Forensic Science International 278 (2017) 296–303

Contents lists available at ScienceDirect

Forensic Science International

journal homepage: www.elsevier.com/locate/forsciint

Postmortem blood sampling—Comparison of drug concentrations at different sample sites

B. Zilg[a,*], G. Thelander[b], B. Giebe[a], H. Druid[a]

[a] Swedish National Board of Forensic Medicine, Retzius väg 5, 171 65 Solna, Sweden
[b] Department of Forensic Genetics and Forensic Toxicology, National Board of Forensic Medicine, Linköping, Sweden

ARTICLE INFO

Article history:
Received 6 March 2017
Received in revised form 7 June 2017
Accepted 5 July 2017
Available online 25 July 2017

Keywords:
Postmortem redistribution
Forensic
Toxicology
Drug concentration

ABSTRACT

Drug concentrations in postmortem blood samples can differ considerably, depending on the sample site — a phenomenon named postmortem redistribution. In this study, blood samples from 48 cases of suspected intoxications were collected during autopsy at the Department of Forensic Medicine in Stockholm, Sweden. Samples were collected from the right and left heart, the carotid artery, jugular vein, external iliac artery and external iliac vein. The mean ratio of right heart/iliac vein was 1.3, which confirms the results from previous studies that drug concentrations in central blood are generally higher than in peripheral blood. The mean ratio of the ext iliac artery/ext iliac vein and the ratio of the carotid artery/jugular vein were 1.3 and 1.4, respectively, suggesting that drug concentrations are higher in arterial than in venous blood. Drugs with a low volume of distribution had a lower ratio of central/peripheral blood than drugs with a high volume of distribution (1.2 vs 1.4) and also a lower ratio of arterial/venous blood (1.3 vs 1.4). In cases with a short postmortem interval (PMI) there were no significant concentration differences in central and peripheral blood, but in cases with medium and long PMI, the ratios increased (1.2 and 1.4). Cases with a long PMI had an arterial/venous concentration ratio of 2.0. The results suggest that postmortem blood sampling should be performed as soon as possible after death and that peripheral venous blood, if available, should be used for analysis.

1. Background

In forensic pathology casework, toxicological analysis of alcohol, pharmaceutical drugs and illicit drugs is requested in most cases. The drug concentrations determined are often important, and sometimes even decisive, for the interpretation of the case, either for confirming or excluding a fatal intoxication or for estimating the possible degree of incapacitation. It has been known for several decades, however, that drug concentrations in postmortem blood samples can differ considerably, depending on the sample site — a phenomenon called postmortem redistribution. Several mechanisms have been proposed: drugs that are accumulated in various tissues, such as the heart, lungs, stomach and liver can diffuse to nearby blood vessels, blood movements due to pressure and fluidity changes may distribute substances to other sites, and later, cell autolysis and putrefaction may participate in changes of drug concentrations [1]. Different drugs are to a variable extent prone to postmortem redistribution. The postmortem interval, the route of administration of the drug and possibly the position of the body play a part. Pounder and Jones summarized the situation with the suitable article title “Postmortem drug distribution — a toxicological nightmare” [2].

A substantial body of literature has been produced on the topic of postmortem redistribution over the years. It has been established that postmortem blood samples should be collected as soon as possible, since the postmortem interval has a major impact on concentration changes [3–5]. There is also a general agreement that femoral blood should be used, since peripheral blood is less subject to postmortem redistribution than blood from central sites like heart blood, and since femoral blood is typically available in larger amounts than other peripheral blood. Apart from that, sampling procedures seem to differ considerably between forensic medicine departments, although recommendations for standardized postmortem blood sample collection have been suggested [6].

Few studies have addressed the question if there are concentration differences in arterial and venous blood. It has been shown that arteriovenous differences exist in vivo [7], and it cannot be ruled out that concentration differences also exist postmortem.

* Corresponding author.
E-mail address: brita.zilg@gmail.com (B. Zilg).

http://dx.doi.org/10.1016/j.forsciint.2017.07.006
0379-0738/

Table 1
Postmortem drug concentrations (μg/g) and ratios from all included cases.

Case	Estimated PMI (h) (warm/cold time)	Drug	Left heart	Right heart	Carotic artery	Jugular vein	Ext iliac artery	Ext iliac vein	LH/RH ratio	CA/JV ratio	EIA/EIV ratio	RH/EIV (central/peripheral)
1	166	Propiomazine	n.d.	n.d.	0.03	0.04	n.d.	n.d.		**0.75**		
	(27/138)	Dihydro-propiomazine	0.11	0.12	0.16	0.19	0.13	0.23	**0.92**	**0.84**	**0.6**	**0.5**
		Oxazepam	0.13	0.12	0.21	0.17	0.12	0.11	**1.08**	**1.24**	**1.1**	**1.1**
2	213	Metoprolol		1.00			0.70	0.60			**1.2**	**1.7**
	(123/89)	Warfarin		0.80			1.10	0.60			**1.8**	**1.3**
3	51	Alprazolam	0.02	0.03	0.02		0.02	0.02	**0.67**		**1.0**	**1.5**
	(12/38)	Diazepam	0.08	0.06	0.07		0.06	0.06	**1.33**		**1.0**	**1.0**
		Nordazepam	0.07	0.07	0.05		0.04	0.04	**1.00**		**1.0**	**1.8**
		Pregabalin	1.10	0.92	0.75		0.85	0.64	**1.20**		**1.3**	**1.4**
4	114	Methadone	n.d.	0.20	0.40	0.35	0.23	0.25		**1.14**	**0.9**	**0.8**
	(3/111)	Tramadol	n.d.	0.15	0.22	0.16	0.14	0.14		**1.38**	**1.0**	**1.1**
		7-amino-clonazepam	0.04	0.04	0.05	0.05	0.04	0.05	**1.00**	**1.00**	**0.8**	**0.8**
		Alprazolam	0.01	0.01	0.01	0.01	0.01	0.01	**0.88**	**1.29**	**1.0**	**1.3**
		Nordazepam	0.03	0.03	0.08	0.05	0.03	0.03	**1.00**	**1.60**	**1.0**	**1.0**
5	101	Methadone	0.09	0.11	0.30	0.17	0.28	0.10	**0.82**	**1.76**	**2.8**	**1.1**
	(16/84)	Alprazolam	0.01	0.01	0.01	0.01	0.01	0.01	**1.00**	**1.00**	**1.0**	**1.0**
		Diazepam	0.20	0.19	0.26	0.15	0.16	0.18	**1.05**	**1.73**	**0.9**	**1.1**
		Nordazepam	0.42	0.30	0.36	0.29	0.24	0.25	**1.40**	**1.24**	**1.0**	**1.2**
6	79	Alimemazine			0.09		0.10	0.10			**1.0**	
	(10/68)	Prometazine			0.20		0.10	0.10			**1.0**	
		Desmetyl-prometazine			0.10		n.d.	n.d.				
		Alprazolam	0.01		0.02	0.01	0.01	0.01		**2.00**	**1.0**	
		Diazepam	n.d.		n.d.	n.d.	0.03	n.d.				
		Duloxetine			0.02		0.01					
7	128	Olanzapine	0.19	0.13		0.09			**1.46**			
	(21/107)	Desmetyl-olanzapine	0.22	0.13		0.09			**1.69**			
		Alimemazine	0.08	0.10		0.20		0.10	**0.80**			**1.0**
		Desmetyl-alimemazine	0.10	0.20		0.20		0.20	**0.50**			**1.0**
		Paracetamol		11.00		11.00						
		Sertraline	0.20	0.20		0.20		0.10	**1.00**			**2.0**
		Desmetyl-sertraline	0.40	0.30		0.30		0.20	**1.33**			**1.5**
		Alprazolam	0.02	0.01		0.01			**2.00**			
8	95	Alimemazine	0.20	0.20		0.50	0.60	0.60	**1.00**		**1.0**	**0.3**
	(4/91)	Desmetyl-alimemazine	n.d.	n.d.		0.20	0.20	0.20			**1.0**	
		Methadone	2.80	2.90			4.40		**0.97**			
		EDDP	0.98	1.10		0.65	0.66	0.76	**0.89**		**0.9**	**1.4**
		Clonazepam	n.d.	n.d.	n.d.	n.d.	n.d.	0.01				
		7-amino-clonazepam	0.07	0.08	0.11	0.14	0.11	0.15	**0.88**	**0.79**	**0.7**	**0.5**
		Diazepam	0.37	0.38	0.36	0.64	0.33	0.76	**0.97**	**0.56**	**0.4**	**0.5**
		Nordazepam	0.73	0.75	0.54	0.69	0.50	0.82	**0.97**	**0.78**	**0.6**	**0.9**
		Temazepam	0.14	0.15	0.10	0.15	0.09	0.19	**0.93**	**0.67**	**0.5**	**0.8**
		Oxazepam	0.05	0.05	0.04	0.04	0.04	0.05	**1.00**	**1.00**	**0.8**	**1.0**
9	117	*O*-desmetyl-tramadol										
	(58/58)	Mirtazapine										
		Venlafaxine										
		O-desmetyl-venlafaxine										
		7-amino-clonazepam	0.01	0.01	0.01		0.01	n.d.	**0.89**			
		Diazepam	0.16	0.18	0.22		0.17	0.13	**0.89**		**1.3**	**1.4**
		Nordazepam	0.40	0.27	0.38		0.23	0.22	**1.48**		**1.0**	**1.2**
10	43	Quetiapine	0.15	0.18		0.20		0.17	**0.83**			**1.1**
	(6/36)	Methadone	0.73	0.72		1.10		0.81	**1.01**			**0.9**
		Nordazepam	n.d.	n.d.	0.03	n.d.	0.04	n.d.				
11	75	7-amino-clonazepam	0.01	0.02		0.01	0.01	0.01	**0.50**		**1.0**	**2.0**
	(11/64)	Alprazolam	0.07	0.09		0.08	0.08	0.08	**0.78**		**1.0**	**1.1**
		Nordazepam	0.06	0.10		0.03	0.03	n.d.	**0.60**			
12	77	Venlafaxine				1.40						
	(6/71)	*O*-desmetyl-venlafaxine				1.10						