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Investigation into the effectiveness of filters for use by intravenous drug users

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Abstract

Injecting drug users are at risk of and can suffer from serious health problems due to intravenous administration of insoluble particles from street drugs and tablets. Makeshift filters are used to try to remove particles from the injections. The decision to distribute filters from Harm Reduction Centres cannot be based on evidence of efficacy and safety as no such published data exists. The work presented here is part of a larger study which anticipates to provide such evidence. Laboratory methods were developed based on information gathered from drug users. Injections were prepared using drugs of abuse and filtered either through makeshift or commercially available filters. The resulting solutions were assayed for particle size and number (using Coulter Counter®). Comparisons were made with unfiltered injections. The results presented here are from the first part of this study, which investigated the effectiveness of various filters on reducing particulate count and size range of injections made from tablets. The commercially produced filter (Acrodisk®) showed a much greater reduction in particle number and size. This strongly suggests the risks to health could be reduced by the use of such filters. Of the makeshift filters, the Rizla® acetate filter showed the most satisfactory reduction in the number of particles, suggesting their use may be preferable to the currently popular cigarette filter. The ongoing work is looking at the effect of the filtration methods on amount of drug in injections made from tablets and repeating the work using street heroin.

Keywords: Filters; Intravenous; Drug users

1. Introduction

Public health and health care policies increasingly have to be evidence based. Harm reduction is one area where there is difficulty in making

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some practice evidence based, purely because the only evidence available is anecdotal and not research based (Paxton, 1998). One such example is the provision of injecting paraphernalia. In the UK it is an offence under section 9A of the Misuse of drugs Act (1971) to supply any article believing it to be used or adapted for use to administer a controlled drug except clean needles and syringes. This applies to swabs, citric acid, filters etc. At the 1997 UK Association of Chief Police Officers conference this matter was debated and a firm recommendation made that the law be changed to permit supply of such paraphernalia from recognised agencies including pharmacies (Wray, 1997). The high prevalence of hepatitis C and the link of transmission through sharing filters, water, swabs etc. makes such a change in the law not only very welcome but vital for harm reduction. If such a change in the law does occur, we will then be faced with the decision of what kinds of equipment to supply. Even with no change in the law, evidence of effectiveness is necessary to provide drug users with accurate information. One such example is the use of filters to remove insoluble materials from injections. Intravenous (IV) drug use carries many risks of harm and associated medical complications. Direct access to the vascular system and administration of drugs which are not prepared to pharmaceutical standards for injection (such as street drugs and tablets) are related to some medical problems. Insoluble particles are often present in amounts far higher than those that are considered to be safe in pharmaceutically manufactured injections. Both the size of the particles and the number present in injections are important. In the microcirculation of the body the smallest vessels are the capillaries, which are ≈ 8 μm in diameter. Next are the terminal arterioles which are between 20 and 50 μm. The more particles there are and the bigger they are, the greater the risk to health. Consequently, there are limits placed on the particulate content of commercially made injectables. The British Pharmacoepia (B.P) stipulates that for large volume parenterals (fluids for IV administration, > 100 ml), there should be no more than 1000 particles per ml over 2 μm and of these no more than 100 per ml should be over 5 μm (British Pharmacoepia, 1993). There is no limit given in the B.P for small volume parenterals. Obviously, the injections prepared by IDUs will contain greater numbers of particles than those made commercially because of the presence of insoluble adulterants in street drugs and diluents in tablets that are crushed up to make injections. Also the IDU is not preparing injections in an aseptic environment, unlike pharmaceutical industry formulated injections.

Examples of the problems caused by insoluble particles include: phlebitis, abscesses, blocked blood vessels (which can lead to deep vein thrombosis, varicose ulcers and gangrene) and endocarditis. (The latter is more commonly due to bacterial seeding from infected wounds but can be caused by the build up of insoluble adulterants and diluents behind the valves in the heart leading to irritation). (Posner and Guill, 1985, Haverkos and Lange, 1990, Stein, 1990, ANSWER, 1996, Scott and Bruce, 1997). There is a belief amongst some drug users that certain materials are better to be used as filters than others. It is also believed that filtering certain drugs reduces the concentration of drug in the injection, resulting in the loss of the hit.

The definition of an effective filter, devised for the purpose of this study, is as follows: For an IDU's filter to be effective it must reduce the particulate content of the injection to a level that presents a lower risk of harm. It must be acceptable to the user, so must not remove the drug and has to be quick and easy to use. It is the first part of this statement which is being investigated in the work presented here. The overall aim of this study is to provide evidence from the laboratory and liaison with drug users to investigate the effectiveness and predicted safety of filters. If such evidence can be produced its use will be two-fold: to support bids for funding from needle exchanges to enable the distribution of suitable filters and the creation of harm reduction information for IDUs to advise on effective filtering methods.

2. Method

Semi structured interviews were carried out with twenty current or ex-IDUs to explore the drugs that are used by injection and the methods used to prepare injections. From this, the most commonly used drugs by the IV route were established. For financial reasons and constraints on time, it was decided to investigate three pharmaceuticals and one street drug, the most popular drugs being selected for investigation. From the interview data, it was established that heroin was the most commonly used 'street drug' by the IV route. Several pharmaceuticals were also stated as being injected. Data on the use if these were compared with national statistics (Drug Misuse Statistics Scotland, 1996). From this the three pharmaceuticals chosen for investigation; these were Physeptone tablets, Temgesic tablets and Diconal tablets. Use of the latter appears to vary greatly between region, but because of the continuing popularity in some Scottish areas and many beliefs amongst IDUs which warn against filtering of Diconal, it was decided to select this drug for investigation.

It became clear that the method of preparation used by each IDU for heroin was similar, but the preparation method used for tablets varied. Safer Injecting Guidelines published for IDUs were therefore also consulted to assist in establishing the preparation method (Exeter Drugs Project, HIT, 1995).

The type and quantity of tablets used were as follows: Physeptone® (methadone 5 mg, Glaxo Wellcome) nine tablets in 5 ml of water; Diconal® (dipipanone 10 mg and cyclizine 30 mg, Glaxo Wellcome) two tablets in 2 ml of water; Temgesic® (buprenorphine 0.2 mg, Reckitt and Coleman) five tablets in 2 ml of water. The injections were prepared by crushing the tablets between paper with a spoon and mixing the resulting powder on the spoon with water from the kettle which had been boiled and cooled. The methods of filtration investigated were as follows: a piece of a cigarette filter (Lambert and Butler®) prepared by removing the surrounding paper and tearing it in two down the middle then halving one piece with a scissors and smoothing any stray fibres with the fingers before placing it in the edge of the solution. A hand rolling filter (Rizla Extras® 7 mm acetate filter tips), used whole, placed in the solution. A cotton bud tip (Unichem 100% cotton), removed from the plastic stalk by pulling and the end twisted to smooth the stray fibres and then placed in the edge of the solution. In all of these cases the needle was attached to the syringe and the solution drawn up through the filter. A commercially available syringe filter was also tested (5 μm Acrodisk®, Gelman Sciences). This was placed on the end of the syringe and the solution drawn through, then removed and the needle attached. Also investigated were unfiltered solutions prepared in this way and unfiltered solutions prepared by breaking the tablets in half and shaking them with water in the syringe barrel. Controls were tested using boiled and cooled water and Water For Injections BP (Antigen Pharmaceuticals®) to investigate the contribution of the filtration and preparation methods on particulate content.

Particle count and size range were measured using the Coulter Multisizer®, using 0.5 ml samples withdrawn from the injections immediately after preparation. Each test was repeated three times and the average result taken. It was decided to do this instead of taking three consecutive readings from each sample, as there could be a reduction in the particle count as the sample is stirred. The Multisizer operates on the electrical zone sensing principle: there are two electrodes in a conducting fluid (saline which has been filtered twice using a 0.2 μm filter) separated by an orifice of known diameter. A stirrer keeps any particles suspended in the saline. When a particle passes through the orifice there is a change in resistance (measured as a voltage pulse at a fixed current), the magnitude of this relates to particle size. Total number of particles that are drawn through the orifice in a given time (12 s) and number of particles within a size channel can be measured. In this case the 100 μm orifice was used, which measures particles in the size range 2–60 μm.

Table 1
Percentage reduction in total number of particles

Drug	Crush and mix (%)	Shake in barrel	Cigarette filter	Rizla filter	Cotton bud	Acrodisk
Physeptone	100	36	—	—	—	—
Diconal	100	15	29	39	36	99.0
Temgesic	100	24	24	42	56	99.9

3. Results

Changes in trends seen in particle size and number before and after filtration were looked for. The total number of particles present in the injections can be estimated by extrapolating the count from the 0.5 ml sample, but is of little value because there will be a large variation in numbers depending on the volume of water the IDU uses to make injections, how finely the drug is crushed, etc. Therefore, the number of particles in the unfiltered sample was taken to be 100% and the effects of filtration shown as the percentage reduction in the total number of particles. This is shown in Table 1.

The Physeptone solutions were thick and did not pass through the filters quickly or easily. Several filters had to be used as they clogged and it took longer than was deemed acceptable by the IDU. Since this does not fit with the definition of an effective filter given earlier, it was decided not to continue with the Physeptone filtration investigations at this stage. From Table 1 it can be seen than all methods of filtration cause a reduction in the total number of particles in the prepared injections. Preparation by splitting the tablets in two and shaking them in the syringe barrel also reduces the number of particles. However, in preliminary work on the effect of filtration on drug concentration, the amount of methadone was found to be only 90% of the drug contained in the nine Physeptone tablets when they were split and shaken, compared with 100% when they were crushed. A slurry was seen to collect at the bottom of the syringe indicating clumping of excipients and drug, explaining why not all the drug dissolved. This material could block the needle or break down enough to pass down the needle and enter the veins as a solid mass. As expected the commercial Acrodisk gave the greatest reduction in the total number of particles. Of the makeshift filters, the Rizla gives the best overall performance for both drugs. The cotton bud showed a good reduction in particle count with Temgesic injections, but was not as effective with Diconal. The cotton bud also has loose fibres which could enter the injections after filtering. Because the Multisizer sizes particles as spheres, a long thin fibre passing through the orifice may be counted as several smaller spheres. The cigarette filter was identified in the interviews as being the most commonly used filter, but this preliminary work suggests the Rizla filter to be more effective.

The total number of particles in the sample was taken to be 100% and the distribution of these according to size range is given for each drug in the Table 2.

As said, the particle size analyser gives the total number of particles in the sample and the number of particles in each of the channels within the size range 2–60 μm. Since some of the particles may be <2 μm or >60 μm, the percentage distribution within the size range 2–60 μm does not necessarily add up to 100%. Obviously these particles will still, however pose a risk to health. Table 2 show that all filters cause a shift in size range to the smaller end of the scale for the drugs tested. Again, the Acrodisk shows the greatest reduction in size range with the majority of particles in the filtered solution being smaller than the capillaries in the body. Of the makeshift filters, the reduction in size range appears to be greatest with the cotton bud filter. Splitting and shaking the tablets in the syringe also gives more particles in the smaller size ranges. Thus if no filter was used, this would be preferable to crushing the tablets to a fine powder first.

Table 2
Percentage of particles detected shown by size range for (a) Physeptone, (b) Diconal, and (c) Temgesic injections

Size range (μm)	Crush and mix	Shake in barrel	Cigarette filter	Rizla filter	Cotton bud	Acrodisk
(a) Physeptone						
2–5	24	43	—	—	—	—
5–10	18	15	—	—	—	—
10–20	33	23	—	—	—	—
20–50	3	3	—	—	—	—
(b) Diconal						
2–5	23	32	45	40	39	99
5–10	23	22	25	26	27	1
10–20	37	29	19	26	27	0
20–50	1	1	0	0	0	0
(c) Temgesic						
2–5	9	10	13	12	23	76
5–10	27	30	37	32	33	18
10–20	45	46	38	37	35	6
20–50	1	3	0	1	1	0

Table 3 shows the total number of particles that were counted without the drug present in the injections as a percentage of the total number detected when the drug is present.

This indicates the contribution to the total number of particles that is made by factors such as the kettle, cup, water, spoon, filters, injecting equipment and the non-aseptic environment, including the person preparing the injections (e.g. skin shedding). The contribution to particle count not from the drug is low except in the case of kettle water and the Acrodisk. This is because the total number of particles present is low, so the contribution from the equipment and the environment become significant. It is also shown that in terms of particle count, there is no benefit from using Water For Injections. However, there are obvious microbiological advantages.

4. Discussion

It has been shown that makeshift and commercial filters reduce the particle count and particle size in injections of Diconal and Temgesic. This suggests that the health risks attributed to the injection of insoluble materials could be reduced by filtering the injections prior to administration. The commercially produced syringe filter would be the most appropriate choice, the cost implications of supplying such filters needs to be considered. Clients who inject these drugs should be

Table 3
Percentage of total particle count that can be attributed to sources other than drug (i.e. controls)

		Mix on spoon	Shake in barrel	Cigarette filter	Rizla filter	Cotton bud	Acrodisk
Physeptone	Kettle	0.1	0.1	—	—	—	—
	WFI	0.1	0.3	—	—	—	—
Diconal	Kettle	0.2	0.2	0.2	0.4	0.3	31.5
	WFI	0.1	0.6	0.2	0.1	0.8	0
Temgesic	Kettle	0.2	0.2	0.2	0.5	0.3	230.0
	WFI	0.1	0.6	0.1	0.1	1.1	0

encouraged to filter. The Rizla acetate filer appears to be more effective than the popular cigarette filter. The filters should be handled to a minimum to reduce contamination risks from the hands, and re-use of filters discouraged. However, many users do not use filters because they claim to loose the 'hit'. Therefore the next stage in this work will develop methods to measure the effects of filtering on the concentration of the drug. Also, since many more people use heroin than tablets by injection, it is important to carry out this work using samples of street heroin. Work is ongoing to fulfil these objectives. When the final results are collated, work will be done with IDU's to test the most effective makeshift and commercially produced filters for user acceptability.

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