Lesson of the Week

Dangers of adding insulin to intravenous infusion bags with fixed needle syringes

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Difficulties have been experienced in adding insulin (U100) from single use syringes with fixed needles to infusion bags. Difficulties have included resistance to injection, rupture of the rubber seal of the injection port, and failure of intravenous insulin infusion to control diabetes postoperatively despite the following of recommendations for infusion.¹ I investigated the hypothesis that insulin is in fact often retained in the injection port dead space of the infusion bag. Port dead space was defined as the volume of solution retained between the rubber seal of the injection port externally and the plastic seal separating the port space from the infusion fluid (figs 1 and 2 (top)). The hypothesis was tested using a procedure that closely paralleled the one followed in normal practice.

FIG 1—Infusion bag with arrow indicating dye hidden in inconspicuous space of injection port.

Treatment with intravenous insulin may fail because, the needle injecting insulin into the infusion bag often being shorter than the injection port dead space, the insulin never reaches the infusion fluid

Method

Thirty bags of dextrose 10% infusion fluid 0.5 l were ordered direct from the manufacturer and used in order from the boxes. Thirty single use insulin syringes, volume 100 units, with prefixed needles were taken as needed, in succession, from a box in the ward. (There are two types of fixed needle syringe in common use, both of which have an average needle length of 12.7 mm.) These, both made by Becton Dickinson and Co, with microfine needle

FIG 2—Diagram of what occurs when length of needle is equal to or greater than that of port dead space, showing how insulin may be injected into port dead space and remain unavailable to patient. (Top) Tip of needle punctures inner plastic seal without allowing insulin to be injected into infusion fluid; either all is hidden in port dead space or seal ruptures. (Centre) Orifice of needle passes inner seal permitting injection into infusion fluid (but injection into port dead space is still possible before or after penetration). (Bottom) Needle causes only micropuncture of seal and insulin is injected into port dead space on withdrawal of needle. (Addition to fluid will occur only if pressure of port dead space exceeds hydrostatic pressure of infusion fluid at point of micropuncture.)

11, are the Plastipack syringe (size 1 ml or 100 units) and the LO Dose syringe (0.5 ml or 50 units). The average needle length in this experiment was 13 mm (manufacturers' average 12.7 mm).

The equivalent of 20 units of blue dye, free of bubbles, was injected into the port of each bag until a definite resistance to injection was felt and the reading on the syringe (x) noted. The volume of the port dead space was the 20 units minus x. A separate fixed needle syringe was used for each infusion bag.

An attempt was then made to penetrate the inner plastic seal; the dye mixing with the infusion fluid denoted success. Puncturing the seal was graded as: easy (achieved at the first attempt, although in all cases it was necessary to insert the full length of the needle into the port); difficult (achieved at the second or third attempt); or unsuccessful (shown by all the injected dye remaining in the port dead space). The length of the port dead space was measured with a 0.5 mm steel measuring rule. (The collar on the port was not reliably related to the position of the inner seal.) The length of the needle was also measured.

The bags were examined again three days after injection to assess whether dye in the port had mixed with the infusion fluid. There was no change in appearance of port or infusion fluid. All procedures were carried out in good light and with attention to detail.

Results

Figure 3 shows the lengths of the 30 needles and the lengths and volumes of the port dead spaces of the 30 infusion bags. Comparison of the ratio of needle length to port dead space length for each syringe and bag used together clearly showed that there were instances when an unexpected outcome resulted. In one case a relatively long needle failed to puncture the inner seal, possibly because of obliquity of injection. In three cases no puncture was achieved, although the needles were theoretically just long enough to have punctured the seal. In five cases the inner seal was punctured but should not have been. I think this reflects the force and unbiased determination applied during the experiment.

The table shows that 16 out of 30 ports were not successfully breached by their paired needles and that the external seal ruptured in four of the

FIG 3—Distribution of variables of needle length (range 13.5-13.2 mm) (—●—●—), port dead space length (range 11-15 mm) (---○---), and port dead space volume (—●—●—) in 30 syringes and 30 infusion bags.

Incidence of grades of ease of penetration of seal of infusion bag, staining of infusion fluid, and rupture of seal occurring during addition of insulin to 30 intravenous infusion bags

	No of cases in which penetration was:			Total No of cases (n=30)
	Unsuccessful	Difficult	Easy	
Possible outcome:				
Rupture of injection port seal	4	1	3	8
All or most of insulin hidden in dead space	12	4		16
Effective addition			6	6
Appearance:				
No stain	16			16
Minimal to moderate staining		5		5
Moderate to good staining			9	9

remainder. That is 20 out of thirty attempts to add insulin to infusion fluid failed completely.

The three outcomes possible after injection were:

(1) rupture of seal and loss of injection fluid; (2) loss of all or most of the injection fluid in the port dead space; or (3) successful, easy penetration of the inner seal, with an appreciable addition of insulin to the infusion fluid provided the needle canal remained beyond the inner seal during injection (table). For example, if the dead space volume were 12 units and if 10 units of insulin were injected with a needle shorter than the length of the dead space either the port pressure would break the seal and the injection fluid be lost or the insulin would be injected into the port dead space and remain unavailable to the patient.

Discussion

Dead space in syringes has been described previously² and is equivalent to five units in the new BS1619 glass U100 syringe but to only 1.1 units in the 1 ml plastic single use syringe. Here I have described the dangers attached to the injection port dead space of the infusion bag, which has been found to vary from eight to 18 units. My findings show that insulin can be injected with syringes with prefixed needles into the port dead space of an infusion bag without any entering the infusion fluid (fig 1), the whole dose therefore remaining unavailable to the patient.

The major fault in introduction is that the needle is shorter than the dead space, thus preventing penetration of the inner seal (fig 4).

FIG 4—Comparison of length of needle and of port dead space, showing how insulin can be injected into port dead space and remain unavailable to patient.

A second fault occurs when the dead space is filled before perforation of the inner seal (on entering the port), or after perforation of the seal (on withdrawal), as figure 2 (bottom) shows. A volume of insulin approaching that of the dead space will thus remain unavailable to the patient. In the present study, when this occurred the dye remained in the port dead space and tended not to mix with the infusion fluid.

Volume of the syringe (units added) essentially does not alter the effectiveness of addition but, if increased, would directly affect only the proportion of seals ruptured. This is because a change in volume added would have no effect on the principal fault of the needle often being shorter than port dead space. Penetration of insulin to the infusion fluid does not occur regularly; consequently insulin may be withheld from the patient. I believe that this is a more important cause of apparent resistance to treatment than the rare antibody mediated true insulin resistance³ and that this would explain why diabetes in some patients in hospital is difficult to control.

RECOMMENDATIONS

When adding insulin to infusion bags:

- (1) Do not use syringes with short fixed needles.
- (2) Use the common, 25 mm length, 23G 1 blue disposable needle with the new, single use, needleless U100 syringes (1 ml Gillette (Gillette UK Ltd) or 1 ml Steriseal (Needle Industries (Medical) and 1 ml Terumo (Rand Rocket)).
- (3) At the same time be alert to seal leakage.
- (4) Visually check that the needle has penetrated the inner seal before injecting the insulin.
- (5) Insulin successfully injected will cause a disturbance in the infusion fluid. Visually check that this occurs.
- (6) Keep the needle in position, with canal open to infusion fluid, until the injection is complete.

(7) Check that fluid can be injected and withdrawn through the same needle.

The hazard of the injection port dead space has been reported to the Drug Information Centre, the Pharmaceutical Society of Great Britain, and the medical assessor at the Committee on the Safety of Medicines.

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References

- 1 Watkins P. *ABC of diabetes*. London: British Medical Association, 1983.
- 2 Hall GH, Thompson CJ, Palmer A. Danger of dead space in U100 insulin syringes. *Br Med J* 1984;288:284-5.
- 3 Watkins PJ. Choice of insulin. *Br Med J* 1983;287:1571-2.

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Is dry ginger of value in preventing travel sickness?

Does "dry ginger" refer to dried ginger rhizome or to dry ginger ale? I presume that the question arises from the recent report by Mowrey and Clayton¹ claiming that powdered ginger rhizome is superior to dimenhydrinate and placebo in preventing the gastrointestinal symptoms of motion sickness. Whether or not dry ginger ale is effective is not known. Certainly it is flavoured with a ginger extract; the active ingredient may or may not be present in that extract, since the flavour concentrates used by the soft drinks industry are manufactured and formulated so as to be wholly soluble in the finished product—most of the aromatic and pungent constituents of ginger rhizome are not particularly soluble in carbonated water and hence are deliberately eliminated from the flavour concentrate before its use in the manufacture of the finished soft drink. The plant material used by Mowrey and Clayton was not authenticated; the manner in which it was processed before administration was not described; the quantity administered is not clear ("... two gelatin capsules (940 mg) of the powdered rhizome ..."). It is therefore impossible to state how much dry ginger ale is likely to contain an equivalent quantity of ginger to that used in the clinical study. Having said that, there is a good case for the tentative recommendation of ginger ale for the patient with a pioneering attitude who wishes to avoid the sedating properties of the usual treatments. Further research is needed, however, before its clinical use can be justified.—RICHARD J SCHMIDT, lecturer in pharmacognosy, Cardiff.

¹ Mowrey DB, Clayton DE. Motion sickness, ginger, and psychophysics. *Lancet* 1982;i:655-7.

A young healthy man suffers static electric shocks, which have taken the form of a blue flash between the hand and a metal handle with an audible crack and an unpleasant shock. Other members in his office are not affected. Is there any way of preventing this phenomenon?

Three factors in modern living have combined to make this phenomenon more common. Some air conditioning systems stop, or reduce, humidification when the outside temperature falls so that the warmed air inside the building develops a low relative humidity. Large open plan offices and long hotel corridors allow people to walk relatively long distances before touching anything. Carpets made of man made fibre are increasingly used. Walking for about 20 or 30 seconds across a very dry carpet of man made fibre, or even wool, may generate voltages of 2000 or more. As the electrical capacity of the body is low—about 200 pF—the energy stored is small, although sufficient to cause a shock or spark. People differ by a factor of about 2 in their threshold of sensation for such shocks.¹ Once the mechanism is understood, the solutions are seen to be by control of the indoor environment rather than in medical measures. Suggestions would include raising the humidity (large leaved plants have more than decorative value), experimenting with different types of footwear, touching other objects on the way (before voltage builds up), and approaching the metal handle with a firmly held metal pen, pencil, or paper clip (the discharge energy is spread over a wider

surface area of the skin and not concentrated at the point of a spark). It may be possible to increase the conductivity of some carpets.—W R LEE, professor of occupational health, Manchester.

¹ Lee WR. Little shocks. *The Practitioner* 1981;225:1674-83.

What is the prognosis for a 35 year old woman who has had a renal transplant?

Survival of patients being treated for end stage renal failure has been carefully monitored by the registry of the European Dialysis and Transplantation Association. The latest report has been based on data obtained on nearly 40 000 kidney transplants performed in 32 countries. The proportion of patients aged 35-44 who survived one, two, and three years respectively was 91%, 84%, and 78%.¹ Diabetics have been analysed separately since their prognosis is worse, the proportion surviving at the three time points being 73%, 56%, and 47%. Lupus erythematosus has been a rarer cause of renal failure, with only 18 patients a year being accepted for treatment for renal failure.² An analysis of 120 patients transplanted within Europe before 1982 has shown that patients with systemic lupus erythematosus fare worse, with 65% surviving two years.³ Since the numbers of patients were comparatively small, a long term prognosis cannot be given.—J R SALMON, director, renal transplant unit, Cardiff.

¹ Wing AJ, Broyer M, Brunner FP, et al. Combined report on regular dialysis and transplantation in Europe. XIII 1982. *Proc Eur Dial Transplant Assoc* 1983;20:5-71.

² UK Transplant Service Review 1982. Bristol: UK Transplant Service, 1982.

³ Kramer P, Broyer M, Brunner FP, et al. Combined report on regular dialysis and transplantation in Europe. XII 1981. *Proc Eur Dial Transplant Assoc* 1982;19:4-60.

Is there any point giving a healthy infant taking a normal diet cod liver oil supplement?

All proprietary baby milks and most infant foods are supplemented with vitamin D and the breast fed baby receives an adequate supply of vitamins. Healthy, well fed white infants born at term, therefore, do not need extra vitamin D. All premature babies and all dark skinned babies should be given a vitamin supplement in the form of children's vitamin drops or their equivalent. The Department of Health and Social Security's recommendations on this subject are indecisive. The 1980 report contains the following statements: "It seems a wise public health measure to ensure the availability of cheap vitamin supplements and to recommend their general use" and "It is unnecessary to advise the use of vitamin supplements when there is no doubt that an individual infant is already receiving an adequate intake."¹ Children whose families originate on the Indian sub-continent should probably be given a vitamin supplement throughout childhood.—D P ADDY, consultant paediatrician, Birmingham.

¹ Department of Health and Social Security. *Present day practice in infant feeding: 1980*. Report of a working party of the panel on child nutrition, committee on medical aspects of food policy. (Report on health and social subjects No 20.) London: DHSS, 1980.