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Toxicological and Pathological Findings in Fatalities Involving Pentazocine and Tripelennamine

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ABSTRACT: Toxicological and pathological findings are described in fatalities involving pentazocine (Talwin®) and tripelennamine (Pyribenzamine®). Procedures using thin-layer chromatography, gas chromatography, ultraviolet spectrophotometry, and spectrophotofluorometry are described, as well as the quantitative analysis of biological specimens of drug abuse and homicide victims. Microscopic findings in lung specimens from drug abuse deaths are also described.

KEYWORDS: pathology and biology, toxicology, pentazocine, tripelennamine

The incidence of deaths attributed to the combined usage of pentazocine (Talwin®) and tripelennamine (Pyribenzamine®) has increased dramatically in Wayne County (metropolitan Detroit), MI since the first three cases were observed in Nov.–Dec. 1979. In 1980, 17 such deaths occurred. Although these drugs were not detected in any homicide victims in 1979, in 1980 eight homicide victims were using this drug combination.

Details of pentazocine and tripelennamine abuse have previously been described [*1,2*]. Briefly, this mixture represents the combination of an analgesic (pentazocine) and an antihistamine (tripelennamine). This particular combination, referred to as "T's and Blues," is injected intravenously after dissolving the two components in water and filtering the mixture. The ratio of the compounds is variable, but most preparations contain a larger quantity of pentazocine than tripelennamine.

Metabolic studies using the oral administration of pentazocine [*3,4*] indicate that only approximately 0.5 to 20% of the dosage is excreted unchanged in the urine. Oxidation occurs at the dimethylallyl side chain producing two isomeric alcohols, one of which (trans-alcohol) is further oxidized to the corresponding acid group before, and following, alcohol formation.

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Four metabolites of tripelennamine have been isolated from the urine of human subjects [5]. Three are glucoronide conjugates, one being unique in that it has been identified as a quarternary ammonium *N*-glucoronide structure. The fourth is an *N*-oxide derivative of tripelennamine and is considered a minor metabolite.

Several methods are available for detecting pentazocine in biological specimens. Thin-layer chromatography [6] and gas chromatography [7] have been used qualitatively, whereas fluorescence [8] and gas chromatography have been described for quantitative analysis [9]. Only a few investigators have described the detection of both pentazocine and tripelennamine simultaneously. Thin-layer chromatography [10] and a combination of thin-layer chromatography and gas chromatography/mass spectrometry [11] have been used for this analysis.

The methods described here use a combination of thin-layer chromatography (one solvent system), gas chromatography (two columns), ultraviolet spectrophotometry, and spectrophotofluorometry. The physical-chemical properties of these compounds permit the use of all four techniques for their detection in biological specimens. Quantitative analysis may be achieved with gas chromatography using flame ionization detection.

Experimental Procedures

Thin-Layer Chromatography

Urine specimens were extracted according to the procedure of Davidow [12]. Analtech plates were used and the solvent system consisted of ethyl acetate (85), methanol (10), ammonium hydroxide (0.5), and water (4.5). The spray sequence consisted of ninhydrin-phenylacetaldehyde, 5% sulfuric acid, and iodoplatinate followed by concentrated hydrochloric acid.

Ultraviolet Spectrophotometry

A Beckman Model 35 ultraviolet visible spectrophotometer was used. Urine specimens (10 mL) were made alkaline and extracted with diethyl ether (50 mL). The ether layer was washed with distilled water, filtered through sodium sulfate, and extracted with 0.1*N* sulfuric acid (2.0 mL). The ultraviolet spectrum was recorded from 360 to 220 nm in both acid and aklaline solutions.

Spectrophotofluorometry

A Perkin Elmer Model MPF-2A spectrophotofluorometer equipped with a xenon light source was used. The extract from the ultraviolet spectrophotometric procedure was made acidic before recording the fluorescence spectrum.

Gas Chromatography

Urine specimens (2 mL) were made alkaline with saturated sodium borate (1 mL). Fifty micrograms of internal standard (aminopyrine) were added, and, while vortexing, 200 μL of chloroform were added with a microliter syringe. After centrifugation, 4 μL of chloroform were injected onto a Perkin Elmer Model 900 gas chromatograph equiped with a 1.83-m (6-ft) 3% OV-17 and 10% SE-30 columns and flame ionization detectors. Any positive result obtained on the OV-17 column was confirmed on the SE-30 column.

Blood specimens (5.0 mL) were made alkaline with 0.5 mL of ammonium hydroxide, 50 μg of methadone internal standard were added (the retention times of aminopyrine and tripelennamine were too similar for separation), and the specimen was extracted with 10 mL

of *n*-butyl chloride. After centrifugation, the *n*-butyl chloride was extracted with 3 mL of 0.1*N* sulfuric acid. The sulfuric acid layer was recovered, made alkaline with 6*N* sodium hydroxide, and extracted with 200 μL of chloroform. After centrifugation, 15 μL of chloroform were injected onto a Perkin Elmer Model 3920 gas chromatograph equipped with a 1.83-m (6-ft) 3% OV-17 column, MS-41 Solid Sampler, and flame ionization detector.

Tissue specimens were homogenized (1:1 with distilled water), and 2 g of tissue were analyzed as in the blood procedure.

Materials

All chemicals were reagent grade.

Pentazocine, pentazocine trans-alcohol, and pentazocine trans-acid were obtained from Sterling Winthrop Research Institute, Renesselaer, NY 12144. Tripelennamine was obtained from Geigy Pharmaceuticals, Summit, NJ 07901. Methadone was obtained from Eli Lilly and Company, P.O. Box 618, Indianapolis, IN 46206. Aminopyrine was obtained from Pfaltz and Bauer, Inc., 126-02 Northern Blvd., Flushing, NY 11368.

Results

Recovery Experiments

Only the more common extraction solvents were investigated for recovering pentazocine and tripelennamine from aqueous solutions. These results are shown in Table 1 and represent the extraction into organic solvent and reextraction into 0.1*N* sulfuric acid. Comparison was made to the nonextracted drugs dissolved in 0.1*N* sulfuric acid.

With the exception of ethyl acetate, all of the solvents extracted pentazocine comparably. The recovery of tripelennamine is generally poorer than that of pentazocine, with diethyl ether exhibiting the best recovery. It is noteworthy that *n*-butyl chloride is the poorest extracting solvent for tripelennamine since this solvent is often used for extracting organic basic drugs in general. For extracting this particular combination of drugs in the same specimen, diethyl ether is clearly the most effective agent. However, this laboratory routinely uses *n*-butyl choride since mechanically it is simpler to handle, chromatograms contain few extraneous peaks, and adequate sensitivity (0.5 μg/5 mL of blood) is achievable with the solid injection system.

TABLE 1—*Comparison of organic solvents for extraction of pentazocine and tripelennamine from aqueous solution.*

Solvent	Pentazocine[a]		Tripelennamine[a]	
	% Recovery	Average Deviation	% Recovery	Average Deviation
Ethyl acetate	54	3	47	1
Diethyl ether	85	3	75	1
Toluene[b]	...	...	68	4
n-butyl chloride	82	3	40	2
Chloroform	85	4	62	2
Methylene chloride	81	6	62	2
Ethylene chloride	84	3	60	2

[a]The average of three determinations on three different days.
[b]Unsuitable for ultraviolet assessment of the recovery of pentazocine.

Ultraviolet Spectrophotometry

The ultraviolet spectra of pentazocine, tripelennamine, and a mixture of these two drugs are shown in Figs. 1 to 3, respectively.

The main characteristic of the pentazocine spectrum is the shift in absorption maximum from approximately 280 nm in acid to approximately 300 nm in base, with significantly increased absorption in base. Both the trans-alcohol and trans-acid metabolites exhibit this same shift. There is an additional shift at the lower wavelength maximum from 222 to 240 nm. This latter shift, however, is not very obvious when biological extracts are examined.

In acid, tripelennamine has absorption maxima at approximately 314 and 240 nm. When the solution is made alkaline, the 240-nm maximum shifts to 250 nm with slightly increased absorption, and the 314-nm maximum shows little shift in absorption wavelength but markedly decreased absorption. This decrease in absorption at 314 nm is significant when pentazocine and tripelennamine are present in the same specimen since this absorption maximum virtually disappears when the ultraviolet spectrum of both drugs is recorded under alkaline conditions, as discussed below.

If pentazocine and tripelennamine are both present in acid solution, absorption maxima are observed at 314 and 280 nm, and inflections are observed at 240 and 222 nm. When the solution is made alkaline the pentazocine maximum at 300 nm appears and the 314-nm max-

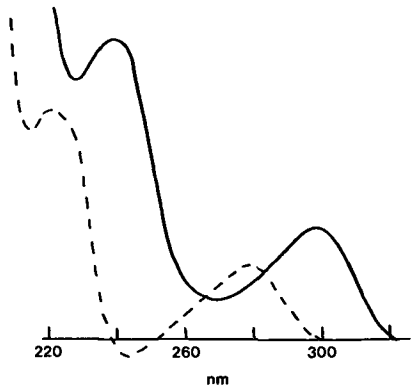

FIG. 1—*Ultraviolet spectra of pentazocine, --- = acid and ____ = base.*

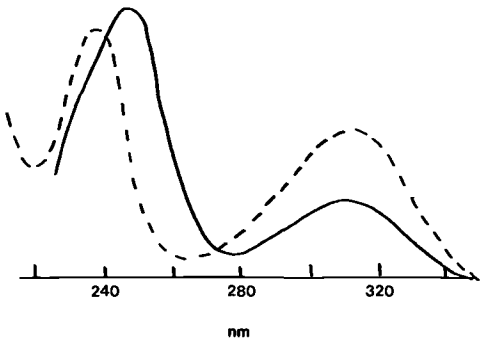

FIG. 2—*Ultraviolet spectra of tripelennamine, --- = acid and ____ = base.*

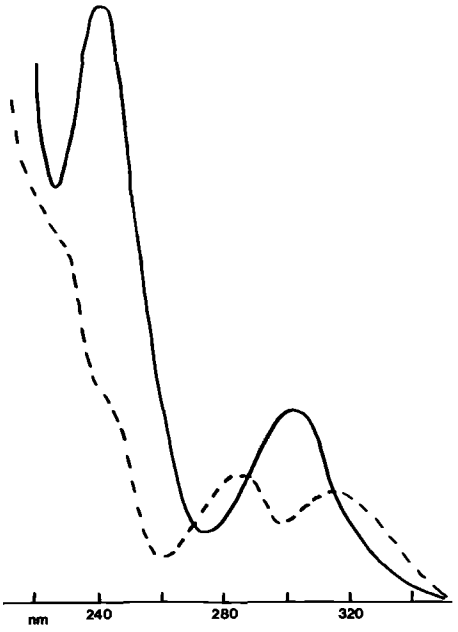

FIG. 3—*Ultraviolet spectra of pentazocine and tripelennamine, --- = acid and ____ = base.*

imum of tripelennamine disappears. A second maximum, also a result of pentazocine, appears at 240 nm. The ultraviolet spectrum of this mixture, if recorded in acid and base, is extremely useful for identification of these substances in biological specimens. Typical ultraviolet spectra of biological extracts are shown in Figs. 4 and 5.

Spectrophotofluorometry

Both pentazocine and tripelennamine exhibit native fluorescence, and these excitation and emission spectra are shown in Figs. 6 and 7. When excited at approximately 286 nm, pentazocine fluorescences at 310 nm. The trans-alcohol metabolite exhibits this same fluorescence, but the trans-acid metabolite does not. Tripelennamine fluoresces at about 410 nm when excited at 350 nm.

Since the fluorescence properties of these compounds are sufficiently different, both drugs may be detected fluorometrically in the same specimen. The convenient procedure is to retain the urine extract after recording the ultraviolet spectrum in acid and base, make the solution acid, and then record the fluorescence spectrum using excitation wavelengths of 286 and 350 nm, respectively. The fluorescence spectrum is particularly useful for pentazocine since some drugs may exhibit similar ultraviolet spectra, but none are known to fluoresce under the described conditions. Examples of such drugs are morphine, hydromorphone, and hydroxyamphetamine.

Thin-Layer Chromatography

Only one solvent system is generally used in this laboratory since the thin-layer chromatography data are always compared with ultraviolet spectrophotometry, spectrophotofluorometry, and gas chromatography data before making a positive identification of these two substances in a biological specimen.

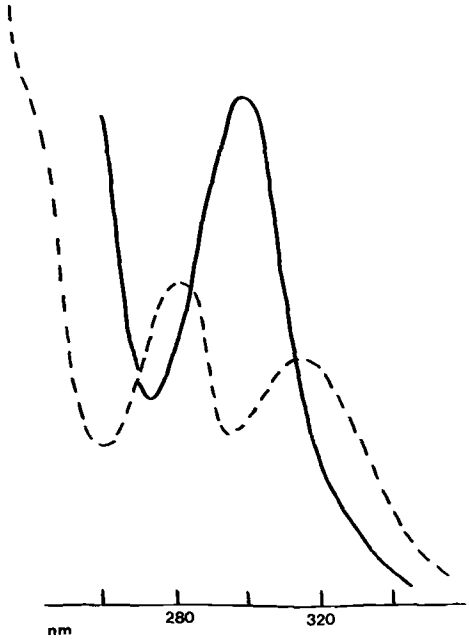

FIG. 4—*Ultraviolet spectra of urine extract.* --- = *acid and* ___ = *base.*

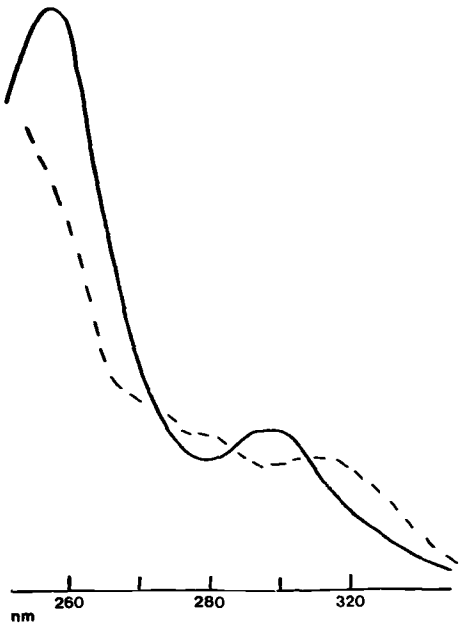

FIG. 5—*Ultraviolet spectra of kidney extract.* --- = *acid and* ___ = *base.*

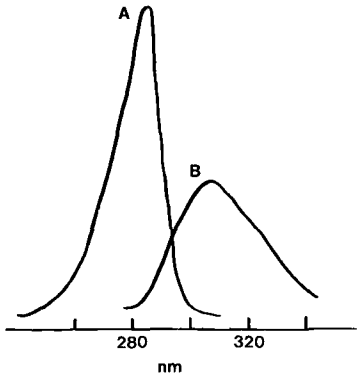

FIG. 6—*Fluorescence spectra of pentazocine.* A = *excitation spectrum and* B = *emission spectrum.*

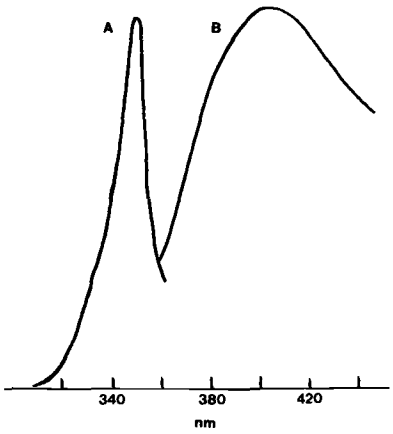

FIG. 7—*Fluorescence spectra of tripelennamine.* A = *excitation spectrum and* B = *emission spectrum.*

Pentazocine is well separated from the more common drugs with the possible exception of methadone. However, the fluorescence of pentazocine is observable on the thin-layer plate, and this observation, in combination with the absence of the major metabolite of methadone, assists in the identification. The trans-alcohol metabolite of pentazocine migrates and reacts with the spray reagent (iodoplatinate) in a similar fashion to quinine, while the trans-acid metabolite does not migrate in this particular solvent system.

Methapyrilene reacts identically (both fluorescence and color produced with iodoplatinate) to tripelennamine in this solvent system, and only a slight difference in R_f values is observed. This difference is usually adequate, however, if both reference drugs are developed on the same thin-layer plate. An additional spray reagent assists in the differentiation of these two compounds. Following the iodoplatinate spray, ammonium vanadate produces a red-brown color with methapyrilene, but essentially no color change with tripelennamine.

Gas Chromatography

In this laboratory 3% OV-17 and 10% SE-30 columns are routinely used for qualitative gas chromatographic analysis of urine specimens. Other drugs may interfere with the iden-

tification of both pentazocine and tripelennamine; however, all of these drugs are clearly distinguishable by their ultraviolet absorption properties.

Blood specimens may be analyzed on 3% OV-17 using methadone as an internal standard once it is established that methadone is not present in the biological specimen. Employing *n*-butyl chloride as extracting solvent and flame ionization detection, in this laboratory it is necessary to inject 15 μL of extract to achieve adequate sensitivity (0.5 to 1.0 μg in 5 mL of blood or 2 g of tissue). Representative gas chromatograms are shown in Figs. 8 and 9. Using the procedures described, neither the trans-alcohol nor the trans-acid metabolite of pentazocine possess useful gas chromatographic properties.

Discussion

Toxicological Findings

In virtually every fatality caused by drug abuse described above, some form of drug usage was indicated by either investigation of the scene or external examination of the body. In ten instances needle tracks were specifically mentioned in the autopsy protocol. In the remaining cases either some form of drug paraphernalia was retrieved at the scene of death or drug usage was indicated by history. In four cases pentazocine and tripelennamine specifically

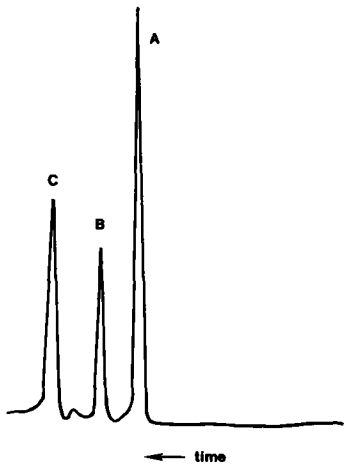

FIG. 8—*Gas chromatrogram of blood control containing* (A) *tripelennamine,* (B) *methadone (internal standard), and* (C) *pentazocine. The blood control contains 5 mg/L each of tripelennamine and pentazocine.*

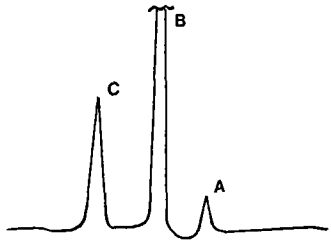

FIG. 9—*Gas chromatogram of blood specimen containing* (A) *tripelennamine,* (B) *methadone (internal standard), and* (C) *pentazocine.*

were mentioned in the medical examiner's investigative report, and in two cases pentazocine alone was indicated.

Toxicological findings in the 17 deaths attributed to drug abuse are summarized in Table 2. In three instances neither pentazocine nor tripelennamine were detected in blood. In one case only pentazocine was detected in blood, but both compounds were detected in liver and kidney. Therapeutic blood concentrations are reported to range from 0.05 to 0.20 mg/L and fatal blood concentrations from 1 to 5 mg/L [*13*]. Although factors such as tolerance and time interval between exposure to the drug and death are difficult to determine postmortem, with only one exception all of the blood concentrations of pentazocine were in the range usually associated with toxicity. Therapeutic blood concentrations of tripelennamine are usually less than 0.06 mg/L [*14*], which approximates the limit of detection in this laboratory using the procedure described. When detected in blood (13 of 17 cases), tripelennamine was usually present (11 of 13 cases) in concentrations equal to or greater than twice the higher therapeutic concentration. In three instances the drug was present in blood in concentrations ten times greater than the reported higher therapeutic concentration.

Two of the victims survived for several hours in the hospital. Case 11 survived for nearly 6 h after allegedly injecting "three ampoules" of pentazocine. Case 5 received treatment for 7 h after injecting "T's and Blues." In one case (Case 15), ice used to revive the victim was found in the pants of the victim when Emergency Medical Service arrived at the scene. This individual expired 25 min after arrival at a hospital. Other victims (Cases 3, 5, 6, 7, 8, 13, and 16) survived for 35 min or less in a hospital. In none of these cases was information available indicating the time interval between exposure to the drugs and discovery of the body.

Consistent with the reported practice of using more pentazocine than tripelennamine in the preparation of the mixture to be injected, blood concentrations of pentazocine are always greater than the corresponding tripelennamine concentration. This was true for every case but one; in this exception the blood concentrations were equal. This same observation is apparent in the relative concentrations of pentazocine and tripelennamine in liver and kidney specimens.

In five cases the liver/blood ratio of pentazocine could be determined. This ratio ranged from 2.6 to 4.8 in four cases and was less than 1.0 in the remaining case. This exception (Case 13) also had significant blood concentrations of amitriptyline and nortriptyline.

The liver/blood ratio of tripelennamine could be determined in only four cases, and this ratio ranged from 2.0 to 6.9. The lowest ratio was observed in Case 13, as described above.

Other drugs, including ethanol, were detected in 47% [*8*] of these deaths. In two cases (one decomposed) only ethanol was detected. The only other substance appearing in more than one death is codeine which was present in three different individuals.

For comparison, blood concentrations of homicide victims are shown in Table 3.

Pathology Findings

Lung specimens from 25 of the 29 fatalities were examined microscopically. Specimens from 21 of these individuals exhibited severe diffuse pulmonary granulomatosis. In three of the 25 cases granulomatous changes were sparse, and in one case none could be found. In the most severely involved cases the cut surface of the affected lung was speckled with tiny, gritty, hard, 1- to 2-mm nodules, which gave a sandy consistency to the lung as it was being cut.

The microscopic appearance was that of diffuse intravascular and perivascular involvement with foreign body granulomata. Adjacent arteriolar and capillary thrombosis was noted along with identifiable foreign body reaction within the vessel walls and lumena. Use of polarized light allowed the identification of birefrigent crystals of talc-like material within the foreign body cells.

The pulmonary disease resulting from intravenous injection of crushed tablets is well recognized and has been observed with the use of such drugs as propoxyphene [*15*],

TABLE 2—*Summary of pentazocine and tripelennamine concentrations in deaths attributed to drug abuse.*

Case	Blood[a]		Liver[b]		Kidney[b]		Other Positive Findings
	Pentazocine	Tripelennamine	Pentazocine	Tripelennamine	Pentazocine	Tripelennamine	
1[c]	negative	negative	N.A.[d]	N.A.	N.A.	N.A.	none
2	1.1	0.1	N.A.	N.A.	N.A.	N.A.	none
3	negative	negative	2.8	1.6	N.A.	N.A.	none
4	2.0	0.4	5.3	1.5	7.0	1.4	blood ethanol: 0.11%
5	1.2	negative	5.7	6.5	1.4	0.4	blood codeine: 0.5 mg/L liver codeine: 1.3 mg/Kg kidney codeine: 1.3 mg/Kg
6	4.3	0.7	18	4.8	11	2.0	none
7	1.6	1.5	N.A.	N.A.	N.A.	N.A.	blood carisoprodol: 10 mg/L blood meprobamate: 18 mg/L
8	5.8	0.1	N.A.	N.A.	N.A.	N.A.	blood codeine: 0.4 mg/L
9	5.7	0.3	N.A.	N.A.	N.A.	N.A.	none
10	11	0.2	N.A.	N.A.	N.A.	N.A.	none
11	0.4	0.4	N.A.	N.A.	N.A.	N.A.	none
12[c]	negative	negative	N.A.	N.A.	N.A.	N.A.	blood ethanol: 0.15% urine ethanol: 0.23% blood morphine: 0.19 mg/L urine cocaine: positive
13	3.6	0.5	1.5	1.0	1.6	0.4	blood phenobarbital: 4.3 mg/L blood amitriptyline: 1.1 mg/L blood nortriptyline: 4.8 mg/L
14	4.0	3.0	N.A.	N.A.	N.A.	N.A.	blood ethanol: 0.06% (specimen decomposed)
15	8.1	1.2	N.A.	N.A.	N.A.	N.A.	blood ethanol: 0.08% urine ethanol: 0.17% subdural ethanol: 0.11% blood codeine: 1.1 mg/L blood acetaminophen: 16 mg/L
16	1.4	0.3	N.A.	N.A.	N.A.	N.A.	none
17	1.7	0.4	N.A.	N.A.	N.A.	N.A.	none

[a]Concentrations in mg/L.
[b]Concentrations in mg/Kg.
[c]Pentazocine and tripelennamine positive in urine.
[d]Specimen not submitted for analysis.

TABLE 3—*Summary of blood pentazocine and tripelennamine concentrations in homicide victims.*

Case	Blood Concentratations[a]		Other Positive Findings[b]
	Pentazocine	Tripelennamine	
1	negative	negative	none
2	1.5	1.0	blood ethanol: 0.16% urine ethanol: 0.28%
3	negative	negative	blood ethanol: 0.04% urine ethanol: 0.06% blood amobarbital: 10 mg/L
4	negative	negative	urine morphine: positive
5	0.7	0.4	blood ethanol: 0.08% urine ethanol: 0.07%
6	1.3	negative	urine phenmetrazine: positive
7	0.3	0.1	blood ethanol: 0.22% urine ethanol: 0.27%

[a]Concentrations are in mg/L.
[b]Pentazocine and tripelennamine positive in urine.

methadone [*16*], morphine [*17*], and methylphenidate [*18*] in addition to pentazocine and tripelennamine [*19*]. Although the pulmonary changes in the cases described were severe enough to have possibly produced overt symptoms of pulmonary hypertension, none of the cases examined was determined to have died of this mechanism alone.

Conclusion

Abuse of the combination of pentazocine and tripelennamine increased significantly in the Detroit area during 1980. These compounds may be identified in biological specimens by the combined use of gas chromatography, thin-layer chromatography, ultraviolet spectrophotometry, and spectrophotofluorometry. Quantitation in blood and tissue specimens may be performed by gas chromatography with a flame ionization detector.

Severe diffuse pulmonary granulomatosis was present in the majority of cases. This foreign body reaction was not detectable in only one of 25 cases examined. In none of the cases were the pulmonary changes determined to have caused death.

References

[*1*] Showalter, C. V. and Moore, L., "Abuse of Pentazocine and Tripelennamine," *Journal of the American Medical Association*, Vol. 239, No. 16, 1978, pp. 1610-1612.

[*2*] Poklis, A. and Whyatt, P. L., "Current Trends in the Abuse of Pentazocine and Tripelennamine: The Metropolitan St. Louis Experience," *Journal of Forensic Sciences*, Vol. 25, No. 1, Jan. 1980, pp. 72-78.

[*3*] Pittman, K. A., "Human Metabolism of Orally Administered Pentazocine," *Biochemical Pharmacology*, Vol. 19, 1970, pp. 1833-1836.

[*4*] Vaughn, D. P. and Becket, A. H., "An Analysis of the Intersubject Variation in the Metabolism of Pentazocine," *Journal of Pharmacy and Pharmacology*, Vol. 26, No. 10, 1974, pp. 789-798.

[*5*] Chaudhuri, N. K., Servando, O. A., Manniello, M. J., Luders, R. C., Chao, D. K., and Bartlett, M. D., "Metabolism of Tripelennamine in Man," *Drug Metabolism and Disposition*, Vol. 4, No. 4, 1976, pp. 372-378.

[*6*] Clarke, E. G. C., *Isolation and Identification of Drugs*, Vol. 1, The Pharmaceutical Press, London, Great Britain, 1969, p. 46.

[*7*] Clarke, E. G. C., *Isolation and Identification of Drugs*, Vol. 1, The Pharmaceutical Press, London, Great Britain, 1969, p. 82.

[*8*] Berkowitz, B. A., Asling, J. H., Schnider, S. M., and Way, E. L., "Relationship of Pentazocine

Plasma Levels to Pharmacological Activity in Man," *Clinical Pharmacology and Therapeutics*, Vol. 10, No. 3, 1969, pp. 320-328.

[9] Pittman, K. A. and Davison, C., "Quantitative Determination of Pentazocine in Plasma and of Pentazocine and Metabolites in Urine," *Journal of Pharmaceutical Sciences*, Vol. 62, No. 5, May 1973, pp. 765-768.

[10] Kaistha, K. K. and Tadrus, R., "Thin-Layer Detection of Pentazocine, Tripelennamine, Phencyclidine and Propoxyphene Alone or In Combination with Opiates in Drug Abuse Urine Screening Programs," *Journal of Chromatography*, Vol. 155, 1978, pp. 214-217.

[11] Reid, R. W. and Gerbeck, C. M., "Detection of Pentazocine and Tripelennamine in Urine," *Clinical Chemistry*, Vol. 27, No. 1, Jan. 1981, pp. 10-13.

[12] Davidow, B., Petri, N. L., and Quame, B., "A Thin Layer Chromatographic Procedure for Detecting Drugs of Abuse," *American Journal of Clinical Pathology*, Vol. 50, No. 6, Dec. 1968, pp. 714-719.

[13] Baselt, R. C., "Pentazocine," in *Analytical Procedures for Therapeutic Drug Monitoring and Emergency Toxicology*, Biomedical Publications, Davis, CA, 1980, p. 221.

[14] Baselt, R. C., "Antihistamines," in *Analytical Procedures for Therapeutic Drug Monitoring and Emergency Toxicology*, Biomedical Publications, Davis, CA, 1980, p. 31.

[15] Butz, W. C., "Pulmonary Arteriole Foreign Body Granulomata Associated with Angiomatoids Resulting from the Intravenous Injection of Oral Medications, e.g., Propoxyphene (Darvon)," *Journal of Forensic Sciences*, Vol. 14, No. 3, July 1969, pp. 317-326.

[16] Bainborough, A. R. and Jericho, K. W. F., "Cor Pulmonale Secondary to Talc Granuloma in the Lungs of a Drug Addict," *Canadian Medical Association Journal*, Vol. 103, 1970, p. 1297.

[17] Spain, D. M., "Patterns of Pulmonary Fibrosis as Related to Pulmonary Function," *Annals of Internal Medicine*, Vol. 33, No. 5, Nov. 1950, p. 1150.

[18] Lewman, L. V., "Fatal Pulmonary Hypertension From Intravenous Injection of Methylphenidate (Ritalin) Tablets," *Human Pathology*, Vol. 3, No. 1, March 1972, pp. 67-70.

[19] Butch, A. J., Yokel, R. A., Sigell, L. T., Hanenson, I. B., and Nelson, E. D., "Abuse and Pulmonary Complications of Injecting Pentazocine and Tripelennamine Tablets," *Clinical Toxicology*, Vol. 14, No. 3, March 1979, pp. 301-306.

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