

Missed hits among in drug users.

Not in the vein: ‘missed hits’, subcutaneous and intramuscular injections and associated harms among people who inject psychoactive drugs in Bristol, United Kingdom.

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Running head: *Missed hits among drug users.*

Summary

Background: The extent of intentional or accidental subcutaneous and intramuscular injections and the factors associated with these have rarely been studied among people who inject drugs, yet these may play an important role in the acquisition bacterial infections. This study describes the extent of these, and in particular the factors and harms associated with accidental subcutaneous and intramuscular injections (i.e. 'missed hits').

Method: People who inject drugs were recruited using respondent driven sampling. Weighted data was examined using bivariate analyses and logistic regression.

Results: The participants mean age was 33 years (31% aged under 30-years), 28% were women, and the mean time since first injection was 12 years (N=329). During the preceding three months, 97% had injected heroin, 71% crack-cocaine, and 16% amphetamines; 36% injected daily. Overall, 99% (325) reported that they aimed to inject intravenously; only three aimed to inject subcutaneously and one intramuscularly. Of those that aimed to inject intravenously, 56% (181) reported ever missing a vein (for 51 this occurred more than four times month on average). Factors associated with 'missed hits' suggested that these were the consequence of poor vascular access, injection technique and/or hygiene. 'Missed hits' were twice as common among those reporting sores/open wounds, abscesses, or redness, swelling & tenderness at injection sites.

Conclusions: Intentional subcutaneous and intramuscular injections are rare **in this sample**.

'Missed hits' are common and appear to be associated with poor injection practice.

Interventions are required to reduce risk through improving injecting practice and hygiene.

Word count: 247.

Key words: people who inject drugs; subcutaneous; intramuscular; risk behaviours; infections.

Introduction

People who inject psychoactive drugs (such as heroin, cocaine and amphetamine) normally aim to inject intravenously, but often have difficulty with venous access either as a result of poor injection technique or because of the vascular damage that can occur over time when injecting regularly (Rhodes, Stoneman, Hope, Hunt, & Judd, 2006; Rhodes, Briggs, Kimber, Jones, & Holloway, 2007; Harris & Rhodes, 2012). As a result they may have to make several injection attempts to gain venous access or use multiple areas of the body for injection (Darke, Ross, & Kaye, 2001; Maliphant & Scott, 2005; Harris & Rhodes, 2012). This difficulty with vascular access can result in accidental subcutaneous and intramuscular injections – ‘missed hits’ (Hankins, Palmer, & Singh, 2000; Rhodes, Briggs, Kimber, Jones, & Holloway, 2007). In addition, for some people who inject psychoactive drugs (and also for those people who inject image and performance enhancing drugs, such as anabolic steroids and melanotan) their usual injection practice will be subcutaneous (‘Skin Popping’) or intramuscular (‘Muscle Popping’) (Binswanger, Kral, Bluthenthal, & Rybold, 2000; Pirozzi, Van, Pontious, & Meyr, 2014; Hope, et al., 2015).

Intentional or accidental subcutaneous and intramuscular injections among people who inject psychoactive drugs are known to be a risk factor for injection related bacterial infections (Binswanger, Kral, Bluthenthal, & Rybold, 2000; Pirozzi, Van, Pontious, & Meyr, 2014), particularly those caused by anaerobic organisms, such as, wound botulism and tetanus (CDC, 1995; Brett, Hood, Brazier, Duerden, & Hahne, 2005; Palmateer, et al., 2013).

Injections under the skin and into the muscle, particularly if they are accidental, could cause physical damage to tissues as a result of poor injection technique (Nicoll & Hesby, 2002; Ogston-Tuck, 2014). In addition, the two most commonly injected psychoactive drugs in the United Kingdom, brown heroin and crack-cocaine, both need to be dissolved in acidic solutions (Scott, Winfield, Kennedy, & Bond, 2000; Scott & Ponton, 2004). These acidic solutions when injected into vascular system are likely to be quickly diluted, but if injected under the skin or into the muscle (either during intentional subcutaneous and intramuscular

injections or due to a 'missed hit') they could cause injecting site problems through chemical irritation and damage to these soft tissues (Lake & Beecroft , 2010).

The extent of subcutaneous and intramuscular injections, including 'missed hits', and the factors associated with these have very rarely been studied. Several studies in the western USA, have reported on subcutaneous and intramuscular injections among people who inject drugs, though not on whether these injections were intentional or accidental. In a study from 1997 conducted in San Francisco, California, 22% reported subcutaneous or intramuscular injections in the previous 30 days (Binswanger, Kral, Bluthenthal, & Rybold, 2000), and a more recent study from 2003-2005 indicated these practices were also common in Los Angeles, Oakland, and Berkeley, California, but didn't report on their extent (Fink, Lindsay, Slymen, Kral, & Bluthenth, 2013). In a third study undertaken during 2010 in Seattle, Washington, 56% had ever injected intramuscularly (Coffin, Coffin, Murphy, Jenkins, & Golden, 2012). However, the extent of these practices in the western USA may, in part at least, be related to the injection of 'black tar' heroin and the particular problems associated the use of this drug (Coffin, Coffin, Murphy, Jenkins, & Golden, 2012), thus limiting the generalisability of these findings other areas with different patterns of drug use.

Considering the extent of injecting site infections among people who inject drugs in the United Kingdom (Hope, Kimber, Hickman, Vickerman, & Ncube, 2008), in particular the substantial and ongoing problems with wound botulism and tetanus (Palmateer, et al., 2013; Anon, 2015), data on the extent of, and the harms associated with, both intentional and accidental subcutaneous and intramuscular injections among this population are needed to help inform public health responses. Our study aimed to address this knowledge gap by asking participants about intentional subcutaneous or intramuscular injections and also about 'missed hits'. This paper describes:- a) the extent of subcutaneous injections, intramuscular injections, and 'missed hits'; b) the factors associated with reporting a 'missed hit'; and c) the extent of symptoms of injection site infections and injuries among those who report 'missed hits'.

Methods

People who inject drugs were recruited into a voluntary unlinked-anonymous cross-sectional survey in Bristol, a major urban area in the south west of England, United Kingdom, using respondent driven sampling (RDS) during the September and October of 2009. RDS is an established recruitment process which has been explained fully elsewhere (Salganik & Heckathorn, 2004; Heckathorn D. , 1997; Heckathorn D. , 2002). Briefly, RDS starts with the selection of the initial recruits, or 'seeds', with further subjects then recruited through the participant's social networks. The 'seeds' (n=10) were selected in relation to location and gender through key informant referrals and street outreach. To be eligible, participants had to be aged over 15-years, have injected drugs during the preceding four weeks, live within the Bristol urban area (population: urban area 617,000; city 432,500) and give consent.

Participants provided a dried blood spot (DBS) sample (which was tested for antibodies to HIV [anti-HIV], the hepatitis B core antigen [anti-HBc], and the hepatitis C virus [anti-HCV]), underwent a computer-assisted interview, and were then offered an acknowledgement. Participants were then asked to act as recruiters, and those who agreed to this were given three uniquely numbered and date-limited coupons. They were instructed to give these coupons only to eligible individuals whom they knew and received a further acknowledgement for each coupon that led to a successful participation. A single fieldwork co-ordinator screened all participants for eligibility and also for attempted repeat participations. The study had ethical approval (London REC, MREC/98/2/51).

The questionnaire used in the study was developed from ones that had previously been used with people who inject drugs in the United Kingdom (Judd, et al., 2005; Hickman, et al., 2007; Hickman, et al., 2009; Hope, Ncube, Parry, & Hickman, 2015). The questions on injection technique were developed from the existing questions about injecting practice. Participants were asked "How do you usually try to inject?" with answer options "In to a vein", "Under the

skin - Skin Popping”, or “In to the Muscle - Muscle Popping”. Those injecting into vein were then asked if they had missed the vein when trying to inject and how often this occurred. The questionnaire was reviewed by members of the study team, including the fieldworkers, and by people working with people who inject drugs in the study area. The two main foci were: 1) injecting drug use (drugs used, paraphernalia used and injection practices); and 2) health harms (particularly infections) and uptake of health care related interventions. In addition, the questionnaire asked about demographics, environmental factors (such as contact with the criminal justice system and homelessness), and sexual behaviours.

In RDS studies there is a tendency for participants’ to recruit people like themselves, and a higher probability that people with large networks will be recruited. For example, in our survey people who inject drugs who had been homeless in the last year had larger networks than those who had not, and recruited proportionally more people who were also homeless. RDSTAT software (Version 5.4.0. Ithaca, New York: Volz E, Heckathorn DD; 2005) was used to test for evidence of selection bias and to generate sample derived weights; with age-group, homelessness and crack injection used to weight the data for analysis.

Weighted data were used in all of the analyses, which were undertaken using SPSS 19. First, bivariate associations between reporting a ‘missed hit’ and demographic characteristics, environmental factors, the drugs used, and injecting practices were examined using the χ^2 test. The environmental, drug use and injecting practice variables used in the analyses were for factors that had been shown in previous studies of either injecting risk practice or bacterial infections among people who inject drugs to be related to those outcomes (Hickman, et al., 2007; Hope, Kimber, Hickman, Vickerman, & Ncube, 2008; Salmon, Dwyer, Jauncey, van Beek, Topp, & Maher, 2009). Those characteristics found to be associated in the bivariate analyses were entered using the forward stepwise procedure in SPSS into a logistic regression model with inclusion assessed using the likelihood ratio (with the stepwise probability for inclusion of 0.05 and exclusion of 0.1).

Finally, considering that 'missed hits' may be a factor in the development of injecting site problems, the extent of symptoms of injection site infections or injuries among those who had aimed to inject intravenously were examined. Associations between these symptoms and reporting 'missed hits' were examined using the χ^2 test and logistic regression to adjust for possible confounding variables. In addition, associations were then examined using the χ^2 test between the *frequency* of reporting 'missed hits' and, a) symptoms of injection site infections and injuries, and b) seeking healthcare in response to these symptoms.

Results

Demographic and drug use characteristics.

Questionnaires were obtained from 329 individuals, **weight characteristic a summarised in table 1. Briefly, their mean age was 33 years, one quarter were women, and half had been homeless during the preceding year. The mean time since they had first injected drugs was 12 years, almost all had injected heroin during the preceding three months and nearly three-quarters had injected crack-cocaine. Two-thirds were receiving a detox or maintenance drug regime, such as opiate substitution therapy, and half reported that they had ever cleaned and then re-used needles and/or syringes.**

Injection technique.

Overall, 99% (n=325) reported that they usually aimed to inject intravenously (table 1), with only three participants reporting that they usually injected subcutaneously (i.e. under the skin or 'skin popping') and one reporting they usually injected intramuscularly (i.e. in to the muscle or 'muscle popping'). The four that did not usually aim to inject intravenously were all male, they were older (mean age of 44 years, median 43, vs. mean age of 33 years, median 33) and had been injecting for longer (mean time since first injection of 20 years, median 21, vs. mean time of 12 years, median 12).

Of those who usually aimed to inject intravenously, over half (56%, $n=181$) reported that they had ever missed a vein, that is accidentally injected subcutaneously or intramuscularly (a 'missed hit'). Of those who had ever missed a vein, 51% ($n=92$) reported that this happened less than once a month, for 21% ($n=38$) this typically happened between one and four times a month, and for 28% ($n=51$) 'missed hits' occurred more frequently. Reporting having had a 'missed hit' and the frequency of experiencing a 'missed hit' were both not associated with either age or gender.

Factors associated with 'missed hits' among those who aimed to inject intravenously.

The factors that were found to be associated in both the bivariate and multivariable analyses with 'missed hits' among the 325 participants who aimed to inject intravenously are shown in table 2. In the multivariate analysis, *ever* experiencing a 'missed hit' (table 2a) was more common among those who had been injecting for longer, those who had ever overdosed, those injected into their hands (though this was less common among those injecting into their groin), those who reported saving filters for reuse, and those who injected more frequently.

Experiencing a missed hit *at least monthly* (table 2b) was more common in the multivariate analysis among those who had inserted the needle three or more times on the last occasion that they had injected; those who had shared a needle or syringe; and those who had either reused spoons or saved filters. It also varied by the main area on body used for injecting and by the main source of needles and syringes.

Injection site infections and injuries among those aiming to inject intravenously

Overall of those who aimed to inject intravenously, 62% ($n=201$) reported ever having had redness, swelling & tenderness at an injection site, 44% ($n=145$) ever having had an abscess, and 14% ($n=47$) ever having had a sore or open wound. Ever reporting these three symptoms of an injection site infection and injury was around twice as common among those who reported that they had ever had 'missed hit' (table 3).

Participants were also asked if they had any of these three symptoms during the preceding year; with 41% (n=133) reporting having had redness, swelling & tenderness at an injection site during the preceding year, 15% (n=48) an abscess, and 7.4% (n=24) a sore or open wound. The reporting of these symptoms during the preceding year became more common as the frequency of having 'missed hits' increased (table 4), for example, among those reporting no 'missed hits' 4.9% reported that they had an abscess during the preceding year, this increased to 35% among those who reported having more than four 'missed hits' a month.

Those who reported having either an abscess or a sore/open wound at an injection site during the preceding year, were also asked if they had sought medical advice about either of these two symptoms from a doctor or a nurse (81%, 39/48, and 38%, 9/24, had respectively). Reporting having had a 'missed hit', and the frequency of experiencing a 'missed hit' among those who had, were not associated with seeking medical advice from a doctor or a nurse about either of these two symptoms during preceding year.

Discussion

Our findings show that *intentional* subcutaneous or intramuscular injections are very rare among people who inject psychoactive drugs **sampled**, with these being reported by only around one in 100. However, such injections are actually a fairly common occurrence due to the 'missed hits' that occur when people fail to inject intravenously. Overall, more than half of those surveyed reported having had a 'missed hit', and for a quarter this happened at least once a month, with around one in six reporting having a 'missed hit' more than four times a month. Those who reported that they had experienced a 'missed hit' were twice as likely to also report having had symptoms of injection site infections and injuries.

First, it is important to consider the limitations of this study and also the generalizability of its findings. The comparative rarity of injecting drug use, its illegal nature, and the marginalisation

of those involved are all barriers to the recruitment of a representative sample of people who inject drugs. This study aimed to minimize sampling biases and maximize representativeness by recruiting the participants through RDS (Heckathorn D. , 1997; Heckathorn D. , 2002; Salganik & Heckathorn, 2004) and applying sample derived weights to correct for possible recruitment biases; though it is not possible to test how successful this adjustment has been (Mills, Johnson, Hickman, Jones, & Colijn, 2014). Even so, RDS is currently regarded as one of the most appropriate methods for recruiting community based samples of hidden populations, such as, people who inject drugs. Self-reports were used in this study, the accuracy of these can be questioned as they are potentially subject to recall bias, however, the reliability of self-reported risk behaviours among people who inject drugs has been previously shown (Latkin, Vlahov, & Anthony, 1993). **The cross-sectional approach used in this study allows the exploration of the factors associated with 'missed hits'; however, it does not permit direct examination of causation.** Finally, this study recruited participants from a single area of England during 2009. The characteristics of the sample recruited here were broadly comparable to those of the participants in the United Kingdom's national bio-behavioural survey of people who inject drugs during 2009 (Public Health England, 2014.). Data from this ongoing annual national survey also indicate that the characteristics and nature of psychoactive drug injecting have not change greatly in recent years (Public Health England, 2014.). Considering these issues the findings should be generalised with some caution.

The extent of having ever injected subcutaneously or intramuscularly, either by intent or by accident, in our study was similar to the extent of ever injecting into the muscle found in Seattle, USA (Coffin, et al., 2012), but higher than that reported in an study in San Francisco, California (Binswanger, Kral, Bluthenthal, & Rybold, 2000). Subcutaneous and intramuscular injecting are likely to occur in other populations of people who inject drugs, particular among those populations were people have been injecting for long periods (Coffin, et al., 2012). Over time these practices, and their associated harms, may become an issue among the ageing cohorts of people who inject drugs that are found in many high income countries (European

Monitoring Centre for Drugs and Drug Addiction, 2010), where people who have been injecting for long periods will be come more common.

The finding that symptoms of injection site infections and injuries were associated with reporting a 'missed hit', and that these symptoms became more common as the frequency of having a 'missed hit' increased, corroborate information from case reports, studies of bacterial infections among people who inject drugs, and public health surveillance data that indicate that a wide range bacterial infections, including Meticillin-resistant *Staphylococcus aureus* and wound botulism, are more common among those who inject subcutaneously or intramuscularly (CDC, 1995; Binswanger, Kral, Bluthenthal, & Rybold, 2000; Lowy & Miller, 2002; Brett, Hood, Brazier, Duerden, & Hahne, 2005; Fink, Lindsay, Slymen, Kral, & Bluthenth, 2013; Pirozzi, Van, Pontious, & Meyr, 2014). This probably reflects the damage to muscle and other soft tissues that can result from poor injection technique and/or injecting acidic solutions, making these injection sites particularly vulnerable to infections by organisms introduced during the injection process. When this damage leads to tissue necrosis it can result a local environment that is particularly suited to the growth of anaerobic organisms, such as the bacteria that cause botulism and tetanus (Brett, Hood, Brazier, Duerden, & Hahne, 2005; Palmateer, et al., 2013).

Findings from studies that have looked at both injection site infections and injuries and injection practice suggest that a range of factors are associated with the occurrence of these problems, and many of these factors indicate that both poor injecting technique and hygiene probably play an important role in the development of these largely avoidable harms (Hope, Kimber, Hickman, Vickerman, & Ncube, 2008; Salmon, Dwyer, Jauncey, van Beek, Topp, & Maher, 2009; Hope, Cullen, Croxford, Parry, & Ncube, 2014). They also indicate that the considerable harm caused by these infections and injuries, and the associated costs, can be amplified by delays in seeking healthcare (Marks, et al., 2013; Hope, Ncube, Parry, & Hickman, 2015).

A number of factors were found to be associated with reporting a 'missed hit'. Of particular note are the associations with having injected for longer, injecting into the hands, frequency of injection, and inserting the needle multiple times before injecting. These factors are probably a reflection of the vascular damage that can occur after injecting frequently over long periods of time, particularly if injection technique is poor (Harris & Rhodes, 2012). This vascular damage makes accessing peripheral veins difficult, thus making missed hits more likely, but this can also result in people using potentially more dangerous injecting sites, such as, the hands, neck and groin (Darke, Ross, & Kaye, 2001). There were also associations between reporting a 'missed hit' and aspects of injecting practice – such as the sharing, reuse and saving of injecting equipment - that suggest that there may be a wider issue with poor injecting practice and hygiene amongst those experiencing 'missed hits'.

Public health interventions are needed to reduce the occurrence of 'missed hits' and the associated harms. These should look at ways to support and promote the use of good hygienic intravenous injection technique. The findings presented here, and those from previous studies undertaken in the United Kingdom (Maliphant & Scott, 2005; Hickman, et al., 2007; Harris & Rhodes, 2012; Hope, Cullen, Croxford, Parry, & Ncube, 2014), indicate that there is considerable room to improve injection practice and hygiene through, for example, reducing the reuse of injecting equipment, more consistent cleaning of injections sites and the rotation of the body sites used for injection. Harm reduction responses should therefore include the development of interventions to support and promote good injection site management (including site rotation, always cleaning sites, always using new sterile equipment, and not using excessive acid), so as to minimize vein damage and thus reduce the vascular access problems that could lead to 'missed hits'. These should of course be supported by high coverage needle and syringe programmes, distributing a range of appropriate injecting equipment, including sterile needles, syringes and swabs (MacArthur, et al., 2014).

Reporting 'missed hits' was less common among those who reported their 'groin' (femoral vein) as their main injection site. This possibly reflects that successfully injection into the femoral vein is easier due to the large size of this vein, which also allows the development of a sinus tract (Maliphant & Scott, 2005; Hope, J Scott, Cullen, Parry, Ncube, & Hickman, 2015). As a range of potentially serious harms have been associated with the injection into this particular body site, including deep vein thrombosis (McColl, Tait, Greer, & Walker, 2001; Hope, J Scott, Cullen, Parry, Ncube, & Hickman, 2015), abscesses (Mackenzie, Laing, Douglas, Greaves, & Smith, 2000), chronic venous disease (Pieper, Templin, Kirsner, & Birk, 2009), necrosis of the femoral artery (Mullan, Magowan, & Weir, 2008), septicaemia (Hope, J Scott, Cullen, Parry, Ncube, & Hickman, 2015) and hepatitis C infection (Hope, J Scott, Cullen, Parry, Ncube, & Hickman, 2015), its use should therefore *not* be promoted as a way of reducing the harms that could result from 'missed hits'. Instead priority should be given to improving injecting technique and vascular care, as well as to interventions to move people away injecting. Firstly, this should involve increasing the uptake of opiate substitution therapy (MacArthur, et al., 2014), and secondly, if shown to be effective, supporting the use of alternative less risky routes of drug administration, such as through providing foil for the smoking drugs (Pizzey & Hunt, 2008; Advisory Council on the Misuse of Drugs, 2010).

Conclusions

This is the first study, to our knowledge, to purposively look at 'missed hits', subcutaneous and intramuscular injections among a community recruited sample of people who inject drugs. Though only about one in 100 reported intentionally injecting subcutaneously or intramuscularly; 56% of the participants reported having had a 'missed hit', and for a quarter this happened at least once a month. The 'missed hits' here were associated with having injection site infections and injuries, and appeared to be associated with poor injection practice. Poor injection technique, and the difficulties with vascular access which can result from this, probably play a key role in the occurrence of 'missed hits', but this needs further

investigation. Interventions to improve injecting technique and hygiene and to help sustain access to the peripheral veins are needed.

Table 1. Characteristics of the people who inject psychoactive drugs recruited using respondent driven sampling, Bristol, United Kingdom.

All data presented in the table are weighted using sample derived weights.

Characteristic		n	%
Total		329	
Demographics			
Gender	Male	236	72
	Female	93	28
Age, years (mean age 33 years; median 33, IQR 28 to 39)	<= 29 years	102	31
	30 to 39 years	155	47
	40 years or older	72	22
Homelessness	Yes, but not past year	117	36
	Yes, in past year	170	52
	Never	41	13
Imprisonment	Never	88	27
	Yes, but not past year	165	50
	Yes, in past year	75	23
Main Source of Income	Employment	24	7.4
	Social security	210	64
	Street (e.g. begging, selling 'Big Issue', or busking)	18	5.5
	Sex work	15	4.7
	Theft or drug dealing	53	16
Recent sexual activity	Other or not known	8	2.4
	No sex past year	77	23
	Sex past year, no sex work	228	69
	Sex past year, sex work	24	7.3
Drug use			
Number of years since first injected (mean 12 years; median 12, IQR 6 to 17)	< 5 year	60	18
	5 to 9 years	72	22
	10 to 14 years	76	23
	15 or more years	120	36
Drugs injected during the preceding three months	Heroin	317	97
	Crack-cocaine	233	71
	Powder cocaine	32	10
	Amphetamine	54	16
	Other drugs	14	4.2

Table 1 Continued

<i>Injecting practice</i>			
	Hands	15	4.6
Main area on body used for injection, preceding 28 days	Arms	139	42
	Groin	124	38
	Legs	35	11
	Other	15	4.5
Washed hands before injecting, preceding 28 days	Never	88	27
	Sometimes	86	26
	Always	154	47
Swabbed injection site before injecting, preceding 28 days	Never	67	20
	Sometimes	69	21
	Always	192	59
Reused spoons/ mixing containers, preceding 28 days	Never	56	17
	Sometimes	47	14
	Always	225	68
Reused filters, preceding 28 days	Never	169	51
	Sometimes	79	24
	Always	81	25
Have saved filters for reuse		123	37
Ever clean needles and syringes for reuse		159	48
Times insert needle last time injected	Once	218	67
	Twice	61	19
	Thrice	22	6.7
	Four or more times	27	8.2
Tried more than one site on body last time injected		67	20
Usual injection technique	In to a vein	325	99
	Under the skin – ‘Skin Popping’	3	0.8
	In to the Muscle – ‘Muscle Popping’	1	0.2
<i>Health services use & intervention uptake</i>			
Main source of needles and syringes	Specialist needle & syringe programme	129	39
	Pharmacy needle & syringe programme	60	18
	Mobile needle & syringe programme	79	24
	Friends	31	10
	Other people who inject drugs	14	4.3
	Other	14	4.3
Currently receiving detox or maintenance drug regime		218	66
Ever had a diagnostic test for HIV		268	82
Ever had a diagnostic test for hepatitis C		297	90
Taken up the vaccine against hepatitis B		236	72
Attended Emergency Department for any reason, preceding year		130	40
<i>Health Harms</i>			
Had antibodies to hepatitis B core antigen		58	18
Had antibodies to hepatitis C		186	57
Had overdosed to the point of losing consciousness		133	41

Table 2. Factors associated with ‘missed hits’ among people who aim to inject psychoactive drugs intravenously, Bristol, United Kingdom.

Part A: Factors associated with <u>ever</u> having had missed hit^{†‡}		Reported ever having a missed hit		Total	Unadjusted Odds Ratio, with 95% CI			Adjusted Odds Ratio, with 95% CI				
Total		56%	181	325								
Number of years since first injected	Less than 5	51%	31	60								
	5 to 9	48%	35	72								
	10 to 14	59%	44	75								
	15 or more	61%	72	117								
	Mean	<i>p</i> =0.076**		Yes: 13	No: 11							
per year increase in time since 1st injection					1.03	1.00	-	1.06	1.05	1.01	-	1.08
		<i>p</i> =0.070†										
Ever overdosed	No	52%	100	192								
	Yes	61%	81	133	1.46	0.93	-	2.29	†			
		<i>p</i> =0.098										
Main area on body injected into*	Hands	95%	14	15	9.94	1.01	-	97.6	14.5	1.38	-	152
	Arms	64%	89	138	1.00				1.00			
	Groin	37%	46	124	0.32	0.19	-	0.53	0.24	0.13	-	0.43
	Legs	78%	25	32	1.98	0.80	-	4.89	1.36	0.51	-	3.61
	Other	47%	7	15	0.49	0.17	-	1.42	0.41	0.13	-	1.31
		<i>p</i> <0.001										
Reused spoons*	Never	44%	24	56	1.00							
	Sometimes	52%	24	47	1.37	0.63	-	2.97	†			
	Always	60%	133	222	1.92	1.06	-	3.47				
		<i>p</i> =0.078										
Reused filters*	Never	50%	83	167	1.00							
	Sometimes	59%	45	77	1.43	0.83	-	2.47	†			
	Always	66%	53	81	1.91	1.10	-	3.32				
		<i>p</i> =0.056										
Saved filters*	No	50%	103	204	1.00				1.00			
	Yes	65%	79	121	1.82	1.15	-	2.90	1.97	1.15	-	3.40
		<i>p</i> =0.011										
Ever cleaned and re-used needle/syringes	No	49%	82	168	1.00							
	Yes	63%	99	157	1.75	1.12	-	2.73	†			
		<i>p</i> =0.013										
Times injected*	14 or less	46%	35	76								
	15 to 28	56%	33	59								
	29 to 56	59%	46	78								
	57 to 84	60%	30	49								
	85 or more	62%	39	63								
	Mean	<i>p</i> =0.050		Yes: 67	No: 53							
per injection increase in times injected					1.00	1.00	-	1.01	1.00	1.00	-	1.01
		<i>p</i> =0.057†										
Times insert needle last time injected	Once	46%	100	217	1.00				1.00			
	Twice	65%	39	60	2.17	1.20	-	3.93	1.88	0.98	-	3.62
	Thrice	92%	19	21	14.2	2.76	-	73.0	12.4	2.26	-	67.6
	Four or more	87%	24	27	8.12	2.53	-	26.0	5.09	1.51	-	17.2
		<i>p</i> <0.001										

Part B: Factors associated with having a missed hit <u>at least monthly</u>^{†††}.		Reported a missed hit at least monthly		Total	Unadjusted Odds Ratio, with 95% CI			Adjusted Odds Ratio, with 95% CI		
Total		27%	89	325						
Main source of needles & syringes	Specialist NSP	32%	41	129	1.00			1.00		
	Pharmacy NSP	30%	18	60	0.90	0.46	- 1.75	1.32	0.58	- 2.99
	Mobile NSP	24%	19	79	0.68	0.36	- 1.28	0.80	0.37	- 1.74
	Friends	12%	3	30	0.28	0.08	- 0.91	0.31	0.09	- 1.15
	Other PWID	8%	1	14	0.18	0.03	- 1.29	0.12	0.02	- 1.01
	Other	46%	6	13	1.78	0.57	- 5.55	4.02	0.85	- 19.0
		<i>p</i> =0.059								
Ever had a test for hepatitis C	No	15%	5	31	1.00					
	Yes	29%	85	294	2.37	0.85	- 6.61	†		
		<i>p</i> =0.090								
Injected heroin during last three months	No	0%	0	11						
	Yes	28%	89	314						
		<i>p</i> =0.039††								
Main area on body injected into*	Hands	29%	4	15	0.70	0.22	- 2.23	0.43	0.10	- 1.93
	Arms	37%	52	138	1.00			1.00		
	Groin	15%	18	124	0.29	0.16	- 0.53	0.19	0.09	- 0.41
	Legs	34%	11	32	0.88	0.39	- 1.96	0.58	0.21	- 1.56
	Other	25%	4	15	0.57	0.17	- 1.93	0.69	0.18	- 2.70
		<i>p</i> =0.002								
Reused spoons*	Never	10%	6	56	1.00			1.00		
	Sometimes	21%	10	47	2.33	0.77	- 7.07	4.76	1.26	- 17.9
	Always	33%	74	222	4.32	1.74	- 10.7	6.14	2.05	- 18.4
		<i>p</i> =0.002								
Reused filters*	Never	21%	35	167						
	Sometimes	26%	20	77	1.30	0.69	- 2.43	†		
	Always	42%	34	81	2.68	1.50	- 4.77			
		<i>p</i> =0.003								
Shared needle/syringe*	No	24%	70	284	1.00			1.00		
	Yes	48%	20	41	2.90	1.48	- 5.68	3.07	1.30	- 7.26
		<i>p</i> =0.001								
Saved filters*	No	20%	40	204	1.00			1.00		
	Yes	41%	49	121	2.79	1.69	- 4.60	2.77	1.50	- 5.12
		<i>p</i> <0.001								
Ever cleaned and re-used needle/syringes	No	21%	34	168	1.00			1.00		
	Yes	35%	55	157	2.08	1.26	- 3.42	†		
		<i>p</i> =0.004								
Times injected*	14 or less	10%	8	76	1.00			1.00		
	15 to 28	25%	14	58	2.97	1.14	- 7.74			
	29 to 56	35%	28	79	4.86	2.02	- 11.7			
	57 to 84	32%	16	49	4.23	1.62	- 11.0			
	85 or more	38%	24	63	5.49	2.22	- 13.6	†		
		<i>p</i> =0.001								
		Mean	Yes: 74	No: 56						
		per injection increase			1.00	1.00	1.01			
		<i>p</i> =0.022‡								
Times insert needle last time injected	Once	18%	40	217	1.00			1.00		
	Twice	29%	18	60	1.84	0.96	- 3.53	1.67	0.78	- 3.59
	Thrice	57%	12	21	5.93	2.33	- 15.1	5.97	1.97	- 18.1
	Four or more	73%	20	27	12.28	4.90	- 30.8	11.0	3.69	- 32.5
		<i>p</i> <0.001								

All data presented in the table are weighted using sample derived weights.

* during preceding 28 days.

† Not in final model

** χ^2 for linear trend

‡ T test

†† Fisher's Exact Test

No associations ($p>0.1$) in part A with: Age in years; Gender; Imprisonment; Homelessness; Being prescribed a substitute drug; Main source of source needles & syringes; Having had a voluntary confidential test for HIV or hepatitis C; Uptake of the hepatitis B vaccine; Attended Emergency Department for any reason preceding year; Having injected during the preceding 3 months: heroin, crack, powder cocaine, amphetamines, or other drugs; Washing hands before injecting; Swabbing injection sites; Sharing needle/syringe; Sex in last year (paid or unpaid).

††† *No associations ($p>0.1$) in part B with:* Age in years; Gender; Imprisonment; Homelessness; Being prescribed a substitute drug; Having had a voluntary confidential test for HIV; Uptake of the hepatitis B vaccine; Attended Emergency Department for any reason preceding year; Ever overdosed; Number of years since first injected; Having injected during the preceding 3 months: crack, powder cocaine, amphetamines, or other drugs; Washing hands before injecting; Swabbing injection sites; Sex in last year (paid or unpaid).

Table 3. The extent of ever having symptoms of an injecting site infection or injury among people who aim to inject psychoactive drugs intravenously that report ever having had a 'Missed hit', Bristol, United Kingdom.

Reported ever having a missed hit	Ever had symptom:-	Total (N=325)		Unadjusted Odds Ratio, with 95% CI	Adjusted* Odds Ratio, with 95% CI
	Abscess				
No	36% 52	144		1.00	1.00
Yes	51% 93	181	$p=0.005$	1.89 1.21 - 2.97	2.01 1.19 - 3.39
	Sore or open wound				
No	9.7% 14	144		1.00	1.00
Yes	18% 33	181	$p=0.032$	2.04 1.05 - 3.95	2.15 1.02 - 4.54
	Redness, swelling & tenderness				
No	49% 70	144		1.00	1.00
Yes	72% 131	181	$p<0.001$	2.72 1.72 - 4.32	2.38 1.43 - 3.96

All data presented in the table are weighted using sample derived weights.

P values are for Pearson Chi-Square test.

* adjusted for years since first injecting, gender, main injection area on body and injection frequency.

Table 4. Frequency of 'missed hits' and the extent of recent symptoms of an injection site infection or injury among people who aim to inject psychoactive drugs intravenously, Bristol, United Kingdom.

Had symptom, during the preceding year	No missed hits	A missed hit less than monthly	A missed hit one to four times a month	A missed hit more than four times a month	χ^2 for linear trend
A sore or open wound	3.5% 5	6.5% 6	11% 4	18% 9	$p=0.001$
An abscess	4.9% 7	18% 17	16% 6	35% 18	$p<0.001$
Redness, swelling & tenderness	20% 29	43% 40	61% 23	80% 41	$p<0.001$
Total (N=325)	144	92	38	51	

All data presented in the table are weighted using sample derived weights.

References

- Advisory Council on the Misuse of Drugs. (2010). *Consideration of the use of foil, as an intervention, to reduce the harms of injecting heroin*. London: Home Office.
- Anon. (2015). Botulism among people who inject drugs – update. *HPS Weekly Report*, 49(23), 189.
- Binswanger, I., Kral, A., Bluthenthal, R., & Rybold, D. (2000). High prevalence of abscesses and cellulitis among community-recruited injection drug users in San Francisco. *Clin Infect Dis.*, 30, 579-81.
- Brett, M., Hood, J., Brazier, J., Duerden, B., & Hahne, S. (2005). Soft tissue infections caused by spore-forming bacteria in injecting drug users in the United Kingdom. *Epidemiol Infect.* 2005 133(4):575-82., 133, 575-82.
- CDC. (1995). Wound botulism - California, 1995. *MMWR* , 44, 889-92.
- Coffin, P., Coffin, L., Murphy, S., Jenkins, L., & Golden, M. (2012). Prevalence and characteristics of femoral injection among Seattle-area injection drug users. *J Urban Health*, 89(2), 365-72.
- Darke, S., Ross, J., & Kaye, S. (2001). Physical Injecting Sites Among Injecting Drug Users in Sydney, Australia. *Drug and Alcohol Dependence*, 62, 77-82.
- European Monitoring Centre for Drugs and Drug Addiction. (2010). *Treatment and care for older drug users*. Luxembourg: Publications Office of the European Union.
- Fink, D., Lindsay, S., Slymen, D., Kral, A., & Bluthenthal, R. (2013). Abscess and self-treatment among injection drug users at four California syringe exchanges and their surrounding communities. *Subst Use Misuse*, 48(7), 523-31.
- Hankins , C., Palmer, D., & Singh, R. (2000). Unintended subcutaneous and intramuscular injection by drug users. *CMAJ.*, 163, 1425–6.
- Harris, M., & Rhodes, T. (2012). Venous access and care: harnessing pragmatics in harm reduction for people who inject drugs. *Addiction*, 107, 1090-6.
- Heckathorn, D. (1997). Respondent-Driven Sampling: A New Approach to the Study of Hidden Populations. *Social Problems*, 44, 174-199.
- Heckathorn, D. (2002). Respondent-Driven Sampling II: Deriving Valid Population Estimates from Chain-Referral Samples of Hidden Populations. *Social Problems*, 49, 11-34.
- Hickman, M., Hope, V., Brady, T., Madden, P., Jones, S., Honor, S., et al. (2007). Hepatitis C (HCV) prevalence, and injecting risk behaviour in multiple sites in England in 2004. *Journal of Viral Hepatitis*, 14, 645–652.
- Hickman, M., Hope, V., Coleman, B., Parry, J., Telfer, M., Twigger, J., et al. (2009). Assessing IDU Prevalence and Health Consequences (HCV, Overdose, and Drug Related Mortality) in a PCT: Implications for Public Health Action. *J Public Health (Oxf).*, 31, 374-82.
- Hope, V., Cullen, K., Croxford, S., Parry, J., & Ncube, F. (2014). Factors associated with the use of cleaned needles and syringes among people who inject drugs in the UK: who should we target to minimise the risks? *Int J Drug Policy*, 25(5), 924-927.
- Hope, V., J Scott, J., Cullen, K., Parry, J., Ncube, F., & Hickman, M. (2015). Going into the groin: injection into the femoral vein among people who inject drugs in three urban areas of England. *Drug Alcohol Depend*, 152, 239-45.
- Hope, V., Kimber, J., Hickman, M., Vickerman, P., & Ncube, F. (2008). Factors and cost associated with symptoms with injection site infections in England: findings from a multi-site survey. *BMC Infectious diseases*, 8, 120.
- Hope, V., McVeigh, J., Marongiu, A., Evans-Brown, M., Smith, J., Kimergård, A., et al. (2015). Injection site infections and injuries in men who inject image- and performance-enhancing drugs: prevalence, risks factors, and healthcare seeking. *Epidemiol Infect.*, 143(1), 132-140.
- Hope, V., Ncube, F., Parry, J., & Hickman, M. (2015). Healthcare seeking and hospital admissions by people who inject drugs in response to symptoms of injection site infections or injuries in three urban areas of England. *Epidemiol Infect.*, 143(1), 120-131.

- Judd, A., Hickman, M., Jones, S., McDonald, T., Parry, J., Stimson, G., et al. (2005, Jan). Incidence of hepatitis C virus and HIV among new injecting drug users in London: prospective cohort study. *BMJ.*, 330(7481), 24-25.
- Lake, C., & Beecroft, C. (2010). Extravasation injuries and accidental intra-arterial injection. *Contin Educ Anaesth Crit Care Pain*, 10(4), 109-113.
- Latkin, C., Vlahov, D., & Anthony, J. (1993). Socially desirable responding and self-reported HIV infection risk behaviors among intravenous drug users. *Addiction*, 88, 517–526.
- Lowy, F., & Miller, M. (2002). New methods to investigate infectious disease transmission and pathogenesis — Staphylococcus aureus disease in drug users. *The Lancet Infectious Diseases*, 2(10), 605 - 612.
- MacArthur, G., van Velzen, E., Palmateer, N., Kimber, J., Pharris, A., Hope, V., et al. (2014). Interventions to prevent HIV and Hepatitis C in people who inject drugs: a review of reviews to assess evidence of effectiveness. *Int J Drug Policy.*, 25(1), 34-52.
- Mackenzie, A., Laing, R., Douglas, J., Greaves, M., & Smith, C. (2000). High prevalence of iliofemoral venous thrombosis with severe groin infection among injecting drug users in North East Scotland: successful use of low molecular weight heparin with antibiotics. *Postgrad Med J.*, 76(899), 561–565.
- Maliphant, J., & Scott, J. (2005). Use of the femoral vein ('groin injecting') by a sample of needle exchange clients in Bristol, UK. *Harm Reduct J.*, 2(1), 6.
- Marks, M., Pollock, E., Armstrong, M., Morris-Jones, S., Kidd, M., Gothard, P., et al. (2013). Needles and the damage done: reasons for admission and financial costs associated with injecting drug use in a Central London Teaching Hospital. *J Infect.*, 66, 95-102.
- McCull, M., Tait, R., Greer, I., & Walker, I. (2001). Injecting drug use is a risk factor for deep vein thrombosis in women in Glasgow. *Br J Haematol.*, 112(3), 641–643.
- Mills, H., Johnson, S., Hickman, M., Jones, N., & Colijn, C. (2014). Errors in reported degrees and respondent driven sampling: implications for bias. *Drug Alcohol Depend*, 142, 120-6.
- Mullan, M., Magowan, H., & Weir, C. (2008). Femoral artery necrosis due to parenteral intravascular drug misuse: a case report and literature review. *Ulster Med J.*, 77(3), 203–204.
- Nicoll, L., & Hesby, A. (2002). Intramuscular injection: an integrative research review and guideline for evidence-based practice. *Appl Nurs Res.*, 15(3), 149-62.
- Ogston-Tuck, S. (2014). Subcutaneous injection technique: an evidence-based approach. *Nursing Standard*, 29(3), 53-58.
- Palmateer, N., Hope, V., Roy, K., Marongiu, A., White, J., Grant, K., et al. (2013). Infections with spore-forming bacteria in persons who inject drugs, 2000-2009. *Emerg Infect Dis.*, 19, 29-34.
- Pieper, B., Templin, T., Kirsner, R., & Birk, T. (2009). Substance abuse and chronic venous disorders. *West J Nurs Res.*, 31(8), 1092-3.
- Pirozzi, K., Van, J., Pontious, J., & Meyr, A. (2014). Demographic description of the presentation and treatment of lower extremity skin and soft tissue infections secondary to skin popping in intravenous drug abusers. *J Foot Ankle Surg.*, 53, 156-9.
- Pizzey, R., & Hunt, N. (2008). Distributing foil from needle and syringe programmes (NSPs) to promote transitions from heroin injecting to chasing: an evaluation. *Harm Reduct J.*, 5(24).
- Public Health England. (2014.). *Unlinked Anonymous Monitoring Survey of People Who Inject Drugs in contact with specialist services: data tables*. Centre for Infectious Disease Surveillance & Control and Microbiology Services. London: Public Health England.
- Rhodes, T., Briggs, D., Kimber, J., Jones, S., & Holloway, G. (2007). Crack-heroin speedball injection and its implications for vein care: qualitative study. *Addiction*, 102(11), 1782–1790.
- Rhodes, T., Stoneman, A., Hope, V., Hunt, N., & Judd, A. (2006). Groin injecting in the context of crack cocaine and homelessness: from 'risk boundary' to 'acceptable risk'? *Int J Drug Policy*, 17, 164–70.
- Salganik, M., & Heckathorn, D. (2004). Sampling and estimation in hidden populations using respondent-driven sampling. *Sociological Methodology*, 34, 193-239.

- Salmon, A., Dwyer, R., Jauncey, M., van Beek, I., Topp, L., & Maher, L. (2009). Injecting-related injury and disease among clients of a supervised injecting facility. *Drug Alcohol Depend.*, 101, 132-6.
- Scott, J., & Ponton, R. (2004). Injection preparation processes used by heroin and crack cocaine injectors. *Journal of Substance Use*, 9, 7–19.
- Scott, J., Winfield, A., Kennedy, E., & Bond, C. (2000). Laboratory study of the effects of citric and ascorbic acids on injections prepared with brown heroin. *International Journal of Drug Policy*, 11, 417–422.