Toxicology Findings in Child and Adolescent Suicides in Virginia: 1987–2003

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Objective: In a follow-up report of child and adolescent suicides in Virginia, we describe postmortem toxicology findings in a subset of these youths.

Method: We analyzed "unnatural" deaths from Virginia's Office of the Chief Medical Examiner for 1987 to 2003. There were 2818 unnatural deaths in children and adolescents. We grouped unnatural deaths as accidents, homicides, and suicides. Toxicology records were available for 753 cases, of which 732 were black or white youths.

Results: There were no age differences among suicide victims and accident or homicide victims. Whites were more likely than blacks to die by accident and suicide. White females were more likely than black females to commit suicide. Black males were more likely than white males to suffer homicide. For all unexpected deaths, antidepressants were more commonly found among whites than blacks. Suicide by poisoning occurred more commonly among whites. Recreational drugs were more commonly found among blacks than whites. Suicide by gun occurred more commonly among blacks. Antidepressants were found in 39 black and white suicide victims. Antidepressants (all tricyclic antidepressants) were causally related in 17 cases of suicide by poisoning. No other antidepressants were found in lethal levels in suicide by poisoning. Selective serotonin reuptake inhibitors (SSRIs)/venlafaxine appeared more commonly in the suicides ($p < .0001$) than in accidents or homicides. For suicides, SSRIs appeared no more commonly in poisoning than in gun or hanging deaths ($p = .695$).

Conclusions: Antidepressants appeared more commonly among youths committing suicide than those dying by accident or homicide. SSRIs did not appear more commonly among youths committing suicide by poisoning than those committing suicide by gun or hanging. Because our data are descriptive, they are subject to overinterpretation. Cause-effect inferences should not be drawn.

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Interest in child and adolescent suicide remains intense.[1–3] Although guns are the most common means of suicide among American youths,[4] the U.S. Food and Drug Administration has focused on antidepressant administration in children and teenagers as a means of reducing youth suicide.[5]

Recently, we reported that guns and hanging were the principal methods of suicide among Virginia youths.[4] Among the antidepressants, tricyclic antidepressants (TCAs) were the most common poisons used in suicide, and increasing age was a powerful determinant of suicide by any means. Female youths were 10 times more likely to die from TCAs than male youths after adjusting for race and age. We now report toxicology findings in a subset of these Virginia youths.

METHOD

Records from the Office of the Chief Medical Examiner of the Commonwealth of Virginia were available for the period 1987 to 2003. During this time, 2818 children and adolescents died unexpectedly in Virginia. Toxicology records were available for 753 child and adolescent unexpected deaths during this time interval. Of these youths under the age of 18 years, 732 were blacks or whites. (The remaining 21 children and adolescents were Hispanic. They were excluded from analysis because of small numbers.) The 732 black and white youths formed the study population. During the study period, for the general population of Virginia, about 20% of youths were black, and about 80% were white.

Variables in the databases included (1) date of birth, (2) age in years, (3) sex, (4) race, (5) date of death, (6)

Table 1. Unexpected Death Category According to Sex and Race in 732 Black and White Children and Adolescents in Virginia (1987–2003), N (%)

	Accident (N = 450)		Homicide (N = 136)		Suicide (N = 146)	
Race	Female	Male	Female	Male	Female	Male
White	108 (24.0)	233 (51.8)	18 (13.2)	22 (16.2)	38 (26.0)	91 (62.3)
Black	27 (6.0)	82 (18.2)	12 (8.8)	84 (61.8)	5 (3.4)	12 (8.2)

manner of unnatural death (accident, homicide, or suicide), (7) cause of death, and (8) toxicology findings. No information was provided that would identify any specific subject; that is, the databases contained no Social Security numbers, names, or addresses.

Statistical Analysis

We used SPSS 13.0 for Windows for statistical analysis.[6] We obtained frequency distributions and cross-tabulations of variables of interest. Nonparametric testing included Pearson χ^2 for non-Gaussian distributions and Kruskal-Wallis rank sum test to measure significant differences between groups.

RESULTS

In our study population of 732 children and adolescents, 524 were male youths, 208 were female youths, 222 were black, and 510 were white. There were 146 youths who committed suicide, 450 youths who died in an accident, and 136 youths who died by homicide.

Age

Age for both black and white youths was not distributed normally. White youths (median = 16 years; range, 9–17 years) were slightly older (Kruskal-Wallis rank sum test: $\chi^2 = 4.563$, df = 1, p = .033) than black youths (median = 16 years; range, 9–17 years). Male youths (median = 16 years; range, 9–17 years) were slightly older (Kruskal-Wallis rank sum test: $\chi^2 = 8.782$, df = 1, p = .003) than female youths (median = 16 years; range, 9–17 years). Nonparametric testing (Kruskal-Wallis rank sum test) did not show age differences ($\chi^2 = 4.912$, df = 2, p = .086) among youths committing suicide (mean ± SD = 15.84 ± 1.41 years; range, 11–17 years), youths dying from homicide (15.57 ± 1.85 years; range, 9–17 years), and youths dying from accidents (15.22 ± 2.26 years; range, 9–17 years).

Sex and Race

Table 1 shows sex and race according to unexpected death category. Using cross-tabulations of the categories of accidents, homicides, and suicides and variables of race and sex (category × race × sex), χ^2 test of association revealed that there were significant differences in category of unexpected death between the races in both male and female youths (female $\chi^2 = 8.836$, df = 2, p = .012; male $\chi^2 = 128.597$, df = 2, p < .0001) (Table 2). White female youths were more likely to have died by suicide than black female youths. Black male youths were more likely to die by homicide, and white male youths were more likely to die by accident and suicide.

Table 2. Cross-Tabulation of Mode of Death by Sex and Race, N (%)[a]

	Race			
Mode of Death	Black	White	Total	p Value
Female				
Accident	27 (61.4)	108 (65.9)	135 (64.9)	
Homicide	12 (27.3)	18 (11.0)	30 (14.4)	
Suicide	5 (11.4)	38 (23.2)	43 (20.7)	
Total	44 (100)	164 (100)	208 (100)	.012
Male				
Accident	82 (46.1)	233 (67.3)	315 (60.1)	
Homicide	84 (47.2)	22 (6.4)	106 (20.2)	
Suicide	12 (6.7)	91 (26.3)	103 (19.7)	
Total	178 (100)	346 (100)	524 (100)	< .0001

[a]Chi-square test of association revealed that there were significant differences in category of unexpected death between the races in both male and female youths (female $\chi^2 = 8.836$, df = 2, p = .012; male $\chi^2 = 128.597$, df = 2, p < .0001). White female youths were more likely to die by suicide than black female youths. Black male youths were more likely to die by homicide. White male youths were more likely to die by accident and suicide.

Toxicology by Drug Class and Category of Unexpected Death

Table 3 shows toxicology findings by drug class and unexpected death category. Recreational drugs (cocaine, ethanol, and marijuana)—most frequently alcohol (92.5% of recreational drug findings)—were found most commonly among youths dying in accidents, and recreational drugs were found more commonly among blacks (150 recreational drugs among 222 black youths) than whites (325 recreational drugs among 510 white youths). Antidepressants were found most commonly among youths committing suicide compared with accidents and homicide, and antidepressants were found more commonly among whites (47 antidepressant drugs among 510 white youths) than blacks (6 antidepressant drugs among 222 black youths). Because study subjects may have taken more than 1 drug, the total number of drugs exceeded the total number of youths. Using data from Table 3 (taking or not taking selective serotonin reuptake inhibitors [SSRIs]/venlafaxine and in or not in the group committing suicide), the 2 × 2 contingency table in Table 4 shows that SSRIs/venlafaxine were found more commonly among children and adolescents dying by suicide than those dying by accident or homicide (Pearson $\chi^2 = 27.116$, p < .0001). Of cases in which TCAs were found, they appeared so uncommonly among youths dying by accidents (9.68%) and homicide (6.45%) that statistical analysis was not performed.

Table 3. Toxicology Findings by Drug Class and Category of Unexpected Death in 732 Black and White Children and Adolescents in Virginia (1987–2003)[a]

	Unexpected Death Category			
Drug Class	Accidents (N = 450)	Homicide (N = 136)	Suicide (N = 146)	Total (N = 732)
Antidepressants	11	2	40	53
TCAs	3	2	26	31
SSRIs/venlafaxine	8	0	14	22
Anxiolytics/hypnotics	9	2	4	15
Antipsychotics	3	1	1	5
Anticonvulsants	4	1	3	8
Analgesics	19	8	21	48
Stimulants	6	0	5	11
Anticholinergics	7	1	5	13
Antihistamines	2	2	17	21
Recreational drugs	292	115	69	476
Anesthetics	31	7	17	55
Muscle relaxants	0	0	2	2
Miscellaneous	109	16	25	150
Total	493	155	209	857

[a]Recreational drugs, most frequently alcohol, were found most commonly among youths dying in accidents. Antidepressants were found most commonly among youths committing suicide. Because study subjects may have taken more than 1 drug, the total number of drugs exceeded the total number of youths. A more detailed list of drugs may be obtained from the first author (W.V.R.V.).
Abbreviations: SSRI = selective serotonin reuptake inhibitor, TCA = tricyclic antidepressant.

Table 4. Cross-Tabulation of Mode of Death and Whether Individual Was Taking SSRIs/Venlafaxine[a]

	Mode of Death				
Taking SSRIs/ Venlafaxine	Accident/ Homicide	Suicide	Total	χ^2	p Value
No					
N	578	132	710		
Row %	81.4	18.6			
Yes					
N	8	14	22		
Row %	36.4	63.6			
Total, N	586	146	732	27.116	< .0001

[a]SSRIs/venlafaxine were found more commonly among children and adolescents dying by suicide than those dying by accident or homicide (Pearson $\chi^2 = 27.116$, $p < .0001$).
Abbreviation: SSRI = selective serotonin reuptake inhibitor.

Table 5. Toxicology Findings by Drug Class and Suicide Group (gun, hanging, poison) in 143 Black and White Children and Adolescents in Virginia (1987–2003)[a]

	Suicide Group			
Drug Class	Gun (N = 72)	Hanging (N = 23)	Poison (N = 48)	Total (N = 143)
Antidepressants	3	5	31	39
TCAs	0	0	26	26
SSRIs/venlafaxine	3	5	5	13
Anxiolytics/hypnotics	1	0	3	4
Antipsychotics	0	0	1	1
Anticonvulsants	0	1	2	3
Analgesics	4	0	16	20
Stimulants	2	1	2	5
Anticholinergics	1	3	1	5
Antihistamines	8	0	9	17
Recreational drugs	53	13	2	68
Anesthetics	6	5	6	17
Muscle relaxants	0	0	2	2
Miscellaneous	5	0	19	24
Total	83	28	94	205

[a]Because study subjects may have taken more than 1 drug, the total number of drugs exceeded the total number of youths. A more detailed list of drugs may be obtained from the first author (W.V.R.V.).
Abbreviations: SSRI = selective serotonin reuptake inhibitor, TCA = tricyclic antidepressant.

Toxicology by Drug Class and Method of Suicide

Among the 146 youths committing suicide, 3 did so by jumping from a great height. These 3 youths were excluded for purposes of further analysis, leaving 3 large groups of suicide methods (guns, hanging, and poison). Suicide by gun occurred more commonly among whites (61 instances among 510 white youths) than blacks (11 instances among 222 black youths).

Table 5 shows drugs by class and suicide group in these 143 children and adolescents. Because study subjects may have taken more than 1 drug, the total number of drugs exceeded the total number of youths. Using data from Table 5 (taking or not taking SSRIs/venlafaxine and in or not in the group suicide by poisoning), the 2 × 2 contingency table in Table 6 shows that SSRIs/venlafaxine appeared no more commonly among youths in suicide by poisoning than in the group suicide by gun or suicide by hanging (Pearson $\chi^2 = 0.154$, $p = .695$). TCAs appeared only in the suicide by poisoning group.

Using a 3 × 2 contingency table and data from Table 5 (3 suicide groups and 2 drug classes—antidepressants and recreational drugs), significant differences (Pearson $\chi^2 = 71.042$, $p < .0001$) were found between the 2 drug classes (Table 7). Antidepressants appeared most commonly among the suicide by poisoning group, and recreational drugs appeared most commonly in suicide with a gun.

Drugs Causally Related to Death in Suicide by Poisoning

Table 8 shows the drugs causally related to death (N = 48) by the Medical Examiner. Carbon monoxide was the poison most commonly reported (N = 13). TCAs (N = 17: amitriptyline in 4 subjects, desipramine in 1 subject, doxepin in 3 subjects, imipramine in 6 subjects, and nortriptyline in 3 subjects) were the only antidepressants explicitly implicated by the Medical Examiner as causing death; the Medical Examiner did not implicate SSRIs/venlafaxine in any suicide by poisoning.

DISCUSSION

Almost one half of the subjects were white males. They died more often by accident and suicide than black males. White females too were much more likely to com-

Table 6. Cross-Tabulation of Method Used in Committing Suicide and Whether Individual Was Taking SSRIs/Venlafaxine[a]

Taking SSRIs/ Venlafaxine	Method of Suicide			χ^2	p Value
	Gun/Hanging	Poison	Total		
No					
N	87	43	130		
Row %	66.9	33.1			
Yes					
N	8	5	13		
Row %	61.5	38.5			
Total, N	95	48	143	0.154	.695

[a]SSRIs/venlafaxine appeared no more commonly among youths in suicide by poisoning than in the groups suicide by gun or suicide by hanging (Pearson $\chi^2 = 0.154$, $p = .695$).
Abbreviation: SSRI = selective serotonin reuptake inhibitor.

Table 7. Cross-Tabulation of Method of Suicide and Class of Drug Used[a]

Drug Class	Method of Suicide				χ^2	p Value
	Gun	Hanging	Poison	Total		
Antidepressants						
N	3	5	31	39		
Row %	7.7	12.8	79.5			
Recreational						
N	53	13	2	68		
Row %	77.9	19.1	2.9			
Total, N	56	18	33	107	71.042	< .0001

[a]Antidepressants appeared most commonly among the suicide by poisoning group. Recreational drugs appeared most commonly in suicide with a gun. Among the antidepressants, 26 were tricyclic antidepressants (TCAs) and 13 were selective serotonin reuptake inhibitors/venlafaxine. No TCAs were found among those committing suicide by gun or hanging. Significant differences (Pearson $\chi^2 = 71.042$, $p < .0001$) were found between the 2 drug classes.

mit suicide than black females. Black males died more often by homicide (Table 1).

Often, the subjects were taking more than 1 drug as determined by toxicology findings (Table 3), with recreational drugs (cocaine, ethanol, and marijuana) being found most commonly in all categories of unexpected deaths. Other drug classes commonly found included antidepressants and analgesics. The anesthetic lidocaine was found commonly—presumably due to its use in cardiopulmonary resuscitation.

Of the toxins in the miscellaneous class (Table 3), carbon monoxide was the dominant one. Information was not available to determine the role that carbon monoxide played in the 3 categories of unexpected deaths. Presumably, carbon monoxide from fires explained the drug's toxicity in accidents and homicides. Suicide by carbon monoxide poisoning presumably occurred when the youths trapped this gas in a closed space such as a garage holding an automobile.

Among the 146 children and adolescents dying by suicide, 14 were taking SSRIs/venlafaxine and 132 were not

Table 8. Cause of Death Listed by Medical Examiner for the 48 Children and Adolescents Who Committed Suicide by Poisoning

Poison	Age (y)	Sex	Race
Acetaminophen	16	F	Black
Amitriptyline	15	F	Black
Imipramine	14	F	Black
No specific drug	16	F	White
Acetaminophen	16	F	White
Acute salicylate	16	F	White
Amitriptyline	16	F	White
Carbon monoxide	13	F	White
Carbon monoxide	15	F	White
Carbon monoxide	16	F	White
Cocaine	16	F	White
Colchine	14	F	White
Desipramine	14	F	White
Doxepin	15	F	White
Doxepin	16	F	White
Hydroxyzine	17	F	White
Imipramine	16	F	White
Imipramine	15	F	White
Imipramine	15	F	White
Imipramine	16	F	White
Imipramine	15	F	White
Multiple drugs	17	F	White
Multiple drugs	16	F	White
Nortriptyline	17	F	White
Salicylate	15	F	White
Carbon monoxide	12	M	Black
Amitriptyline	17	M	White
Amitriptyline	17	M	White
Carbon monoxide	17	M	White
Carbon monoxide	14	M	White
Carbon monoxide	16	M	White
Carbon monoxide	17	M	White
Carbon monoxide	17	M	White
Carbon monoxide	17	M	White
Carbon monoxide	17	M	White
Carbon monoxide	17	M	White
Carbon monoxide	17	M	White
Carbon monoxide	17	M	White
Diphenhydramine	17	M	White
Diphenhydramine	17	M	White
Doxepin	17	M	White
Ethylene glycol	16	M	White
Multiple drugs	14	M	White
Multiple drugs	16	M	White
Narcotic	16	M	White
Narcotic	16	M	White
Nortriptyline	17	M	White
Nortriptyline	17	M	White
Propranolol	16	M	White

Abbreviations: F = female, M = male.

(Table 3). SSRIs/venlafaxine appeared more commonly in the toxicology findings in the suicide group than those dying unexpectedly by other means.

Among the 72 children and adolescents using a gun to commit suicide (Table 5), toxicology findings showed that recreational drugs were the most common drug class present, with ethanol the dominant one. No TCAs were found among youths committing suicide by gun or hanging. However, SSRIs and venlafaxine appeared as incidental findings in these 2 suicide groups. We can only surmise that these latter subjects received treatment for depression, albeit unsuccessfully.

Among the 48 youths committing suicide by poisoning, antidepressants appeared most commonly in the toxicology reports (Table 5). TCAs accounted for about 80% of these, with SSRIs accounting for the remaining portion. In contrast, within the group of youths shooting themselves, recreational drugs appeared most commonly (Table 5).

The specific toxins causing death by poisoning as determined by the Medical Examiner appear in Table 8. The only antidepressants appearing on this list were TCAs. The most likely reason that more suicide victims (compared with other modes of unexpected death) were taking antidepressants is that depression is a risk factor for suicide and their depression was being treated with medications—either appropriately or inappropriately.

Drugs and Suicide

The study period 1987 to 2003 covers the introduction and ascendancy of SSRIs as the principal agents to treat pediatric depression. As with adults, SSRIs are also used to treat other psychiatric illnesses in children and adolescents. Even though both amitriptyline and doxepin are highly serotonergic TCAs, no TCAs appeared in the toxicology findings for the children and adolescents in our sample who intentionally shot or hanged themselves (Table 5). This finding does not support the contention that serotonergic agents provoke suicidal actions.

From our data on the nonpoisoning suicides and the absence of antidepressants in the toxicology reports, one could infer any of the following: (1) these youths were not clinically depressed, and we have to look elsewhere to explain their suicides; (2) although they were clinically depressed, these youths had not sought and/or received antidepressant treatment; and (3) although they were clinically depressed and were offered antidepressant treatment, these youths were noncompliant before committing suicide. Again, we emphasize the limitations of our study, because it was not designed to assess any of the above possible inferences. In addition, because our data are descriptive, they are subject to overinterpretation.

Depression is a risk factor for both suicide and taking antidepressants. Finding antidepressants in the suicide by poisoning group may mean any of the following: (1) youths committing suicide received antidepressants for depression, (2) youths committing suicide do so before the antidepressant drugs became effective, (3) antidepressant drugs were "activating" and this led to suicide, and (4) antidepressant drugs induced suicidal behavior by some other means. These hypotheses are not mutually exclusive.

The fatal cardiotoxic features of TCAs are well known and include ventricular tachyarrhythmias and heart block.[7] Neither SSRIs nor venlafaxine was assigned as the cause of death by the Medical Examiner in the 48 children and adolescents who poisoned themselves (Table 8).

Study Limitations

Our study is a retrospective analysis of only about one quarter of the children and adolescents dying unexpectedly from 1987 to 2003. We were limited to the toxicology records available for that period. None of the observations and findings determined whether antidepressant drugs, particularly SSRIs, place children and adolescents at increased risk of committing suicide by increasing suicidality. Limiting subjects to those less than 18 years of age created a ceiling effect that may have constrained differences in cause or source of unexpected deaths in our study population. Finally, the study did not include any premorbid narratives describing the mental state of the youths who committed suicide.

CONCLUSIONS

Antidepressant drugs of current regulatory concern (primarily SSRIs) appeared more commonly as incidental findings among children and adolescents dying by suicide compared with those dying by accident or homicide. SSRIs do not appear more commonly among youths committing suicide by poisoning than those committing suicide by gun or hanging. Our retrospectively derived data do not reveal whether SSRIs are causally involved in provoking suicidal behavior or suicide. Our report does provide data that may be useful in future meta-analyses addressing this issue.

Drug names: desipramine (Norpramin and others), diphenhydramine (Benadryl and others), doxepin (Sinequan and others), hydroxyzine (Vistaril, Atarax, and others), imipramine (Tofranil and others), lidocaine (Lidoderm, Xylocaine, and others), nortriptyline (Aventyl, Pamelor, and others), propranolol (Innopran, Inderal, and others), venlafaxine (Effexor).

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