First, the application of 1kg of pressure will lead to a much swifter expulsion of fluid from the smaller syringe. For patient comfort, it is best to feed a child no faster than they might feed orally (for example, 30 minutes for a full maintenance feed to a six-month-old), so the force generated will be much less than in the example. Indeed, if gravity is used to drain the fluid, there is no problem linked to force.

Second, the theory does not allow for the fact that NG tube length and diameter – to a great extent – dissipate the effects of the force applied.

Third, we are looking at the rate of administration in clinical practice, not the force applied. Using this more patient-focused basis, the evidence was unequivocal. Injecting 2ml of water slowly over 30 seconds generated the following pressures:

- 50ml syringe = 15.6mmHg (40cm tube) or 7.5mmHg (60cm Corflo tube);
- 10ml syringe = 11.3mmHg (40cm tube) or 5.7mmHg (60cm Corflo tube);
- 5ml syringe = 11.6mmHg (40cm tube) or 3.4mmHg (60cm Corflo tube);
- 2.5ml syringe = 9.1mmHg (40cm tube) or 2.9mmHg (60cm Corflo tube).

Given this, there seems to be no benefit to trusts, nurses or patients from using a larger syringe. The only beneficiary will be the syringe manufacturer.

Granted that gravity feeding is by far the safest form as it prevents pressure rises, there can be no real reason to continue to follow the guidelines, which might be considered flawed.

Another reason cited for using large syringes is that tubes may rupture (the manufacturer says Corflo tubes burst at 80psi). Given that car tyre pressure is generally less than 40psi, this rationale may be dubious. Can a 2ml syringe really generate twice the pressure of an inflated tyre? The pressure generated by injection was (at its zenith) 15.6mmHg or 3.1psi.

**Limitations**

There are variables in people for which a laboratory experiment cannot account. These include:

- Patient activity;
- Gastric distensibility;
- Associated pathology such as ileus;
- Different sizes of tubes will cause altered findings (as shown);
- Water was used to avoid damaging the manometer but different fluids have different viscosities. When other fluids are used, the back pressure (that at the plunger end) may still rise, although pressure at the tip may fall;
- Further study might show pressures vary depending on tube length and bore.

**CONCLUSION**

There is no substance to support current practice – the opposite is true. Current practice is unsafe as it gives the opposite effect to that claimed by its supporters.

There is an urgent need to replicate this research using different types of NG tube with a wider variety of lengths and bores. Once this has been done, safety agencies might wish to revise their guidance on ‘best practice’.

As the pressures exerted by different syringe sizes when aspirating or giving feeds showed very small differences between syringes, we suggest that cost may be the overriding factor once an appropriate size has been selected – subject to ratification of this work.

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**REFERENCES**


