

PAPER**PATHOLOGY AND BIOLOGY**

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Nonchemical Suffocation Deaths in Forensic Setting: A 6-Year Retrospective Study of Environmental Suffocation, Smothering, Choking, and Traumatic/Positional Asphyxia*

ABSTRACT: There are still several areas of forensic pathology mainly based on tradition, with textbooks explaining and describing common knowledge that is not supported by modern research data. This study is intended to contribute to evidence-based data on nonchemical suffocation deaths in the forensic population aged more than 1 year. From 2000 to 2005, all autopsy cases were reviewed: age, gender, type of suffocation, and manner of death were compiled for all victims (96 cases). In general, the results from this study are concordant with the textbook literature, therefore supporting common knowledge related to manner of death in nonchemical suffocation. However, discrepancies have been underscored in smothering: smothering, contrary to the general belief, is probably not mostly homicidal, and accidental smothering is probably not that unusual. Furthermore, new data without actual literature correlates were obtained in the conducting of this study and are presented here.

KEYWORDS: forensic sciences, asphyxia, suffocation, smothering, choking, traumatic asphyxia, positional asphyxia, entrapment suffocation, environmental suffocation

Suffocation is a general term that encompasses several forms of asphyxia generated by a deprivation of oxygen, either from lack of gas in the breathable environment, from obstruction of the external airways (smothering) or the internal airways (choking), or from a pressure on the chest or abdomen or a body position restricting respiratory movement (traumatic and positional asphyxia, respectively) (1,2). Suffocation from lack of oxygen in the breathable environment can be encountered by rebreathing in an air-tight or relatively air-tight enclosure (entrapment suffocation), by low atmospheric oxygen in unusual environments (environmental suffocation) or, more commonly, by physical displacement of oxygen by other gases or by chemical changes such as combustion (1,2).

In the forensic literature, suffocation has been the object of several studies, but mainly case reports (3–16) or case series (17–26). Studies of subsets of suffocation deaths, limited to a specific scenery or category, have also been reported (27–29), such as suffocation in motor vehicle collisions (30), lethal crush/traumatic asphyxia (31), fatal entrapments in on-farm grain storage bins (32), suffocation by plastic bags (33–36), or café coronary deaths (37). Overlaying and wedging deaths have also been studied in the infant population (38). These latter entities have to be distinguished from homicidal smothering and sudden infant death syndrome (SIDS). However, this distinction is particularly difficult to assess because all these causes of death may leave no physical

indications as to how the infant died. In this age group, up to a third of cases end up being called “SIDS versus overlaying” (38). Children less than 1 year of age were excluded in this study.

We here present a 6-year retrospective study of all nonchemical suffocation cases in our laboratory in the forensic victim population aged more than 1 year. As far we know, this is the first article to ever portray a systematic study of nonchemical suffocation deaths in the forensic setting.

Materials and Methods

In the province of Quebec (Canada), a single centralized forensic laboratory covers the entire 7.5 million province population. On a 6-year period (2000–2005), all autopsy cases performed at this laboratory were retrospectively reviewed for nonchemical suffocation deaths in the forensic victim population aged more than 1 year. For each case, the type of suffocation, manner of death, gender, and age were compiled.

All cases of autopsies performed in Quebec in the study period were previously compiled in an Excel database. This database was manually searched for suffocation cases. The complete files of selected cases were then consulted. These files include autopsy report, autopsy photograph, toxicological report, and preliminary police report.

In the case selection, three cases of suffocation occurring in association with a lethal sharp or blunt weapon trauma were excluded: a 47-year-old man with lethal sharp trauma to the abdomen found with duct tape on the face, a 54-year-old man with lethal abdominal sharp trauma found with heavy stones compressing his thorax, and a 55-year-old man with severe blunt head trauma found with a plastic bag in the mouth. Also excluded was a case of suffocation in

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association with another category of asphyxia: a 49-year-old woman was asphyxiated by her ex-husband by means of ligature and manual strangulation combined with a plastic bag over her head.

Unfortunately, the classification and definition of suffocation types vary between textbooks. In this study, the following classification for nonchemical suffocation deaths was used: entrapment/environmental suffocation, smothering, choking and traumatic/positional asphyxia. Entrapment/environmental suffocation was defined as asphyxia caused by inadequate oxygen in the environment, either by rebreathing in an air-tight enclosure or by oxygen deficiency in the atmospheric air. Smothering was defined as the mechanical obstruction or occlusion of the upper airways, whereas the obstruction of the lower airways was labeled choking. The upper airways start at the nostril or lips and extend to the nasal conchae or the mouth, to the nasopharynx, hypopharynx, and larynx. The lower airways begin below the epiglottis, including the trachea and bronchi. Finally, the term traumatic/positional asphyxia was used for suffocation secondary to respiratory movements' restriction, either by an outside pressure because of a heavy weight on the body, or by a body being trapped in a position or in a restricted space.

Results

During the 6-year study period (2000–2005), a total of 96 nonchemical suffocation deaths were autopsied in our forensic laboratory. This represents 2.3% of all forensic autopsies for the same period. Overall, victims were aged from 2 to 90 years old (mean \pm standard deviation, 46 ± 19), with similar averages for men (46 ± 19) and women (48 ± 24).

Type of Suffocation

Traumatic/positional asphyxia ranked as the leading type of nonchemical suffocation, with over half of the victims (54%) (Table 1). Smothering and choking followed, in 30% and 14%, respectively. Entrapment/environmental suffocation, on the other hand, was found in only 2%.

Gender and Age

Overall, a strong male predominance was observed, with two-thirds of the victims being men (Table 2). Traumatic/positional asphyxia remained the leading type of nonchemical suffocation in male victims. However, the type distribution of nonchemical suffocation differed in female victims, smothering being the most common type (64%), relegating traumatic/positional asphyxia to second position (32%). Choking occupied third position in both genders, with 16% and 5% in men and women, respectively. As for age, the average in each type of suffocation did not seem to differ significantly.

TABLE 1—Type distribution of all cases of nonchemical suffocation in a 6-year period (2000–2005).

Type of Nonchemical Suffocation	Cases	
	n	Percentage (%)
Entrapment/environmental suffocation	2	2.1
Smothering	29	30.2
Choking	13	13.5
Traumatic/positional asphyxia	52	54.2
Total	96	100.0

TABLE 2—Type of nonchemical suffocation in relation to gender and age.

Type of Nonchemical Suffocation	Gender		Age (average \pm SD)
	Male n (%)	Female n (%)	
Entrapment/environmental suffocation	2 (2.7)	0 (0.0)	30 ± 6
Smothering	15 (20.3)	14 (63.6)	48 ± 22
Choking	12 (16.2)	1 (4.6)	46 ± 16
Traumatic/positional asphyxia	45 (60.8)	7 (31.8)	45 ± 18
Total	74 (100.0)	22 (100.0)	46 ± 19

Manner of Death

Taken as a whole, manner of death in nonchemical suffocation is generally ruled as accidental (73%) (Table 3). In fact, all entrapment/environmental suffocations and traumatic/positional asphyxia deaths were accidental, as well as the vast majority of choking (85%). Smothering, in contrast, is more often encountered in a suicidal context (59%).

Entrapment/Environmental Suffocation

The two accidental deaths by entrapment/environmental suffocation found in this study occurred in the context of autoerotic death. In one case, a 25-year-old man was found submersed underwater, with a homemade diving apparatus, enclosed nude under a self-designed plastic body suit and restrained by complex bondage. Death was related to rebreathing, caused by a faulty air-supply device, the respiratory tube being too long (more than 4.5 m). The other case involved a 34-year-old man found lifeless, completely enclosed from head to toe within a large self-made plastic bag pierced by a too long and thin tube, not allowing sufficient gas exchange. Those two cases were previously published as case reports (39,40).

Smothering

In smothering, a higher variability of manner of death was revealed between cases. Indeed, although suicide makes up the main core (17 cases), manner of death was ruled differently in 12 cases, including six homicides (Table 4) and five accidents (Table 5). The most common form of smothering was from a plastic bag over the head (69%), with all suicidal smothering cases being related to this method. In one case, manner of death was ruled as undetermined: a 75-year-old-woman, suffering of Alzheimer disease, was found dead in the bathroom with a rubber sink stopper trapped in her back throat. Although scene investigation and autopsy findings were highly suggestive of an accident, the forensic team felt that a suicidal manner of death could not be totally excluded.

Choking

Despite the strong predominance of accidents in choking (85%—those cases are presented in Table 6), it is interesting to note that manner of death was ruled as suicide in one case and natural in another case. The suicidal victim, a 58-year-old man with a long-standing history of schizophrenia and suicidal ideation, was found on autopsy with a significant amount of wadded toilet paper filling his entire mouth, oropharynx, and posterior throat. As for the choking ruled as a natural death, it occurred in a 55-year-old man found asphyxiated by a thyroglossal duct cyst tied to the mid

TABLE 3—Type of nonchemical suffocation in relation to manner of death.

Type of Nonchemical Suffocation	Manner of Death				
	Accident <i>n</i> (%)	Homicide <i>n</i> (%)	Suicide <i>n</i> (%)	Natural <i>n</i> (%)	Undetermined <i>n</i> (%)
Entrapment/environmental suffocation	2 (100.0)	—	—	—	—
Smothering	5 (17.2)	6 (20.7)	17 (58.6)	—	1 (3.5)
Choking	11 (84.6)	—	1 (7.7)	1 (7.7)	—
Traumatic/positional asphyxia	52 (100.0)	—	—	—	—
Total	70 (72.9)	6 (6.3)	18 (18.8)	1 (1.0)	1 (1.0)

TABLE 4—Homicidal smothering in the study period.

Case	Age	Gender	Brief Case Description
1	72	M	Obstruction of the mouth by clothes (tie) secured by multiple turns of adhesive tape driving the denture back, obstructing the throat—Victim found tied by Christmas garlands
2	4	F	Obstruction of the mouth and nose by a plastic bag—Context of double homicide The girl was found at the side of her strangled grandmother
3	79	M	Obstruction of the mouth by a disposable dust free mask secured by plastic bags and elastics—The victim was suffering of Alzheimer disease—Killed in a context of homicide/suicide by his spouse
4	72	M	Plastic bag and a pillow case over the head, loosely tied at the neck by a belt, electrical and phone wires—Body found illegally buried
5	64	F	Obstruction of the nose and mouth by a pillow—Killed by her spouse in a context of homicide/suicide (missed suicide with later confession)
6	21	F	Obstruction of the oral cavity by gloves used as a gag—Body found after a man went to the police station stating he killed a woman

M, male; F, female.

TABLE 5—Accidental smothering in the study period.

Case	Age	Gender	Brief Case Description
1	52	F	Obstruction of the external airways by a large alimentary bolus
2	63	M	Obstruction of the mouth and nose by a wheel of a motor quadricycle found close to the face
3	54	M	Obstruction of the external airways by a large alimentary bolus
4	40	M	Obstruction of the external airways by cocaine packages
5	39	M	Obstruction of the external airways by cocaine and cannabis packages

M, male; F, female.

TABLE 6—Accidental choking in the study period.

Case	Age	Gender	Contributing Factor/Circumstances	Choking Material
1	48	M	History of alcoholism and mental disability	Food
2	45	M	Epilepsy and intellectual deficiency	Food
3	50	M	Alcoholic intoxication	Food
4	56	M	Work accident (in a grain silo)	Nonfood
5	47	M	Combined intoxication (alcohol and therapeutic drugs)	Food
6	49	M	None (the man was sucking a coin to control his urge to smoke)	Nonfood (small coin)
7	49	M	Work accident (in a grain silo)	Nonfood
8	71	F	None (depressive under treatment with mirtazapine and oxazepam)	Food
9	34	M	Work accident (in a grain silo)	Nonfood
10	2	M	Forced pill administration by the father in a therapeutic context	Nonfood (Acetaminophen pill)
11	36	M	Epilepsy and multiple psychoactive drugs intake for psychiatric problems	Food

M, male; F, female.

portion of the hyoid bone and pressing on the anterior aspect of the lower segment of the epiglottis. Those two cases were previously published as case reports (41,42).

Traumatic/Positional Asphyxia

Traumatic/positional asphyxia constituted the largest group of nonchemical suffocation, with 54% of cases. The vast majority of

victims were men (male:female ratio of 6:1). All these deaths were accidental. The 52 deaths by traumatic/positional asphyxia reported in this study can be divided into five broad groups (Table 7): positional asphyxia in association with alcohol intoxication (13 cases), traumatic asphyxia related to work accident (18 cases), traumatic asphyxia in motor vehicle accidents (nine cases), accidents related to physical restraint in hospital setting (four cases), and miscellaneous (eight cases).

TABLE 7—Traumatic/positional asphyxia in the study period.

Group	Circumstances	Number of Cases	Comments
1	Positional asphyxia in alcohol intoxication	13	The vast majority are males (12:1); Aged 21 to 61 years (average 46)
2	Traumatic asphyxia related to work accident	18	Chest compression by heavy machinery (including 5 individuals found under a car or bus) No alcohol intoxication in this group
3	Traumatic asphyxia in motor vehicle accidents	9	Motor vehicle type: car (4 cases), truck (1 case), quad (3 cases), seaplane (1 case); 2 cases associated with alcohol intoxication (1 car and 1 quad accident)
4	Accidents related to physical restraint in hospital setting	4	Victims aged 78–90 years
5	Miscellaneous	8	Shizophrenic patient who liked to dig tunnels, found partly buried in earth (face uncovered) 10-year-old boy who liked to slide under the garage door, found trapped under it 5-year-old girl found trapped in a staircase 34-year-old quadraplegic patient who fell with his wheelchair 60-year-old woman with multiple sclerosis and hip prosthesis who fell in a bad position 52-year-old woman with severe dorsolombar problems who fell in a bad position 74-year-old man trapped under a heavy piece of furniture 47-year-old man trapped under a heavy piece of furniture

Consideration on Age Group

In this study, the vast majority of cases were adults or elderly, with 89 cases out of 96. In children aged from 1 to 9 years, only four cases were found: one homicidal smothering, one accidental choking, and two traumatic/positional asphyxias. As for adolescents aged from 10 to 19 years, three cases were recorded: two accidental traumatic/positional asphyxias and one suicidal smothering. Adults and elderly cases are further described in Table 8.

Discussion

In the last 15 years, evidence-based medicine has been advocated as a new paradigm, proclaiming that evidence from research is the best basis of clinical decisions and practice (43). In this global context, forensic pathology is no exception and is becoming increasingly a science and decreasingly an art (44). Nevertheless, there are still several areas of forensic pathology mainly based on tradition, with textbooks explaining and describing common knowledge that is not supported by modern research data. This study is intended to contribute to evidence-based data on nonchemical suffocation deaths. Indeed, as presented in Table 9, textbook statements about manner of death in nonchemical suffocation cases are not supported by research and referenced accordingly. This is not surprising despite several case reports, case series, and a few studies on

suffocation subsets, and this is the first time nonchemical suffocation deaths are systematically studied.

In general, the results from this study are concordant with the textbook literature (Table 9), therefore supporting common knowledge related to manner of death in nonchemical suffocation. However, discrepancies have been underscored in smothering.

Smothering, contrary to the general belief, is probably not mostly homicidal. In this study, suicide was the leading manner of death in smothering (59%). All these suicides by smothering were achieved by placing a plastic bag over the head. This is in keeping with an observation by Saukko and Knight (2) that, in Britain, plastic bag smothering is an increasingly common suicidal method. Nevertheless, it is probable that some homicidal smothering cases are missed because autopsy findings can be subtle.

Another inconsistency with textbook literature is that accidental smothering is probably not that unusual. In fact, almost one out of five smothering cases in this study is accidental.

It is also worth mentioning that in choking, manners of death are listed in some textbooks as natural, accidental, and homicidal, with total disregard of suicide as a possible manner of death (1). Although unusual, suicidal choking is also encountered, as illustrated by the finding of one case in this study. This occasional occurrence of suicidal choking was reported in the textbook by Saukko and Knight (2). A few case reports are also found in the forensic literature (46–48).

TABLE 8—Distribution of nonchemical suffocation cases between age groups.

Type of Nonchemical Asphyxia	Manner of Death					Total n (%)
	Accident n (%)	Homicide n (%)	Suicide n (%)	Natural n (%)	Undetermined n (%)	
Adults (20–64)						
Entrapment/environmental suffocation	2 (3.4)	—	—	—	—	2 (2.7)
Smothering	5 (8.5)	2 (100.0)	12 (92.3)	—	—	19 (25.3)
Choking	9 (15.2)	—	1 (7.7)	1 (100.0)	—	11 (14.7)
Traumatic/positional asphyxia	43 (72.9)	—	—	—	—	43 (57.3)
Total	59 (100.0)	2 (100.0)	13 (100.0)	1 (100.0)	—	75 (100.0)
Elderly (65+)						
Entrapment/environmental suffocation	—	—	—	—	—	—
Smothering	—	3 (100.0)	4 (100.0)	—	1 (100.0)	8 (57.1)
Choking	1 (16.7)	—	—	—	—	1 (7.2)
Traumatic/positional asphyxia	5 (83.3)	—	—	—	—	5 (35.7)
Total	6 (100.0)	3 (100.0)	4 (100.0)	—	1 (100.0)	14 (100.0)

TABLE 9—Manners of death in nonchemical suffocation: textbook literature compared to study results.

	Textbook Statement	Referenced	Comparison With Results
Entrapment/ environmental suffocation	“These deaths are almost exclusively accidental in nature” (1)	None	Concordant (accidental in all cases)
	“Suicide and homicide by entrapment are rare, but do occur” (1)	None	Concordant (none in this study)
Smothering	“Deaths such as these are usually either homicide or suicide, very rarely accident” (1); “Accidental smothering is rare...” (45)	None	Discordant (accidental smothering in 17.2%)
	“Smothering is homicidal in the majority of cases” (45)	None	Discordant (suicidal in 58.6%; homicidal in 20.7%)
	“The most common form of suicidal smothering is the placing of a plastic bag over an individual’s head” (1)	None	Concordant (plastic bag in 69% of cases)
Choking	“Most choking deaths are accidental in manner” (1)	“In 1997, there were approximately 3300 deaths ascribed to unintentional inhalation of food or other objects, resulting in obstruction of the respiratory passages” [*] (1)	Concordant (accidental choking in 84.6%)
	“Homicidal deaths by choking are relatively uncommon” (1)	None	Concordant (none in this study)
	“The manner of death can be natural, homicide, or accident” (1) but suicide is not mentioned in this textbook	None	Discordant (1 suicidal choking)
	“Occasionally adults will do the same [...] by design” (2)	None	Concordant (1 suicidal choking)
	“In adults, choking virtually always involves food. Here, it is commonly associated with acute alcohol intoxication, bad-fitting dentures, neurological injury, or senility” (1)	None	Concordant (see Table 4)
Traumatic/ positional asphyxia	“almost always accidental in manner” (1)	None	Concordant (accidental in all cases)

*National Safety Council, Accident Facts: 1998 Itasca, IL.

This study is a first step in obtaining evidence-based data to support our common body of knowledge. Further studies on different populations are required, particularly to assess the discrepancies with the textbook literature highlighted here.

In the conducting of this study, new data were obtained on non-chemical suffocation deaths, these data having no correlates with textbooks or forensic literature:

- Nonchemical suffocation deaths in the population aged more than 1 year represented 2.3% of forensic autopsies in our population.
- Traumatic/positional asphyxia was the leading type of nonchemical suffocation in our population (54%).
- Overall, a strong male predominance was recorded (77% of non-chemical suffocation cases).
- Although nonchemical suffocation deaths in men were more commonly of the traumatic/positional type (60.8% of male cases), smothering was more common in women (63.6% of female cases).

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