Journal of Interdisciplinary Science Topics

Would Pamela Poovey Suffer from a Cocaine Overdose?

Katherine Smith
The Centre for Interdisciplinary Science, University of Leicester
22/03/2016

Abstract
This paper looks at Pam Poovey's cocaine consumption during Season 5 of Archer (Archer Vice), and calculates whether the amount of the cocaine would be of a sufficiently high dosage to cause an overdose. Based on the evidence during screen time of Season 5 Episode 2, it is estimated that from wearing the full body plaster cast for 6 hours (made up of 96 % cocaine) as well as eating part of it, Pam absorbs 17.24 g of cocaine on the first day; high enough to cause Pam to suffer an overdose.

Introduction
During Season 5 of the TV Series Archer (Archer Vice), Pam Poovey becomes addicted to cocaine due to her absorbing it through her skin. This occurs as the cocaine is mixed with plaster to smuggle it out of the country as a plaster cast - as Pam is wearing the cast, she absorbs some cocaine through her skin when it dissolves in her sweat. Over the next few episodes in the series, there are multiple references to how much Pam consumes. Therefore, it is possible that Pam consumes a high enough dosage to suffer an overdose. This paper calculates the amount of cocaine that Pam consumes/absorbs to work out whether this value would be high enough to be fatal.

Assumptions
There are a few assumptions which have to be made when considering Pam's cocaine intake. Firstly, the cause of the cocaine addiction was due to the cocaine being absorbed through the skin from a full body cast [1]. This means that the consumption of any type of drug prior to the first episode of Archer Vice are not counted in these calculations. Secondly, due to the amount of other substances that have been abused by Pam in previous seasons, these calculations are working on the assumption that Pam has a high tolerance to addictive substances; she would require a higher dosage of cocaine to overdose. Additionally, in order to work out the surface area of the body that the cocaine can be absorbed by, it is assumed that Pam is the same size as the average American woman. Lastly, during Season 6 Episode 5, Lana makes a reference to the fact that Season 5 lasted for approximately 1 year [2]. Therefore, the assumption is that the maximum amount of time that Pam could have been ingesting the cocaine for is 12 months.

Quality of Cocaine
In order to work out the amount of the cocaine that was absorbed through the skin or ingested, the purity of the cocaine must be taken into account. As the cocaine was mixed into a plaster cast to be placed around Pam, the purity of the cocaine will not be 100 % as it will be very difficult to separate the remnants of the plaster from the cocaine. However, the purity of the cocaine is still incredibly high - it is mentioned to be 96 % pure [3].

Calculations
As stated earlier, Pam is considered to be the same size as the average American woman [4]. This can be used to calculate the dose that the cocaine-plaster cast (assuming the 96 % purity is also true in this case) gave to Pam by using equation 1 [5],

$$Dose = \frac{cAK_p}{W}, \quad (1)$$

where c is the concentration of the chemical, A the surface area, K_p is the permeability coefficient and W is body weight.

In order to be able to calculate the concentration of the cocaine, a number of steps must be taken.

Firstly, the mass of the cocaine in the cast must be estimated. Next, assuming the sweat has the same solvent properties of water, an estimate of the sweat produced over time is required to calculate the total volume of swear produced. Given the data for these, a concentration of cocaine can be calculated using equation 2.

$$Concentration = \frac{Mass}{Volume} \quad (2)$$

As Pam was wearing the cast for six hours, the total sweat volume can be calculated from the average sweat production per hour. Therefore the volume is 24 litres (from sweat production of 4 litres per hour [6] over six hours [1]).

The mass of the cast is worked out in a number of stages. Firstly, the surface area of the cast must be calculated. This was done by modelling all of the body parts as if they were uniform cylinders, and using equation 3 to calculate the surface area of each body part (shown in Tables 1-3 in the Appendix).

$$Surface\ Area = 2\pi rh \times 2\pi r^2 \quad (3)$$

This gives a total surface area of 25340 cm^2 for 2 arms, 2 legs and trunk [7]. Next, the mass of a typical roll of plaster is stated as 10 pounds for 10 rolls of 6" plaster [8]. As typical casts are made up of calcium sulphate dihydride, the mass of the cocaine-plaster cast can be calculated by the total mass of being 4 % calcium sulphate dihydride, and 96 % cocaine. Assuming an overlap of 5/6ths for the cast (due to the multiple layering of the bandages) [9], each roll of 6" by 5 yards plaster would cover 180 $inches^2$. Therefore the total number of rolls required would be 21.82, meaning a mass of 21.82 pounds (9.9 kg).

The number of moles of calcium sulphate in the original cast can be calculated from equation 4.

$$Moles = \frac{Mass}{Molecular\ Mass\ (M_r)} \quad (4)$$

This gives a value of 57.49 total moles of calcium sulphate dihydride in the original cast. Therefore, by using 4 % calcium sulphate dihydride (M_r of 172.2) and 96 % cocaine (M_r of 303.4), there are 2.30 moles of calcium sulphate dihydride and 55.19 moles of cocaine in the cast. Therefore the weight of the plaster-cocaine cast can be calculated as 396 g + 16740 g = 17140 g (4.s.f). Therefore, by using mass = 17140 g and volume = 24 litres, the concentration of cocaine becomes 714 g $litre^{-1}$. This means that the dosage that Pam absorbs 1.42 g of cocaine (as calculated from equation 1) as the average mass of an American female is 63.5 kg, and the permeability coefficient is 0.005 cm min^{-1} [10].

Amount of Cocaine for an Overdose

Given the assumption that Pam can tolerate higher levels of cocaine consumption, it is considered that Pam would be able to tolerate values of ingestion higher than 1.2 g per day - the assumed minimal fatal dose in people who have little to no drug tolerance. As some cocaine addicts can tolerate up to 5 g of cocaine daily [11], this paper works on the assumption that Pam would have to ingest more than 5 g of cocaine in order to suffer from an overdose. Therefore, Pam does not absorb enough cocaine to suffer an overdose just through the body cast; however, this would be enough to kill someone who did not have a high drug tolerance.

However, in the same episode as the full body cast [1], Pam is shown to be nibbling at the lower leg portion of the cast. By modelling this like a cylinder, it can be calculated that there is a cocaine mass of 767.2 g in the lower leg. Therefore, by using a typical Japanese female bite have the volume of 8 cm^3 [12] and assuming that this is the same as the typical American female, it can be calculated that in order to consume the entire lower leg cast's surface area of 1,164 cm^2 that Pam required 145.5 bites to consume the leg (assuming the volume is the same as the surface area e.g. 1 cm thick cast layer). Therefore, for the three bites seen in the episode, Pam would consume 15.82 g of cocaine per bite on the same day. This would put the total consumption for that day at a minimum of 17.24 g, as some bites may not be shown on screen. This means that Pam would suffer an overdose from this first day of ingestion.

Conclusion

Given the values calculated in this paper, it can be seen that Pam's cocaine consumption in Archer Vice is equivalent to 17.24 g on the first day, meaning that Pam does consume enough cocaine to suffer an overdose, without having to consider the full timeline of the season.

References

[1] Reed, A. (2014) *Archer Vice: A Kiss While Dying,* Archer, Season 5 Episode 2. First Broadcast 20 January 2014.

[2] Reed, A. & Hoffman, B. (2015) *Vision Quest*, Archer, Season 6, episode 5. First Broadcast 5 February 2015.

[3] Reed, A. (2014) *Archer Vice: Smugglers' Blues*, Archer, Season 5 Episode 6. First Broadcast 10 March 2014

[4] The University of Texas at Austin, (2015). *Body Image*. [online] Healthyhorns.utexas.edu. Available at: http://www.healthyhorns.utexas.edu/n_bodyimage.html [Accessed 04/03/2016].

[5] Wikipedia, (2016). *Absorption (skin)*. [online] Available at: https://en.wikipedia.org/wiki/Absorption_%28skin%29 [Accessed 04/03/2016].

[6] The Anatomical Travelogue, (2014). *Sweating TheVisualMD.com*. [online] Thevisualmd.com. Available at: http://www.thevisualmd.com/searchimg/?idu=1083618606&q=%20psychological&p=13 [Accessed 04/03/2016].

[7] NASA, (2008) *ANTHROPOMETRY AND BIOMECHANICS*. [online] Msis.jsc.nasa.gov. Available at: http://msis.jsc.nasa.gov/sections/section03.htm [Accessed 04/03/2016].

[8] Orthotape, (2016) *Plaster Bandages – Plaster Gauze for Art, Hobby or Medical*. [online] Available at: http://www.orthotape.com/plaster_bandages.asp [Accessed 15/03/2016].

[9] Orthotape, (2015). *Plaster Bandages: A how to application and use video*. [video] Available at: https://www.youtube.com/watch?v=ivWvxYj0A-Y [Accessed 11/03/2016].

[10] Fiala, M., Gan., X.-H., Zhang, L., House, D. Newton, T., Graves, M.C., Shapshak, P., Stins, M. Kim, K.-S., Witte, M. & Chang, S.L. (1998). *Cocaine enhances monocyte migration across the blood-brain barrier*. In: Drugs of Abuse, Immunomodulation, and Aids. Edited by Friedman, H., Madden, J. & Klein, T. Boston, MA: Springer US.

[11] Drug.addictionblog.org, (2014). *Cocaine overdose: How much amount of cocaine to overdose? | Addiction Blog*. [online] Available at: http://drug.addictionblog.org/cocaine-overdose-how-much-amount-of-cocaine-to-overdose/ [Accessed 04/03/2016].

[12] Nakamichi, A., Matsuyama, M. & Ichikawa, T. (2014) *Relationship between mouthful volume and number of chews in young Japanese females*, Appetite, vol. 83, pp. 327-332

Appendix

			Full Leg Surface Area (cm^2)
Circumference (cm)	Thigh	60.0	5139
	Calf	37.6	
	Average	48.8	
Average Radius (cm)		7.77	
Length (cm)	Thigh	61.3	
	Calf	36.2	
	Total	97.5	

			Full Arm Surface Area (cm^2)
Circumference (cm)	Forearm	22.0	1788
	Upper Arm	25.5	
	Average	23.8	
Average Radius (cm)		3.78	
Length (cm)	Forearm	41.7	
	Upper Arm	29.8	
	Total	71.5	

			Trunk Surface Area (cm^2)
Circumference (cm)	Chest	82.1	11490
	Waist	63.2	
	Average	72.7	
Average Radius (cm)		11.6	
Length (cm)	Trunk	146	

Tables A-C) A series of tables showing the surface area for the leg, arm and trunk respectively when modelling the body parts as uniformed cylinders using equation 3 [7].