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Sharp force fatalities: differentiating homicide from suicide through a retrospective review (2012-2019) of autopsy findings in Lisbon (Portugal)

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ABSTRACT

Keywords: forensic pathology, sharp force death, homicide, suicide, manner of death

Sharp force fatalities may have a homicidal, suicidal or accidental manner of death. To aid in such differentiation this study aimed to identify medico-legal elements which were predictors of a given manner of death as well as to describe the characteristics of these deaths. A retrospective review was performed on all homicides and suicides due to sharp force injury admitted at the South Branch of the National Institute of Legal Medicine and Forensic Sciences between January 2012 and December 2019. Deaths with a performed external examination or forensic autopsy and with available demographic, circumstantial or necroscopic information were included. Each case was reviewed and inferential analysis was employed with both parametric and non-parametric tests as well as binary logistic regression to identify independent predictors, with significance defined at α=0.05.

Fifty-seven homicides and twenty suicides were identified, with the demographic and circumstantial profile of the homicide victim being that of a young foreign male whose body was found outside home, with no weapon nearby and without a known psychiatric background. Regarding wound characteristics, homicides presented more prominently stab wounds, with these being conspicuous on the thorax and neck. Conversely suicides notably presented cut wounds, being critically present in the neck and upper limbs. Oblique thoracic stab wounds conveyed a homicidal death. Other findings suggestive of homicide included the presence of clothing lacerations, additional traumatic lesions and injured lungs or bone/cartilage. Toxicologically, alcohol presence was associated with homicides while psychiatric drugs suggested suicide. The logistic regression identified the presence of additional traumatic lesions (OR 14.8, p=0.032) and the absence of lethal neck (OR 0.109, p=0.043) and upper limb (OR 0.022, p=0.015) wounds as independent autopsy predictors of a homicidal death.

To achieve a cogent conclusion, all investigative elements must be considered while attending to the specifics of each case.

RESUMO

Palavras-chave: patologia forense, morte por arma branca, homicídio, suicídio, etiologia médico-legal

As mortes por arma branca podem ter uma etiologia médico-legal homicida, suicida ou acidental. Para auxiliar nesta distinção o presente estudo procurou identificar elementos médico-legais que fossem preditores de uma dada etiologia assim como descrever as características destas mortes. Uma revisão retrospetiva foi feita a todas as mortes homicidas e suicidas por arma branca admitidas na Delegação do Sul do Instituto Nacional de Medicina Legal e Ciências Forenses entre Janeiro 2012 e Dezembro 2019. Foram incluídas mortes com exame de hábito externo ou autópsia médico-legal realizada e com informação demográfica, circunstancial ou necroscópica disponível. Consequentemente foi empregue uma análise inferencial com testes paramétricos e não paramétricos assim como regressão logística binária para identificar preditores independentes, com significância definida α=0.05.

Identificaram-se 57 homicídios e 20 suicídios, tendo o perfil demográfico e circunstancial obtido para a vítima de homicídio sido o de um homem estrangeiro jovem cujo cadáver foi encontrado fora de casa, sem a arma nas proximidades e sem antecedentes psiquiátricos conhecidos. Relativamente às características das lesões, os homicídios apresentaram lesões de natureza corto-perfurante mais proeminentes, sendo estas conspícuas no tórax e pescoço. Contrariamente, os suicídios apresentaram predomínio de lesões de natureza cortante, estando criticamente presentes no pescoço e membros superiores. Feridas corto-perfurantes torácicas oblíquas indiciaram uma morte homicida. Outros achados sugestivos de homicídio incluem a presença de lacerações da roupa, lesões traumáticas adicionais e lesões nos pulmões e osso/cartilagem. Toxicologicamente, o álcool associou-se aos homicídios e os psicofármacos a suicídios. A regressão logística identificou a presença de lesões traumáticas adicionais (OR 14.8, p=0.032), assim como a ausência de lesões letais no pescoço (OR 0.109, p=0.043) e membros superiores (OR 0.022, p=0.015), como preditores autópticos independentes de etiologia médico-legal homicida.

Para estabelecer uma conclusão convincente todos os elementos investigativos devem ser considerados atendendo às especificidades de cada caso.

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INTRODUCTION

SHARP FORCE FATALITIES: DEFINITIONS AND CONCEPTS

Sharp force trauma refers to traumatic lesions that are produced by pointed and / or sharp-edged objects. Examples of such objects include knives, scissors, razor blades, screwdrivers, broken glass, among many other examples.

In Portugal, several sharp objects are recognized by law as '*armas brancas*' ('white weapons') with this term being classically used likely due to the steely white glow when light is shone upon their metal blades(C. Hercules, 2014). The legal provisions of *armas brancas* are present in the *Regime jurídico das armas e suas munições (Lei n.º5/2006 Diário da República n.º 39/2006, Série I-A de 2006-02-23*) in which the following, roughly translated, definition of *armas brancas* is given: All portable object or instrument possessing a blade or a cutting, stabbing or chopping surface with a length over 10 centimetres and also, regardless of dimensions, butterfly knives, switchblade knives, throwing knives, throwing stars, cardsharps, utility knives and objects destined to propel blades, arrows or bolts. This legal definition is illustrative of the wide scope of sharp force objects recognized by Portuguese law as a weapon, with these objects being able to inflict a variety of wound types. While the nomenclature is not always clear, most authors(DiMaio, V.; DiMaio, 2001; Knight & Saukko, 2004; Shepherd, 2003) acknowledge cut (or incised/slash) wounds, stab (or puncture) wounds and chop wounds.

Cut or incised wounds are lesions produced by the fairly tangential contact of the sharp object's edge with the skin. These have a greater length in the skin's surface than depth in their track. Due to their more superficial nature, these are rarely fatal as they typically spare vital organs and deep vessels. Despite this, a special mention should be made to cut wounds on the neck and wrists which may prove fatal due to the appreciable presence of major arteries in superficial tissues.

Stab wounds, on the other hand, are produced by the application of a sharp tip or edge of a sharp object in a reasonably perpendicular direction to the skin. Conversely to cut

wounds, these injuries have a greater depth in their track through the body than length in the skin. Due to greater penetration, with potential lesion of major organs and vessels, stab wounds are of particular forensic interest and are the major culprits in sharp force fatalities, most prominently in homicides.

Lastly, chop wounds(DiMaio, V.; DiMaio, 2001) are inflicted when an object with a cutting edge is impelled towards the body surface with great kinetic energy, determining contused margins and often underlying bony injury. These wounds, therefore, present with both sharp and blunt force features.

EPIDEMIOLOGY OF HOMICIDAL AND SUICIDAL SHARP FORCE FATALITIES

Sharp force fatalities may be encountered as homicidal in nature, constituting roughly 20% of all homicides worldwide according to the United Nations Office on Drugs and Crime's 2019 Global Study on Homicide(United Nations Office on Drugs and Crime (UNODC), n.d.) and the most frequent in countries such as the United Kingdom(Hunt & Cowling, 1991; Knight & Saukko, 2004; Megan, 2019; Shepherd, 2003), Sweden(Karlsson, 1998c), Denmark(Thomsen, Hougen, Villesen, Brink, & Leth, 2020), Poland(United Nations Office on Drugs and Crime (UNODC), n.d.), Slovenia(United Nations Office on Drugs and Crime (UNODC), n.d.) and Hungary(United Nations Office on Drugs and Crime (UNODC), n.d.) and the second most frequent method in Italy(Verzeletti, Russo, Bin, Leide, & De Ferrari, 2014; Vichi et al., 2020), Lithuania(Chmieliauskas et al., 2019), Norway(Kristoffersen, Lilleng, Mæhle, & Morild, 2014) and France(Cros, Alvarez, Sbidian, Charlier, & Lorin De La Grandmaison, 2012; Saint-Martin, Bouyssy, Bathellier, Sarraj, & O'Byrne, 2006). While firearm deaths generally lead in the Americas (accounting for roughly three-quarters of all American murders(United Nations Office on Drugs and Crime (UNODC), n.d.)), sharp force homicides are far more relevant in European nations. In 2019, the Portuguese reality was that most intentional homicides were committed by use of sharp objects (31%)(Portuguese Ministry of Internal Administration (MAI), n.d.), followed by other mechanisms (23%) and firearm deaths (19.5%).

Despite not being uncommon in homicides, suicides by sharp force are exceptional with the prevalence being often quoted as less than 2-3% in several international case series(Fukube et al., 2008; Start, Milroy, & Green, 1992; Värnik et al., 2008; Watanabe, Kobayashi, & Hata, 1973). In Portugal, a 7-year study(Dias & Mendonc, 2014) of suicides in the Centre region made no specific mention of sharp force suicides while a study(Assunção, Santos, & Magalhães, 2009) in the Northern region revealed a total of 16 cases found in a 10-year period comprising 1.2% of all suicides.

MEDICO-LEGAL INVESTIGATION OF SHARP FORCE FATALITIES

Sharp force fatalities may be homicidal, suicidal or accidental in nature. Since accidental sharp force fatalities are uncommon(Kemal, Patterson, & Molina, 2013; Prahlow, Ross, Lene, & Kirby, 2001) and usually pose no great difficulty in establishing the manner of death, a greater challenge arises from discerning suicidal from homicidal nature.

Establishing manner of death constitutes a complex task which requires an in-depth analysis of several characteristics, namely those present in the available circumstantial information, autopsy findings as well as the results from ancillary diagnostic exams (e.g.: toxicological analysis). It is by scrutinizing all these features that the forensic pathologist may reach upon a conclusion.

The characteristics of homicidal and suicidal sharp force fatalities have been described in the literature, and several medico-legal aspects have been noted as being distinctly useful to distinguish between these two manners of death.

Said elements will be further explored within the following three sections: demographic and circumstantial information; autopsy information and toxicological information.

DEMOGRAPHIC AND CIRCUMSTANTIAL INFORMATION

Before initiating necroscopic examination, the forensic pathologist should have an in-depth knowledge of the circumstances surrounding the victim's death by analysing all

supplied information (be it by police reports, health records or death scene examination). This information may impact the technical conduction of the autopsy, facilitate in elucidating certain questions established *a priori* and enable the pathologist to correlate such circumstantial elements with necroscopic findings allowing for cogent final conclusions.

SEX AND AGE

In all the reviewed literature(Au & Beh, 2011; Brunel, Fermanian, Durigon, Lorin, & Grandmaison, 2010; Burke, Baber, Cheung, & Fitzgerald, 2018; Hunt & Cowling, 1991; Karlsson, 1998a; Kemal et al., 2013; Kranioti & Kastanaki, 2017; Krywanczyk & Shapiro, 2015; Mazzolo & Desinan, 2005; Scolan et al., 2004; Terranova et al., 2020; Vassalini, Verzeletti, & De Ferrari, 2014) the majority of both homicidal and suicidal sharp force victims were male. An important distinction to note, however, is that the male-to-female ratio was greater in suicide victims with male victims being seven times more frequent than female victims in one case series.(Racette, Kremer, Desjarlais, & Sauvageau, 2008)

Two important points help explain such findings: firstly, it is patently established in the literature(Countries, Grinshteyn, & Hemenway, 2010; Ertl et al., 2019; World Health Organization (WHO), 2014) and national reports(Portuguese National Institute of Statistics, n.d.) that men are more frequent victims of violent deaths, regardless of manner. Secondly, regarding suicidal deaths, men tend to employ more violent self-destructive methods when compared to females with hanging, firearm use and self-stabbing being all more common in males(Bachmann, 2018; Ertl et al., 2019; Kranioti & Kastanaki, 2017; Värnik et al., 2008). Several lines of thought have been put forward to explain this(Murphy, 1998; Värnik et al., 2008), namely women's lesser intent to die, greater concern with postmortem physical appearance and other gender-specific cultural norms.

Despite these differences in gender ratios for manner of death, most studies failed to observe it as a reliable predictor of manner of death(Brunel et al., 2010; Terranova et al., 2020).

Regarding age most studies presented a wide age-range for homicidal deaths (mean age between 33 – 43.5 years)(Brunel et al., 2010; Burke et al., 2018; Kemal et al., 2013; Scolan et al., 2004; Terranova et al., 2020; Vassalini et al., 2014) with one reporting a range from 3 to 98 years old.(Kemal et al., 2013) Suicide victims had an average age slightly greater than those of homicide victims in most of the reviewed literature. This may be explained due to several factors, namely the inclusion of far younger homicide victims (with one study including two newborn babies(Scolan et al., 2004)) which may yield a lower average age. Another point to mention is the association between older age and suicide with elderly people having the highest reported suicide rates(Hawton & van Heeringen, 2009), particularly in persons aged 70 years or over in almost all regions of the world according to a WHO report(World Health Organization (WHO), 2014). Finally, in pediatric ages, sharp force suicide is exceedingly rare with no mention in a series of 219 child and adolescent suicides spanning 25 years(Molina & Farley, 2019) and only one reported case in a Canadian 10-year retrospective study(Shaw, Fernandes, & Rao, 2005). Together, these factors substantiate that a younger age in a sharp force death may be a predictor of a homicidal manner of death as put forward by some authors(Brunel et al., 2010; Scolan et al., 2004).

PLACE OF BIRTH

Amongst the many demographic determinants of violent death is the place of birth. Immigrants as a special group may yield useful idiosyncrasies that allow for a distinction in the manner of death. Regarding suicidal behaviour in general immigrant population, a review of literature(Forte et al., 2018; Kellogg, Kaur, & Blank, 2014) and a global WHO report(Bachmann, 2018) found mixed results with some studies purporting a higher risk, others identical and some even lower.

What may explain such difficulty in attributing a clear pattern in immigrant population is the intrinsic heterogeneity of this population. Distinct ethnical backgrounds confer different acceptability of suicide, assimilation rates and cultural values which may contribute on a case-by-case basis to an increased propensity to violence.

Regarding sharp forces, this parameter is no less controversial with only one study(Terranova et al., 2020) having compared it and finding no significant association. Vassalini, Verzeletti(Verzeletti et al., 2014) and Cipollini(Cipolloni et al., 2020) observed a steady increase in the number of foreign victims of homicide in Italy with Verzeletti making note that foreign victims were mostly killed by sharp force instruments, attributing to the difficulty faced by immigrants in obtaining firearms – this in the context of migrant-on-migrant violence.

LOCATION OF THE BODY

By far, in both suicides and homicides, the victim's home was the most frequently reported place of where the body was found.

It should be noted however that suicide victims have consistently been found in their home with a higher frequency (58.8% - 75%)(Assunção et al., 2009; Fukube et al., 2008; Karlsson, 1998a; Mazzolo & Desinan, 2005; Scolan et al., 2004; Terranova et al., 2020; Vassalini et al., 2014) when compared to homicide victims (41% - 51.6%)(Karlsson, 1998c; Scolan et al., 2004; Terranova et al., 2020; Vassalini et al., 2014) in all of the reviewed case series.

Another aspect to take into consideration and which some studies have reported is the division within the home in which the body was found. For suicides the bedroom followed by the bathroom appeared to be the most frequent divisions(Assunção et al., 2009; Fukube et al., 2008; Karlsson, 1998a).

DATE OF DEATH

Amongst the many contributory factors(Hawton & van Heeringen, 2009; Turecki & Brent, 2016) associated with suicide few are easily accessible to the forensic pathologist, with the clinical and psychiatric background being of utmost importance but infrequently readily and completely available. A far weaker, albeit oft reported, association with suicide is its seasonality, with spring and summer showing peak incidence(Galvão, Silva, & Silva, 2018; Hawton & van Heeringen, 2009). Homicide association with seasonality is controversial with several speculative factors being put forward(Sisti, Rocchi, MacCiò, & Preti, 2012) such as the victim's lower survivability in extreme weather and greater amount of time spent outside home during holiday season which may expose the victim to potential offenders.

In sharp force deaths a study(Terranova et al., 2020) determined that a majority of homicides were committed between 6 PM and 6 AM and mostly on weekend days (Friday through Sunday).

TYPE OF WEAPON

The choice of the weapon is dependent upon multiple factors, namely accessibility, usability as well as occupational and cultural context.

Undoubtedly the most frequent and easily accessible type of weapon used in both homicidal and suicidal sharp force fatalities is the knife, particularly the kitchen knife.(Assunção et al., 2009; Fukube et al., 2008; Karlsson, 1998c; Mazzolo & Desinan, 2005; Scolan et al., 2004; Terranova et al., 2020; Vassalini et al., 2014) An important distinction to note is that in suicidal deaths razor blades come at a close second as the chosen instrument(Assunção et al., 2009; Fukube et al., 2008; Kranioti & Kastanaki, 2017; Vassalini et al., 2014) with one study(Karlsson, 1998a) reviewing 105 suicidal sharp force fatalities determining a prevalence of 33% for kitchen knives and 30% for razor blades. Regarding suicides other described instruments are rarer and may include swords, scissors and boxcutters.(Watanabe et al., 1973)

Due to the rarity of these events, several case reports exist reporting on unusual weapons used to commit suicide such as crossbows(Panata, Lancia, Persichini, Scalise Pantuso, & Bacci, 2017) and spearguns(Nouma, Krimi, & Regaieg, 2018) highlighting a wide spectrum of instruments that may be employed for self-termination.

Occupational context may influence the choice of the weapon due to greater accessibility and know-how, as exemplified by a case report of a woodworker using a circular saw to terminate his own life.(Judd & Wyatt, 2007) Craftsmanship by the victim may also enable the construction of elaborate sharp force instruments such as homemade guillotines as described in these case reports(Obenson & Belliveau, 2012; Tournel et al., 2008). Such elaborate contraptions must be carefully examined as to ensure that they are capable of self-activation and were indeed the instruments used in the victim's death by correlating its characteristics with the observed autopsy findings.

Regarding cultural context, sharp force suicides related to Japanese suicide rituals have been described namely *seppuku*(Watanabe et al., 1973) (also known as *harakiri*) and *jigai*(Maiese, Gitto, Dell'Aquila, & Bolino, 2014) (the female counterpart of *seppuku*), which may demand the usage of specific type of knives – namely of the *tantō* variety.

LOCATION OF WEAPON

In the one study that analysed this parameter it was determined that in most homicides and suicides the weapon was found near the body (53.3%) with 100% in suicidal deaths.(Terranova et al., 2020) Despite this, this parameter did not reach statistical significance to differentiate between the two manners of death.

It is reasonable to understand such findings given that in homicidal deaths there may be a deliberate attempt to hide the murder weapon, with such concern of weapon concealment being absent in most suicidal deaths. Notwithstanding its rarity, the eventuality of an altered suicidal death scene should be taken into consideration as described in this unusual report of weapon concealment following self-stabbing.(Pelletti, Visentin, Rago, Cecchetto, & Montisci, 2017) Another point to take

into account is that the weapon may be left near the body in homicides precisely to simulate a suicidal death.

PSYCHIATRIC BACKGROUND

When establishing the manner of death, the pathologist must attend to the victim's clinical background, particularly the presence of risk factors for suicidal behavior. Out of the many societal, sociocultural and familial risk factors few are readily available to the forensic pathologist. Thus, in this forensic context, important elements that are usually available include, but are not limited to, past suicide attempts, psychiatric illness and a history of alcohol or substance abuse.

Past suicide attempts are well documented(Bachmann, 2018; Hawton, Casañas I Comabella, Haw, & Saunders, 2013; Yoshimasu, Kiyohara, & Miyashita, 2008) as being the strongest predictors of suicide risk, with a meta-analysis(Yoshimasu et al., 2008) determining an OR=16.33; 95% CI [7.51 – 35.52].

The majority of suicides are associated with positive mental illness (with the risk being 10 times as high when compared to the general population)(Bachmann, 2018) with depression followed by schizophrenia(Bachmann, 2018) being leading risk causes of suicide. A WHO report(World Health Organization (WHO), 2014) highlights that in high-income countries psychiatric disease is present in up to 90% of suicide victims and that such risk is cumulative with the total number of mental disorders. Substance related disorders are also associated with increased suicide risk.(World Health Organization (WHO), 2014; Yoshimasu et al., 2008)

Most studies specifically reviewing sharp force fatalities evaluate the presence of psychiatric illness. In such studies, there is a noticeable tendency for suicide victims to have a greater incidence of mental disease when compared to homicide victims(Krywanczyk & Shapiro, 2015; Terranova et al., 2020; Vassalini et al., 2014), particularly depression followed by schizophrenia. Despite this, the reported incidence

of psychiatric illness for suicide victims has a wide range from 32% to 70%(Assunção et al., 2009; Terranova et al., 2020; Vassalini et al., 2014).

Two considerations should be taken into account when interpreting such data: the absence of documented psychiatric background is not synonymous with its clinical absence as reports presented to the forensic pathologist are frequently incomplete or imprecise. Secondly, the diagnosis of psychiatric illness, particularly depression, is so prevalent in the general population that it may not be reliably used as an independent predictor for a given manner of death – the analysis of other elements must be considered.

In studies that analysed both sharp force homicides and suicides, only two collected psychiatric background date on the homicide victims which yielded a lower incidence of 6%(Terranova et al., 2020) and 14%(Krywanczyk & Shapiro, 2015).

SUICIDE NOTES

Examination of the scene may reveal the presence of a manuscript detailing the victim's intention to commit suicide usually shortly preceding said act. The presence of a suicide note only occurs in a minority of victims with a USA National Violent Death Reporting System analysis with a total of 32151 victims finding it present in 31% of the cases.(Rockett et al., 2018)

This does not seem to differ in regard to sharp force suicides in which most studies(Assunção et al., 2009; Burke et al., 2018; Karlsson, 1998a; Mazzolo & Desinan, 2005) observed an incidence less than 50% with only one study(Terranova et al., 2020) finding it present in half (n=10) of the reported cases.

AUTOPSY INFORMATION

CLOTHING LACERATIONS

During external examination of the victim, whenever possible, it is essential to evaluate the presence of clothing lacerations. In suicidal deaths, the victim may have the aforethought care of exposing the skin upon which the sharp force injury is inflicted, thus leaving the clothing intact. Understandably, such care is rarely present in homicidal deaths due to the haphazard nature of the inflicted injuries.

It is well described in the literature(Burke et al., 2018; Karlsson, 1998c; Scolan et al., 2004; Terranova et al., 2020) a presence of clothing lacerations in the majority of sharp force homicidal cases (obviously cases in which the clothing was available for analysis), with a 33 victims case series finding it present in 93% of homicides.(Burke et al., 2018)

Regarding suicidal deaths, clothing lacerations are far rarer with most studies(Assunção et al., 2009; Fukube et al., 2008; Karlsson, 1998a; Scolan et al., 2004; Terranova et al., 2020) reporting an incidence under 40% and only one study(Burke et al., 2018), with 9 cases reporting a majority of 55.5%.

NUMBER AND DISTRIBUTION OF DIFFERENT WOUND TYPES

- NUMBER:

Number of total sharp force wounds

It is a consistent finding in the literature that homicidal deaths present with a higher mean number of wounds when compared to suicidal deaths: 11.5 vs 8.6(Brunel et al., 2010), 5.3 vs 4.1(Kemal et al., 2013), 7 vs 3(Terranova et al., 2020). In some studies the number of sharp force wounds reached statistical significance to differentiate between the two manners of death(Scolan et al., 2004)

Despite this, again other medico-legal elements must be taken into consideration as there are reports(Alunni, Cabusat-Mailliet, & Quatrehomme, 2020; Austin, Guddat, Tsokos, Gilbert, & Byard, 2013; Kaliszan, 2011) of suicidal deaths with multiple stab

wounds including a case with over 90 stab wounds with one being intracranial.(Karger & Vennemann, 2001)

Number of stab and cut wounds

In a study(Kemal et al., 2013) that compared the number of stab and cut wounds in homicidal and suicidal deaths, homicide victims presented with a higher average number of stab wounds when compared to suicide victims (3.3 vs 0.7) and a lower number of cut wounds (2.1 vs 3.3). Another study(Brunel et al., 2010) reported that victims that presented exclusively with cut wounds had a more likely suicidal manner of death (19 vs 6) – despite this difference, the type of wound as a criteria was insufficient to reach statistical significance to discriminate manner of death. Such data may be explained due to the following: hesitation marks, by their definition as superficial sharp force wounds, correspond to cut wounds. These wounds, being far more prevalent in suicidal deaths, contribute to the total number of cut wounds being greater in suicides when compared to homicides.

It is worth mentioning – perhaps unsurprisingly – that, by virtue of the nature of the cases observed by the forensic pathologist, most sharp force fatalities reveal, on average, a higher number of stab wounds when compared to cut wounds, regardless of manner of death, due to their greater lethality.(Brunel et al., 2010; Fukube et al., 2008; Kemal et al., 2013)

- LOCATION:

The location of sharp force wounds is of great relevance to distinguish manner of death. In suicides it is reasonable to expect that the site of injury will be in an anatomically accessible region and that hard structures, such as bone, will be avoided – this explains why lesions observed in the back and head are far more common in homicidal deaths.

An important caveat when interpreting such data in the literature is to verify how the distribution of injuries was reported as it varies considerably; some authors report the distribution including all types of wound while others may choose to specify the distribution of specific injuries namely: stab wounds, cut wounds, hesitation wounds, defence wounds and lethal wounds.

Anatomical distribution of total sharp force injuries

Regarding studies that reported the most frequent locations by total number of sharp force injuries in suicides, these(Karlsson, 1998a; Kemal et al., 2013; Scolan et al., 2004; Vassalini et al., 2014) report a clear predominance of limb injury followed by the thorax and neck while a Greek 12 cases series(Kranioti & Kastanaki, 2017) established the thorax and neck followed by the abdomen and limbs as the most frequently injured anatomical units. Yet, one study(Terranova et al., 2020) chose to exclude hesitation marks with the most frequent locations being the neck (65%), abdomen (40%), left chest (20%) and limbs (25%), emphasizing the relevance of reporting detailed distribution of injuries.

Most studies(Karlsson, 1998a; Kemal et al., 2013; Krywanczyk & Shapiro, 2015; Scolan et al., 2004; Vassalini et al., 2014) report homicidal deaths presenting with the most frequent locations being chest and limbs followed by neck, back and abdomen. In terms of injury site the following aspects seem to be the most relevant contributors in differentiating suicidal from homicidal death: back and genital sharp force injury are seldom found in suicides while such injuries may occasionally be found in homicidal deaths.(Kemal et al., 2013; Scolan et al., 2004)

Anatomical distribution of cut and stab wounds

In a study(Kemal et al., 2013) that discriminated the anatomical site by type of injury, it was determined that in suicides cut wounds were prevalent in the extremities (61%) and the neck (34%) – a finding in line with other similar studies.(Fukube et al., 2008; Mazzolo

& Desinan, 2005) while in homicides such lesions were also mostly found in the extremities (45%) and neck (25%) albeit with a lower frequency. An important distinction to note is that in homicides incised wounds were also found far more frequently in the head (18%) when compared to suicides (2%).

Alternatively, with reference to stab wounds, in suicides these were found in the chest (67%), neck (17%) and abdomen (17%), findings in line with other similar studies(Fukube et al., 2008; Start et al., 1992). The distribution of stab wounds in homicidal deaths was more diversified being present in the chest (37%), back (20%), neck (18%), abdomen (8%), head (7%), extremities (10%) and genitals (0.2%).

Such results corroborate the aforementioned conclusion that chest and neck are preferential sites of injury in suicidal deaths, with the presence of back, head and genital injuries being more suggestive of a homicidal death. Another pertinent point to make is that most of sharp force injuries observed in the extremities of suicidal deaths are of an incised nature.

Anatomical distribution of lethal wounds

An additional parameter to report is the site of the injury that constitutes the putative cause of death. One study(Vassalini et al., 2014) reported such sites for both homicidal and suicidal sharp force deaths with suicides having limbs (42.9%), neck (32%) and the left chest (28.6%) as the most common fatal injury sites. Assunção also reported the anterior aspect of the neck followed by the anterior aspect of upper extremities as the most common sites of suicidal fatal wounds. Vassalini additionally analysed homicide victims and concluded that these presented fatal wounds most frequently in the left chest (44.6%), neck (35.9%), right chest (17.4%), abdomen (7.6%), head (3.3%) and limbs (3.3%).

Therefore, according to these results, determining the presence of lethal wounds in the right chest, back and posterior neck is highly suggestive homicide whereas lethal extremity wounds (particularly on the forearms) point towards suicide.

HESITATION WOUNDS:

Hesitation wounds or marks are self-inflicted incised wounds which tend to be superficial, multiple, parallel and present in easily accessible anatomical regions.(DiMaio, V.; DiMaio, 2001) In terms of site of injury, hesitation marks are typically present in the neck and limbs being more frequent in the left side of the body likely due to the right-handedness of the general population.

Hesitation wounds are important landmarks of self-injuring behavior which may translate suicidal ideation. Therefore, their incidence is particularly relevant in suicidal deaths with most studies in the literature reporting an incidence of at least 50%(Assunção et al., 2009; Fukube et al., 2008; Karlsson, 1998a; Racette et al., 2008; Terranova et al., 2020; Vassalini et al., 2014) with Karlsson(Karlsson, 1998a) reporting the presence of hesitation marks in 65 of the 105 (62%) sharp force suicide victims. Karlsson also reports a homicide with hesitation wound-like lesions present in the victim's neck which may have resulted from the assailant's own hesitation or initial lack of strength in performing the cut, highlighting that hesitation-like wounds are not pathognomonic of suicides.

Generally hesitation wounds assume more relevance in the anterior aspects of upper limbs(Assunção et al., 2009; Kranioti & Kastanaki, 2017; Racette et al., 2008; Terranova et al., 2020), particularly on the wrist and anterior elbow crease as well the anterior neck.(Terranova et al., 2020) Vassalini et al(Vassalini et al., 2014) identified hesitation marks being more frequently present in the volar surface of the left wrist (39%), with identical presence in the contralateral wrist (33%) – these being generally grouped together.

DEFENSE WOUNDS:

Defense wounds result from the victim's attempts to protect themselves from the sharp weapon attacks. Classically these have been divided into active and passive defense wounds.(DiMaio, V.; DiMaio, 2001; Racette et al., 2008; Terranova et al., 2020) Active

defense wounds occur when the wounds are the result from the victim's attempt to seize the weapon and therefore, these are mostly seen in the flexor surface of the fingers and the palm as they grasp onto the weapon's sharp surface.(DiMaio, V.; DiMaio, 2001; Knight & Saukko, 2004) Passive defense wounds on the other hand result from the victim's attempts to shield one's body from the sharp weapon, thus, the most afflicted regions will be the ulnar surface of the forearms and the back of the hand and knuckles.(DiMaio, V.; DiMaio, 2001; Knight & Saukko, 2004)

In homicidal deaths the reported incidence varies from 31% to 64.51%(Karlsson, 1998a; Kemal et al., 2013; Terranova et al., 2020; Vassalini et al., 2014) The presence of defense wounds in suicidal victims was exceptional with only one study reporting its presence in a murder-suicide victim(Terranova et al., 2020). Despite this, it should be noted that the definition of defense wounds may alter its inclusion, with one study excluding superficial cuts found on the fingers of a few suicide victims as not being proper defense wounds as they "had not passed through the skin".(Karlsson, 1998a)

In terms of location, Vassalini(Vassalini et al., 2014) reported a greater presence of defense wounds in the palmar surface of the right hand (51.2%), anterior surface of the right forearm (25.6%), palmar surface of the left hand (11.6%) and anterior surface of the left forearm (23.3%). Unlike hesitation marks in suicidal deaths, defense wounds have a greater preponderance in the posterior aspects of the extremities and have a more heterogeneous distribution through the entire surface of the limb as reported by Racette's(Racette et al., 2008) comparative analysis of hesitation and defense wounds.

- ORIENTATION:

The orientation of the wound (horizontal, vertical, or oblique) provides valuable insight into how the weapon was manoeuvred. In suicide victims, grasping the handle of the weapon parallel to the palm with the elbow bent at 90º to the body, determines a horizontal orientation to self-inflicted chest stab wounds. In contrast, homicidal stab wounds tend to present with a more vertical or oblique orientation.

Multiple studies(Brunel et al., 2010; Karlsson, 1998a; Scolan et al., 2004) are in line with the aforementioned line of thought reporting a higher incidence of horizontal wounds in suicidal deaths, with two studies(Karlsson, 1998b; Scolan et al., 2004) determining vertical chest wounds as an independent predictor of a homicidal death.

OTHER TRAUMATIC LESIONS:

As in other violent deaths, sharp force fatalities may present with additional injuries of varied etiology.

In suicidal deaths, finding additional injuries may reflect the presence of a complex suicide: a suicide in which two or more methods are employed to ensure a fatal outcome.(Marcinkowski, Pukacka-Sokolowska, & Wojciechowski, 1974) Multiple reports exist of self-stabbing deaths with other injuries namely of blunt force trauma(Christin, Hiquet, Fougas, Dubourg, & Gromb-monnoyeur, 2018; Kemal et al., 2013; Kulkarni, Mohite, & Meshram, 2020), poisoning(Karakasi et al., 2017; Petković, Maletin, & Đurendić-Brenesel, 2011), drowning(Kaliszan, Karnecki, Tomczak, Gos, & Jankowski, 2013; Peyron, Casper, Mathieu, Musizzano, & Baccino, 2018; Terranova et al., 2020), asphyxia(Karlsson, 1998a; Kemal et al., 2013; Kranioti & Kastanaki, 2017; Palmiere, Risso, & Hecke, 2003) as well thermal injuries.(Karlsson, 1998a; Kemal et al., 2013; Petković et al., 2011; Terranova et al., 2020) Despite such reports, globally, the incidence of additional traumatic lesions is rare in suicidal sharp force deaths, with case series reporting 8 to 11% (Karlsson, 1998a; Kemal et al., 2013; Kranioti & Kastanaki, 2017; Terranova et al., 2020) when present. Some, however, report no additional injuries(Brunel et al., 2010).

Whilst additional injuries are unusual in suicidal self-stabbings, in homicidal sharp force fatalities these have a higher occurrence. An ample range between 7.1% to 76%(Brunel et al., 2010; Karlsson, 1998c; Kemal et al., 2013; Krywanczyk & Shapiro, 2015; Scolan et al., 2004) is reported with blunt force trauma being the type of additional lesion most frequently found with stabbing wounds, with asphyxia and gunshot wounds also being reported.(Karlsson, 1998c; Kemal et al., 2013; Krywanczyk & Shapiro, 2015)

INJURED ANATOMICAL STRUCTURES:

Few studies make specific mention to the injured anatomical structures with two(Kemal et al., 2013; Thomsen et al., 2020) studies making specific mention to the injured structures. It is well described that fatal sharp force trauma occurs through injuries to major vessels and the heart with the mechanism of death being related either to exsanguination, aspiration or air embolism.(DiMaio, V.; DiMaio, 2001; Knight & Saukko, 2004)

For homicides the most frequently injured structures were the heart 28-49.5%, lungs 24-73.2% and major thoracic and cervical vessels with 19-23.8% and 15-26.3%, respectively according to Thomsen(Thomsen et al., 2020) and Kemal(Kemal et al., 2013). Kemal also described suicidal fatalities with the neck vessels (29%), vessels of the extremities (28%) and the heart (24%) being the most affected structures.

Not only may organs and vessels suffer damage but also bone and cartilage. In a case series of 21 sharp force homicides and 25 sharp force suicides bone or cartilage injury was present in 14 (67%) of homicides and only in 1 (4%) of suicides. Other studies(Banasr, Lorin De La Grandmaison, & Durigon, 2003; Brunel et al., 2010; Krywanczyk & Shapiro, 2015) further corroborate such findings of a lower incidence of bone or cartilage injury in suicidal deaths vs homicidal deaths (74.3% vs 14.6%)(Brunel et al., 2010) and (67% vs 4%)(Krywanczyk & Shapiro, 2015).

Such consistent results in the literature may be justified due to the greater care in inflicting the stab wounds present in suicidal fatalities with deliberate avoidance of solid anatomical structures – with such caution being understandably more difficult to employ in homicidal deaths.

TOXICOLOGY INFORMATION

The toxicology report provides the forensic pathologist with valuable information regarding the cause and circumstances of death. The presence or absence of certain substances in the blood may present as risk factors for the occurrence of a given manner

of death (e.g: antidepressants detected with sub-therapeutic concentrations in suicidal deaths).

By far the most prominent substance to be tested is the presence of alcohol, being mentioned in nearly every study with available toxicology reports.(Assunção et al., 2009; Burke et al., 2018; Karlsson, 1998a; Kranioti & Kastanaki, 2017; Krywanczyk & Shapiro, 2015; Scolan et al., 2004; Vassalini et al., 2014) Other substances evaluated included other drugs such as amphetamines(Burke et al., 2018) and psychiatric drugs(Assunção et al., 2009; Burke et al., 2018) such as antidepressants and antipsychotics.

Alcoholic consumption, both acute and chronic, has been consistently linked in the literature to an increased risk of suicidal behavior(Bilban & Škibin, 2005; Choi, DiNitto, Sagna, & Marti, 2018; Crombie, Pounder, & Dick, 1998; Kõlves, Värnik, Tooding, & Wasserman, 2006) with moderate consumption of alcohol being called by some as a 'courage dose'.(Große, Stefan, & Thierauf, 2010) Due to its association with violent and uninhibited behavior homicidal deaths are also associated with alcoholic consumption(Knight & Saukko, 2004; Shepherd, 2003).

In sharp force fatalities the literature is in agreement with such findings, with homicide victims having higher blood alcohol content (BAC) levels when compared to suicide victims(Burke et al., 2018; Karlsson, 1998c, 1998a; Krywanczyk & Shapiro, 2015; Vassalini et al., 2014). Due to this fact, BAC has been determined by some as a predictor of a homicidal manner of death(Karlsson, 1998b) with other studies finding no such association.(Scolan et al., 2004) A pertinent aspect when reporting BAC is to specify the exact concentration namely if it is high enough to influence behavior – mere dichotomic reporting of its presence or absence may erroneously skew statistical analysis and yield an incorrect predictive value. Some authors explicitly mention a threshold value from which the presence is considered positive.(Scolan et al., 2004)

Regarding other tested substances, Burke et al(Burke et al., 2018) tested for amphetamines finding it positive in 14,3% (n=8) of homicides and in zero suicide cases. One study detected(Burke et al., 2018) positive psychiatric drugs in 3 out of 56 homicide victims and in 5 out of 15 suicide victims. A majority of the sharp force suicide victims

evaluated by Assunção(Assunção et al., 2009) tested positive for psychiatric drugs (n=4/7; 57.1%), making however no mention if such drugs were at therapeutic levels or not.

OBJECTIVES

The literature is plentiful with case reports related to unusual sharp force fatalities, and (to a lesser extent) also presents some retrospective cohort studies that sought out to describe and highlight particularities in sharp force fatalities that enable a differential diagnosis between homicide and suicide.

However, few of these studies are fully comprehensive in their analysis only focusing on a small number of elements as well as sometimes suffering from a paucity of cases (notably of the suicidal variety).

To curtail such limitations and to provide a perspective of the Portuguese reality, the present study aims to:

- Characterize demographic, circumstantial, autopsy and toxicological findings present in suicidal and homicidal sharp force fatalities;
- Identify independent statistical predictors of a given manner of death in sharp force fatalities.

MATERIAL AND METHODS

A retrospective case control review was performed on all deaths due to sharp force injury admitted at the Forensic Pathology Unit of the South Branch of the National Institute of Legal Medicine and Forensic Sciences between January 2012 and December 2019.

Deaths were included if they had either a homicidal or a suicidal manner of death following complete external examination or forensic autopsy and if demographic, circumstantial and necroscopic information was available. Cases with medically altered morphology of lesions were to be excluded.

Each casefile was reviewed, whenever possible, for circumstantial information (e.g: police report, clinical/circumstantial information bulletin, death verification report), necroscopic information (external examination or autopsy report) and toxicological information (toxicology report).

The following elements were collected:

- Demographic and circumstantial data:
    - Sex
    - Age
    - Place of birth
    - Location of the body
    - Date of death
    - Type of weapon
    - Location of the weapon
    - Psychiatric background
    - Presence of suicide note

- Autopsy data:
    - Clothing lacerations
    - Number and anatomical distribution of stab, cut, chop, defense, hesitation and lethal wounds
    - Orientation of thoracic stab wounds
    - Presence of other traumatic lesions
    - Injured organs and vessels.

- Toxicology report: toxicological analysis.

Stab wounds were defined as sharp force wounds with a greater depth than length, cut wounds as sharp force wounds with greater length than depth. Chop wounds were identified as sharp force wounds associated with blunt force features such as abraded and/or contused margins. Thoracic stab wounds were classified as vertical whenever their greater axis was parallel to the midline, horizontal when perpendicular to the midline and oblique when between these two positions. The anatomical distribution of lesions was displayed through 23 anatomical regions represented in the anatomical diagram present in figure 1. Hesitation wounds were defined as parallel, superficial cut wounds in accessible anatomical locations while defense wounds were sharp force wounds observed in the upper extremities which may have resulted from the grasping or deflection of a sharp instrument.

For the toxicology report, no concentration threshold was used to include substances, these were included for analysis as long as they were detectable.

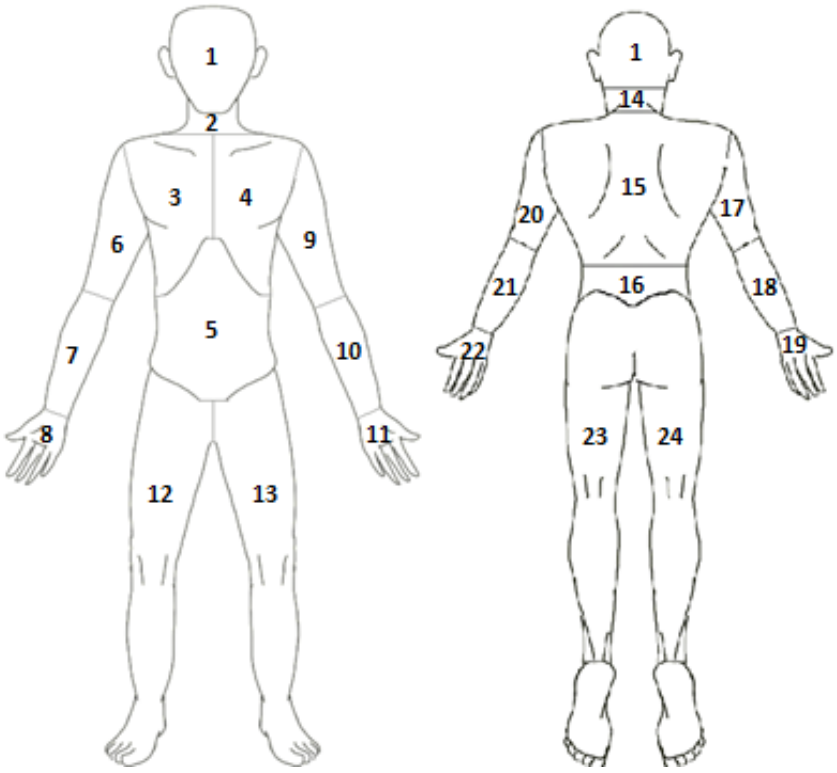


Figure 1 – Anatomical diagram with identified anatomical regions: 1 – head, 2 – anterior neck, 3 – right thorax, 4 – left thorax, 5 – abdomen, 6 – anterior right arm, 7 – anterior

right forearm, 8 – anterior right hand, 9 – anterior left arm, 10 – anterior left forearm, 11 – anterior left hand, 12 – anterior right lower limb, 13 – anterior left lower limb, 14 – posterior neck, 15 – dorsal back, 16 – lower back, 17 – posterior right arm, 18 – posterior right forearm, 19 – posterior right hand, 20 – posterior left arm, 21 – posterior left forearm, 22 – posterior left hand, 23 – posterior left lower limb, 24 – posterior right lower limb

Descriptive statistical analysis was performed using measures of central tendency and dispersion measures. Inferential analysis was employed with both parametric and non-parametric tests. To evaluate the normality of distribution Kolmogorov-Smirnov and Shapiro-Wilk tests were employed when appropriate. Levene's test was used to verify homogeneity of variances.

Binary logistic regression analysis was used to construct a model predictive of a given manner of death.

Significance was defined at $\alpha=0.05$ with all tests being bilateral. To perform said analysis IBM SPSS version 20.0 was used.

RESULTS

A total of 57 sharp force homicides (31.84% of 179 homicides) and 20 suicides (1.91% of 1047 suicides) were identified at the Forensic Pathology Unit of the South Branch of the National Institute of Legal Medicine and Forensic Sciences between January 2012 and December 2019.

All homicidal and suicidal deaths were included for analysis, with no cases being excluded.

DEMOGRAPHIC AND CIRCUMSTANTIAL INFORMATION

SEX

Regarding sex, a total of 63 men and 14 women were included. In homicidal deaths, 46 victims (80.7%) were male and 11 (19.3%) were female. In suicidal deaths, 17 victims (85%) were male and 3 (15%) were female. Such difference was not statistically significant following a Fisher's exact test (p = 1.000).

AGE

The average age of all victims was 43.0 ± 19.07 years with the lowest age being 5 months old and the highest age being 89 years old. In suicidal deaths the average age was 56.2 ± 18.6 years with a minimum of 25 and a maximum of 83. Homicidal deaths had an average age of 38.4 ± 17.1 with a minimum of 5 months old and a maximum of 89 years old. Age difference for suicide victims (mean rank = 54.03) and homicide victims (mean rank = 33.73) was statistically significant following an independent samples Mann-Whitney U test [U = 269.5, z = -3.492, p<0.001].

PLACE OF BIRTH

A total of 27 foreign birth victims were identified, with 25 being homicide victims (43.9% of all homicide victims) and 2 being suicide victims (10% of all suicide victims). Such difference was statistically significant following a chi-squared test for association, $\chi^2(1) = 7.455$, p= 0.006. There was a moderate association between place of birth and manner of death, $\phi = 0.311$, p=0.006.

LOCATION OF THE BODY

Overall, the location where the body was found was documented in 67 out of the 77 included cases. Out of these deaths, 36 (53.7%) occurred within a residential unit while 31 (46.3%) occurred outside home. Table 1 details, whenever possible, the specific room in which the body was found.

TABLE 1 – LOCATION OF BODY BY MANNER OF DEATH. INMLCF, I.P.

Main location	Division	Homicide	Suicide
Home (n = 33)	Bedroom	4	5
	Bathroom	1	4
	Kitchen	2	2
	Hallway	2	3
	Living room	1	0
	Unspecified	9	0
	TOTAL	**19**	**14**
Outside home (n = 34)		**29**	**5**

When contrasting the main location (inside home or outside it), homicidal deaths featured a total of 19 deaths (39.6%) inside home and 29 (60.4%) outside it, while suicidal deaths presented with a total of 14 (73.7%) inside home and 5 (26.3%) outside it. Such difference was statistically significant following a chi-squared test for

association, $\chi^2(1) = 6.333$, p=0.012. There was a moderate association between place of death and manner of death, $\phi = -0.307$, p=0.012.

DATE OF DEATH

Overall in all of the examined years 2013 revealed the greatest number of deaths (a total of 15 sharp force fatalities). There was an average of 7.12 homicides and 2.5 suicides per year. Figure 2 and 3 details the distribution of sharp force fatalities by year and seasons, respectively. Regarding seasonality, summer appeared to be the season with the greatest average number of deaths with winter having the lowest.

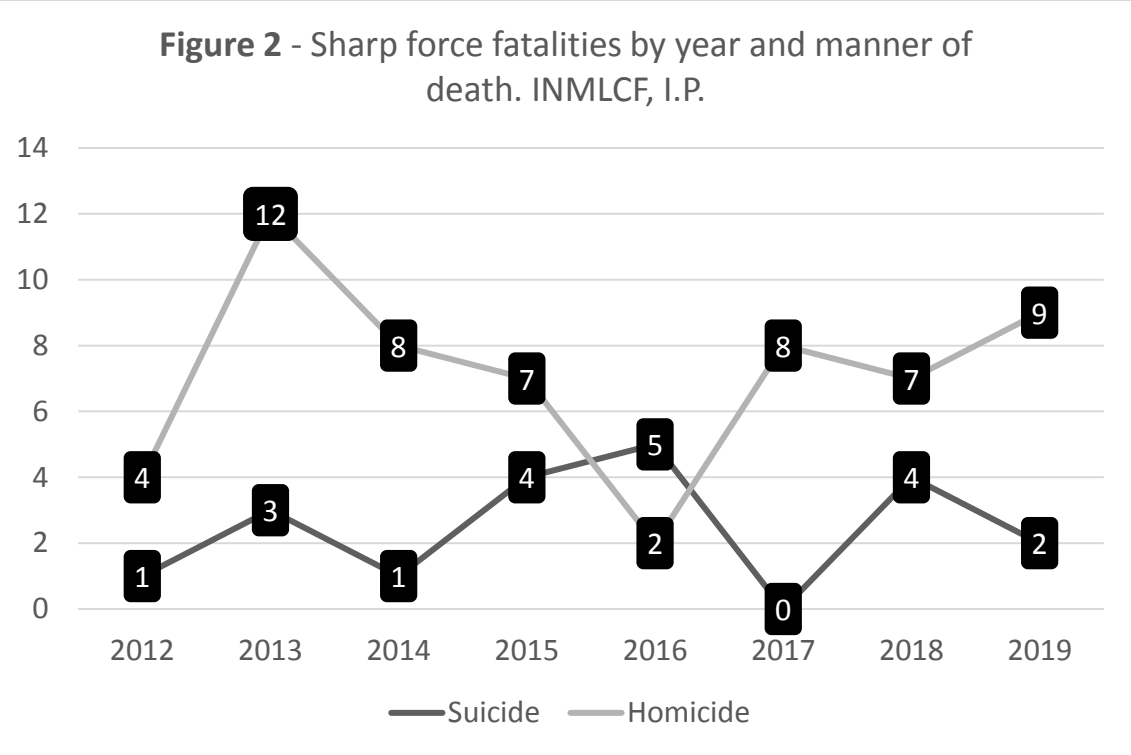
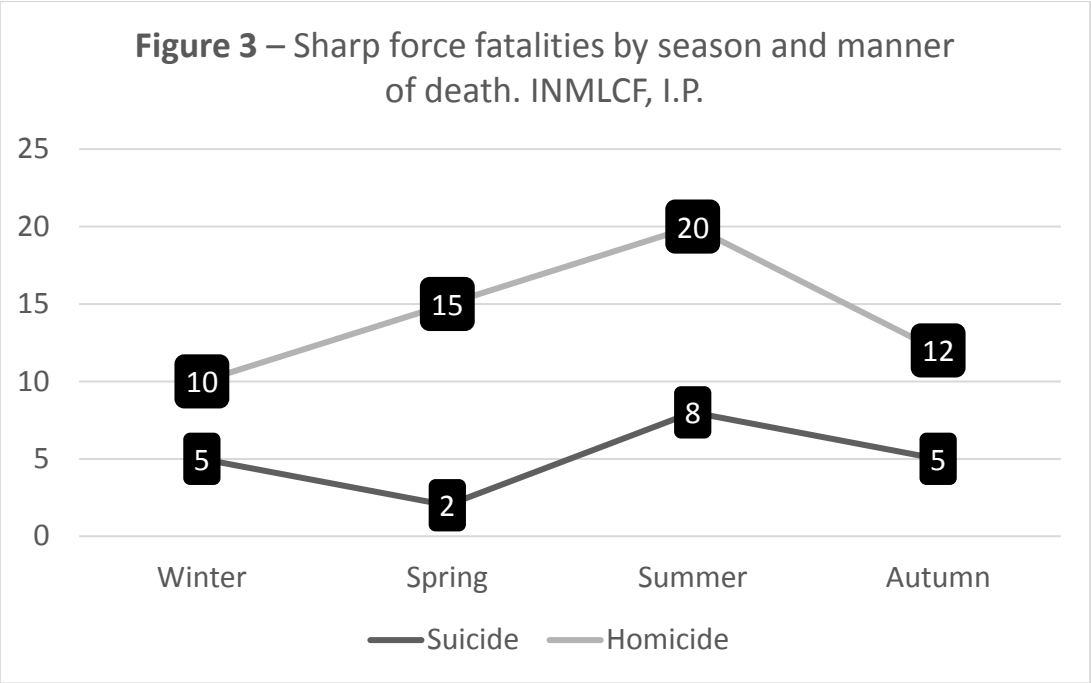


Figure 2 - Sharp force fatalities by year and manner of death. INMLCF, I.P.



TYPE OF WEAPON

Out of the 77 sharp force fatalities, only 23 (42.9%) had an identified weapon. Homicidal deaths were more likely to feature an unidentified weapon (70.2%) in comparison to suicidal deaths (20%).

Globally, the most commonly used weapon was the knife with 27 cases (81.8%) followed by scissors (6.1%) which were used in 2 cases. Table 2 further details the found type of weapons.

TABLE 2 – WEAPON TYPE BY MANNER OF DEATH. INMLCF, I.P.

Weapon type	Homicide	Suicide
Knife (n = 27)	15	12
Scissors (n = 2)	1	1
Razor (n = 1)	0	1
Axe (n = 1)	1	0
Electric saw (n = 1)	0	1
Box cutter (n = 1)	0	1
Unidentified (n = 44)	40	4

LOCATION OF THE WEAPON

Regarding weapon location, globally a total of 51 cases (66.2%) found that the weapon was either far from the body or missing while it was found near the body in the 26 (33.8%) remaining cases. In homicides it was found near the body in 10 cases (17.5%) while suicides had the weapon found near the body in 80% of cases (n=16).

Such difference was statistically significant following a chi-squared test for association, $\chi^2(1) = 25.82$, $p<0.001$. There was a relatively strong association between location of weapon and manner of death, $\phi = 0.579$, $p<0.001$.

PSYCHIATRIC BACKGROUND

Out of the 77 sharp force fatalities, only 9 cases (11.7%) featured a positive psychiatric background in the supplied documentation. The remaining cases made no specific mention of psychiatric background. Homicidal deaths had only 1 case (1.8%) with a documented psychiatric illness while suicides had 8 cases (40%), with specific diseases being specified in Table 3. Such difference was statistically significative with a Fisher's exact test yielding $p<0.001$.

TABLE 3 – PSYCHIATRIC BACKGROUND BY MANNER OF DEATH. INMLCF, I.P.

Psychiatric background	Homicide (n=57)	Suicide (n=20)
Suicidal ideation / attempt (n = 5)	0	5
Depression (n = 3)	0	3
Alcohol abuse (n = 1)	1	0
Absent (n = 68)	56	12

PRESENCE OF SUICIDE NOTE

A suicide note was found in only 4 (5.2%) of all 77 cases, with all of them being suicidal deaths. Such difference was statistically significant with Fisher's exact test yielding p=0.004.

AUTOPSY INFORMATION

CLOTHING LACERATIONS

Overall, the victim's clothing was available for analysis in 49 (63.6%) cases, with clothing lacerations being present in 29 (59.2%). In the 33 homicidal deaths with available clothing, lacerations were present in 26 cases (78.8%) and in the 16 suicidal deaths with available clothing lacerations were present in 3 cases (18.8%). Such difference was statistically significant following a chi-squared test for association, $\chi^2(1) = 16.08$, p<0.001. There was a relatively strong association between clothing lacerations and manner of death, $\phi = 0.573$, p<0.001.

TOTAL NUMBER OF SHARP FORCE WOUNDS

For all 77 cases, a total of 485 sharp force wounds were recorded. Homicidal deaths featured a mean total of 7.51 ± 11.29 wounds whereas suicidal deaths featured a total of 2.85 ± 2.13 wounds. A Shapiro-Wilk test showed a significant departure from normality, W(20) = 0.825, p=0.002 for suicide and W(57)=0.619, p<0.001 for homicides. Total number of sharp force wounds difference for suicide victims (mean rank = 33.50) and homicide victims (mean rank = 40.93) was not statistically significant following an independent samples Mann-Whitney U test [U = 460, z = -1.304, p=0.192].

NUMBER AND DISTRIBUTION OF STAB WOUNDS

For all 77 cases, a total of 274 stab wounds were recorded. Homicidal deaths featured a total of 265 stab wounds with a mean value of 4.65 ± 7.98 whereas suicidal deaths featured a total of 9 stab wounds with a mean value of 0.45 ± 0.605 stab wounds.

A Shapiro-Wilk test showed a significant departure from normality, $W(20) = 0.701$, $p<0.001$ for suicides and $W(57)=0.524$, $p<0.001$ for homicides. Number of stab wounds difference for suicide victims (mean rank = 17.33) and homicide victims (mean rank = 46.61) was statistically significant following an independent samples Mann-Whitney U test [$U = 136.5$, $z = -5.274$, $p<0.001$].

The anatomical distribution of the stab wounds in homicides and suicides is further detailed in figures 4 and 5, respectively. Table 4 details the inferential analysis related to manner of death and anatomical distribution of stab wounds.

TABLE 4 – LOCATION OF STAB WOUNDS BY MANNER OF DEATH. INMLCF, I.P.

Stab wound location	Suicide (n=20)	Homicide (n=57)	p-value
Head	0	7 (12.3%)	0.180‡
Neck	4 (20%)	18 (31.6%)	0.324*
Thorax	3 (15%)	33 (57.9%)	**0.001***
Abdomen	1 (5%)	12 (21.1%)	0.165‡
Upper limbs	0	11 (19.6%)	0.057‡
Lower limbs	0	7 (12.3%)	0.180‡
Back	0	10 (17.5%)	0.056‡

* Chi-square test; ‡ Fisher's exact test

The displayed numbers in Table 4 refer to individual cases with the specified type of wound being present (at least once) in a given anatomical location (i.e: a total of 3 suicides had at least one stab wound present in the thorax). Percentages are relative to the total number of said cases for each manner of death.

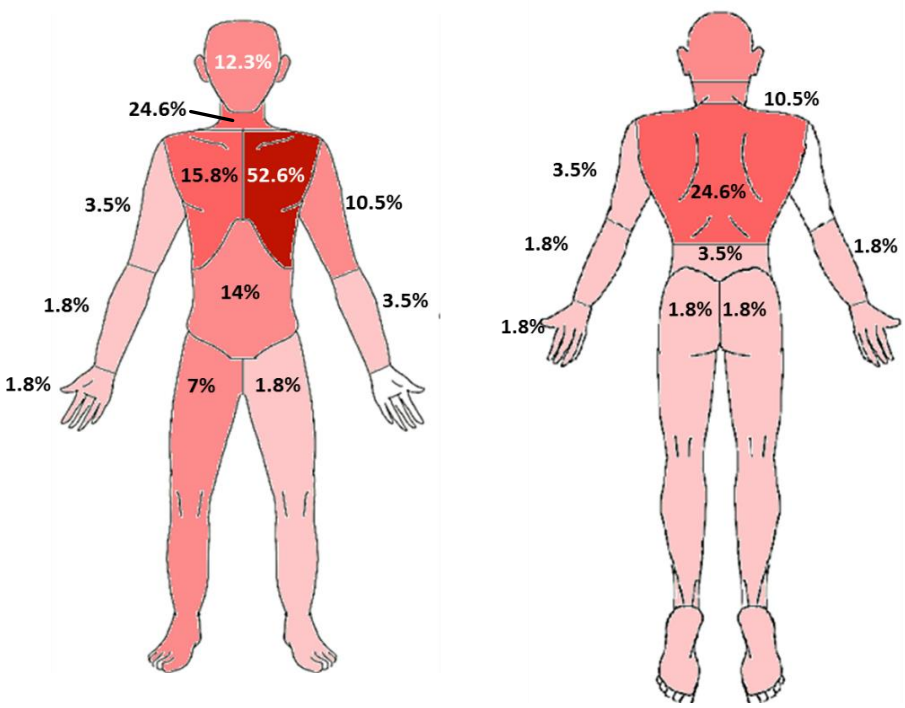


Figure 4 – Percentage of homicide cases with at least one stab wound present in each given anatomical region relative to all 57 homicides. INMLCF I.P.

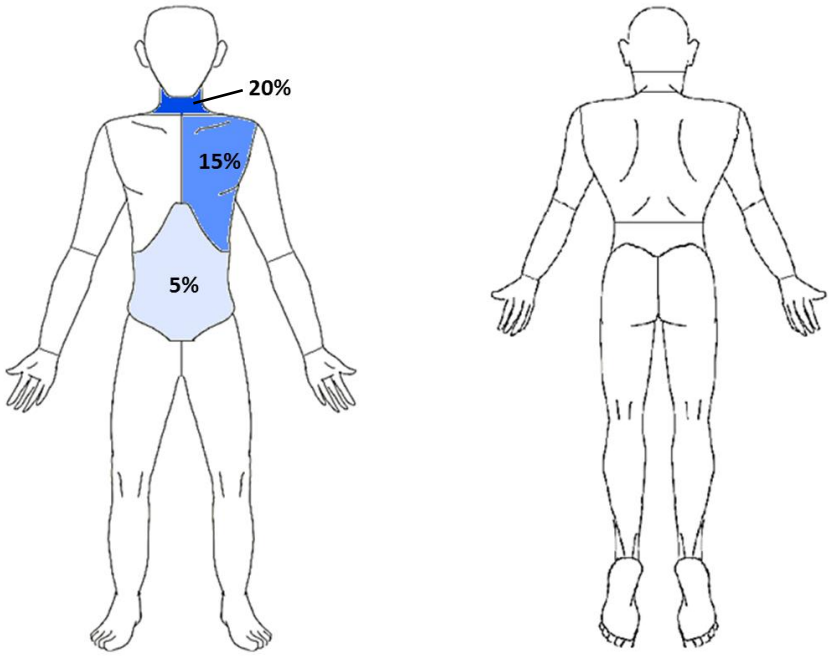


Figure 5 – Percentage of suicide cases with at least one stab wound present in each given anatomical region relative to all 20 suicides. INMLCF I.P.

NUMBER AND DISTRIBUTION OF CUT WOUNDS

For all 77 cases, a total of 191 cut wounds were recorded. Homicidal deaths featured a total of 144 cut wounds with a mean value of 2.53 ± 4.41 whereas suicidal deaths featured a total of 47 cut wounds with a mean value of 2.35 ± 2.5.

A Shapiro-Wilk test showed a significant departure from normality, W(20)=0.865, p=0.010 for suicides and W(57)=0.599, p<0.001 for homicides. Number of cut wounds difference for suicide victims (mean rank = 44.10) and homicide victims (mean rank = 37.21) was not statistically significant following an independent samples Mann-Whitney U test [U = 468, z = -1.225, *p*=0.221].

The anatomical distribution of the cut wounds in homicides and suicides is detailed in figures 6 and 7, respectively. Table 5 details the inferential analysis related to manner of death and anatomical distribution of cut wounds.

TABLE 5 – LOCATION OF CUT WOUNDS BY MANNER OF DEATH. INMLCF, I.P.

Cut wound location	Suicide (n=20)	Homicide (n=57)	p-value
Head	1 (5%)	12 (21.1%)	0.165‡
Neck	5 (25%)	3 (5.3%)	**0.025**‡
Thorax	1 (5%)	7 (12.3%)	0.672‡
Abdomen	0	2 (3.5%)	1.000‡
Upper limbs	9 (45%)	25 (43.9%)	0.930*
Lower limbs	3 (15%)	1 (1.8%)	0.052‡
Back	0	2 (3.5%)	1.000‡

* Chi-square test; ‡ Fisher's exact test

The displayed numbers in Table 5 refer to individual cases with the specified type of wound being present (at least once) in a given anatomical location (i.e: a total of 5 suicides had at least one cut wound present in the neck). Percentages are relative to the total number of said cases for each manner of death.

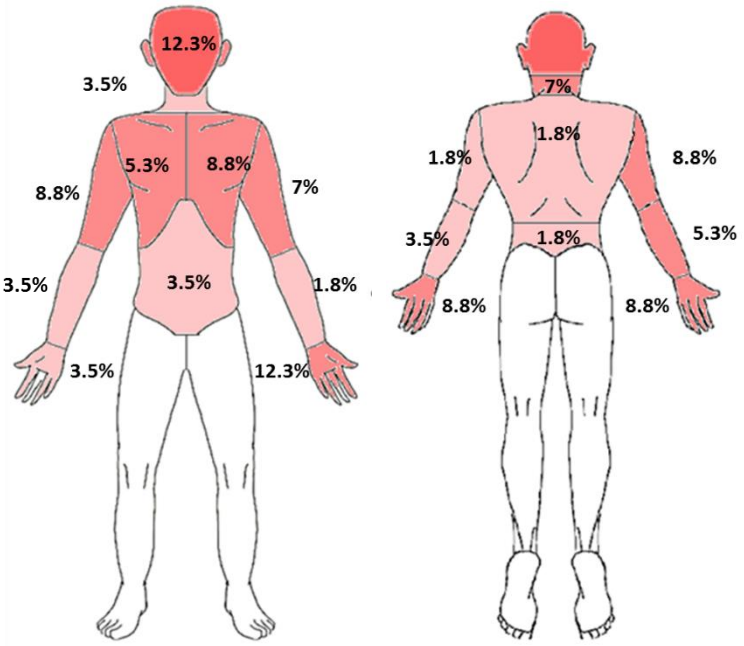


Figure 6 – Percentage of homicide cases with at least one cut wound present in each given anatomical region relative to all 57 homicides. INMLCF I.P.

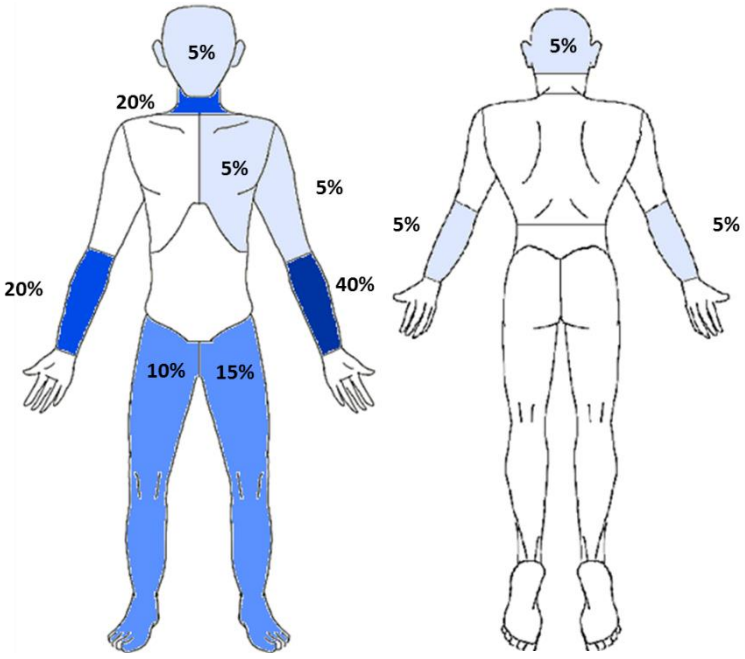


Figure 7 – Percentage of suicide cases with at least one cut wound present in each given anatomical region relative to all 20 suicides. INMLCF I.P.

NUMBER AND DISTRIBUTION OF CHOP WOUNDS

For all 77 cases, a total of 15 chop wounds were recorded. Homicidal deaths featured a mean value of 27 chop wounds whereas suicidal deaths featured only 1 chop wound. The anatomical distribution of the chop wounds in homicides and suicides is detailed in Table 6.

TABLE 6 – LOCATION OF CHOP WOUNDS BY MANNER OF DEATH. INMLCF, I.P.

Chop wound location	Suicide (n=20)	Homicide (n=57)
Head	0	2
Neck	1	1
Thorax	0	1
Abdomen	0	0
Upper limbs	0	1
Lower limbs	0	0
Back	0	0

NUMBER AND DISTRIBUTION OF HESITATION WOUNDS

For all 20 suicide victims, 10 (50%) presented hesitation wounds. A total of 33 hesitation wounds were found featuring a mean value of 3.30 ± 2.21 when considering only those victims with hesitation wounds present.

The anatomical distribution of the hesitation wounds is detailed in table 7 (number of suicide cases with a hesitation wound present on a given location) and figure 8.

TABLE 7 – LOCATION OF HESITATION WOUNDS. INMLCF, I.P.

Hesitation wound location		Number of suicide cases
Left upper limb	Arm	0
	Forearm	3
	Hand	0
Neck	3	
Head	1	
Thorax	2	

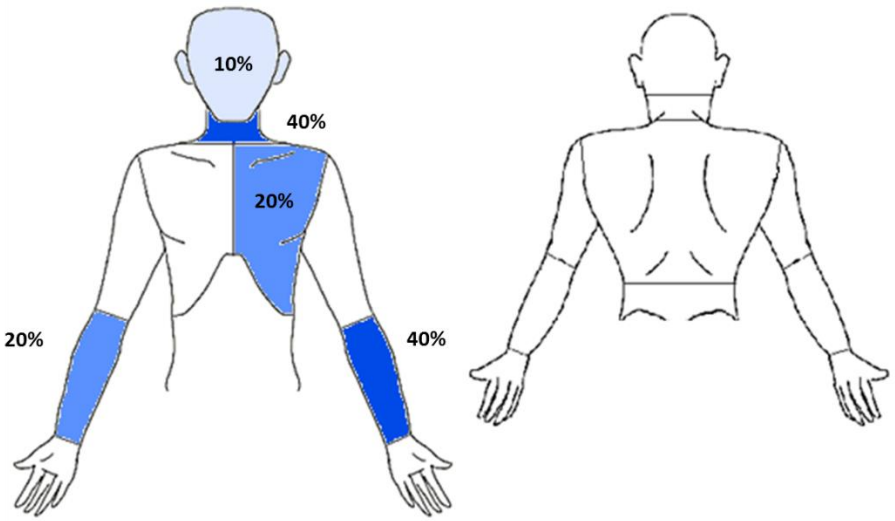


Figure 8 – Percentage of suicide cases with at least one hesitation wound present in each given anatomical region relative to all 10 suicides with hesitation wounds. INMLCF I.P.

NUMBER AND DISTRIBUTION OF DEFENSE WOUNDS

A total of 81 defense wounds were found distributed through 19 (33.3%) homicide victims with a mean value of 4.26 ± 5.31 per victim with present defense wounds. Defense wounds were predominant in the right upper limb, with the right hand being most prominently injured (78.9%) followed by the left hand (68.4%) and right forearm (26.3%).

The anatomical distribution of the defense wounds is detailed in table 8 (number of homicide cases with a defense wound present on a given location) and figure 9.

TABLE 8 – LOCATION OF DEFENSE WOUNDS. INMLCF, I.P.

Defense wound location		Number of homicide cases
Right upper limb (n = 22)	Arm	2
	Forearm	5
	Hand	15
Left upper limb (n = 17)	Arm	1
	Forearm	3
	Hand	13

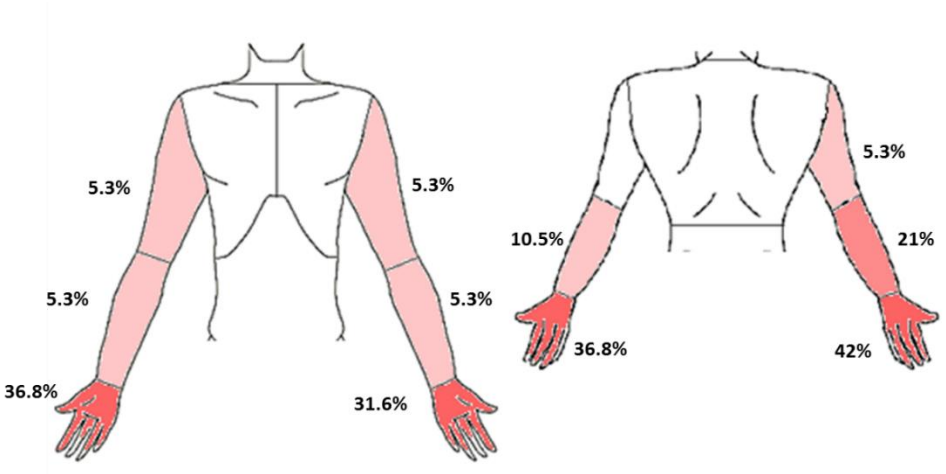


Figure 9 – Percentage of homicide cases with at least one defense wound present in each given anatomical region relative to all 19 homicides with defense wounds. INMLCF I.P.

DISTRIBUTION OF LETHAL WOUNDS

The anatomical distribution of the lethal wounds in homicides and suicides is detailed in figures 10 and 11, respectively, as well as in table 9.

TABLE 9 – LOCATION OF LETHAL WOUNDS BY MANNER OF DEATH. INMLCF, I.P.

Lethal wound location	Suicide (n=20)	Homicide (n=57)	p-value
Head	0	0	-
Neck	8 (40%)	7 (12.3%)	**0.018‡**
Thorax	3 (15%)	34 (59.6%)	**0.001***
Abdomen	0	2 (3.5%)	1.000‡
Upper limbs	8 (40%)	3 (5.3%)	**0.001‡**
Lower limbs	1 (5%)	4 (7%)	1.000‡
Back	0	7 (12.3%)	0.180‡

* Chi-square test; ‡ Fisher's exact test

The displayed numbers in Table 9 refer to individual cases with the specified type of wound being present (at least once) in a given anatomical location (i.e: a total of 3 suicides had at least one cut wound present in the thorax). Percentages are relative to the total number of said cases for each manner of death.

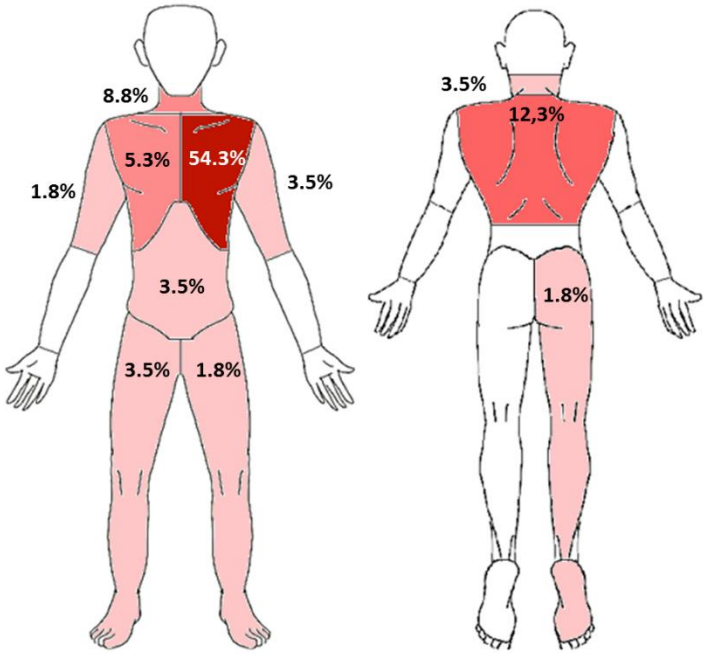


Figure 10 – Percentage of homicide cases with at least one lethal wound present in each given anatomical region relative to all 57 homicides. INMLCF I.P.

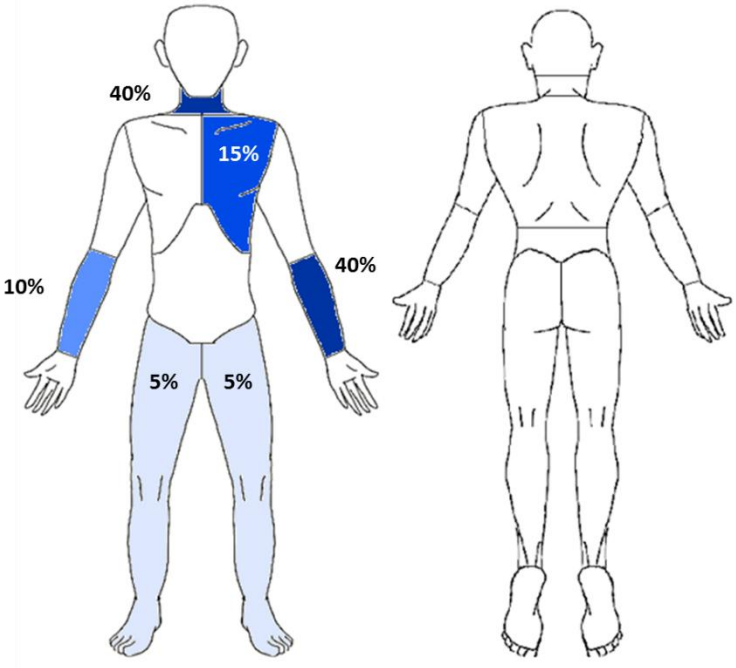


Figure 11 – Percentage of suicide cases with at least one lethal wound present in each given anatomical region relative to all 20 suicides. INMLCF I.P

ORIENTATION OF THORACIC STAB WOUNDS

The distribution of orientation by manner of death is detailed in Table 10. Suicides presented with a total number of 0 vertical stab wounds, 2 horizontal wounds and 1 oblique wound. Homicides presented with a total number of 11 vertical stab wounds, 7 horizontal wounds and 33 oblique wounds.

TABLE 10 – ORIENTATION OF THORACIC STAB WOUND BY MANNER OF DEATH. INMLCF, I.P.

Orientation of thoracic stab wound	Suicide (n=20)	Homicide (n=57)	p-value
Vertical	0	7 (12.3%)	0.180‡
Horizontal	2 (10%)	8 (14.0%)	1.000‡
Oblique	1 (5%)	25 (43.9%)	**0.002***

* Chi-square test; ‡ Fisher's exact test

The displayed numbers in Table 10 refer to the presence of a specified type of thoracic stab wound orientation being present (at least once) for a given homicide or suicide. One case may have multiple types of orientation simultaneously present.

ADDITIONAL TRAUMATIC LESIONS

Additional traumatic lesions were identified in 27 (47.4%) of the 57 cases with homicidal deaths featuring blunt force trauma in 26 (45.6%) of cases followed by asphyxic and thermal injuries being present in 2 (3.5%) cases each. Regarding suicidal deaths, 3 victims (15%) had blunt force trauma present at autopsy. The type of additional traumatic lesion is present in Table 11.

TABLE 11 – ADDITIONAL TRAUMATIC LESIONS BY MANNER OF DEATH. INMLCF, I.P.

Traumatic lesion	Suicide (n=20)	Homicide (n=57)
Blunt force trauma	3 (15%)	26 (45.6%)
Asphyxic	0	2 (3.5%)
Thermal injuries	0	2 (3.5%)
No additional traumatic lesion	17 (85%)	30 (52.6%)

Regarding the overall presence of additional traumatic lesions, it was greater in homicides (47.4% of cases) compared to suicides (15%). Such difference was statistically significant following a chi-squared test for association, $\chi^2(1) = 6.52$, p=0.011. There was a moderate association between the presence of additional traumatic lesions and manner of death, $\phi = 0.291$, p=0.011.

INJURED ANATOMICAL STRUCTURES

In homicides the most frequently injured structures were the lungs (45.6%), followed by the heart (43.9%) and bone/cartilage (35.1%). In suicide victims the vessels of extremities (45%) followed by cervical vessels (25%) and the heart (20%) were the most frequently injured anatomical structures.

The general distribution is given in Table 12 and further detailed in figure 12 with specific organs being mentioned.

TABLE 12 – INJURED ANATOMICAL STRUCTURE BY MANNER OF DEATH. INMLCF, I.P.

Injured anatomical structure	Suicide (n=20)	Homicide (n=57)	p-value
Heart	4 (20%)	25 (43.9%)	0.058*
Lungs	1 (5%)	26 (45.6%)	**0.001***
Cervical vessels	5 (25%)	10 (17.5%)	0.509‡
Vessels of extremities	9 (45%)	12 (21.1%)	**0.039***
Bone / cartilage	1 (5%)	20 (35.1%)	**0.009***
Thoracic vessels	0	2 (3.5%)	1.000‡
Abdominal organs	1 (5%)	14 (24.6%)	0.098‡

* Chi-square test; ‡ Fisher's exact test

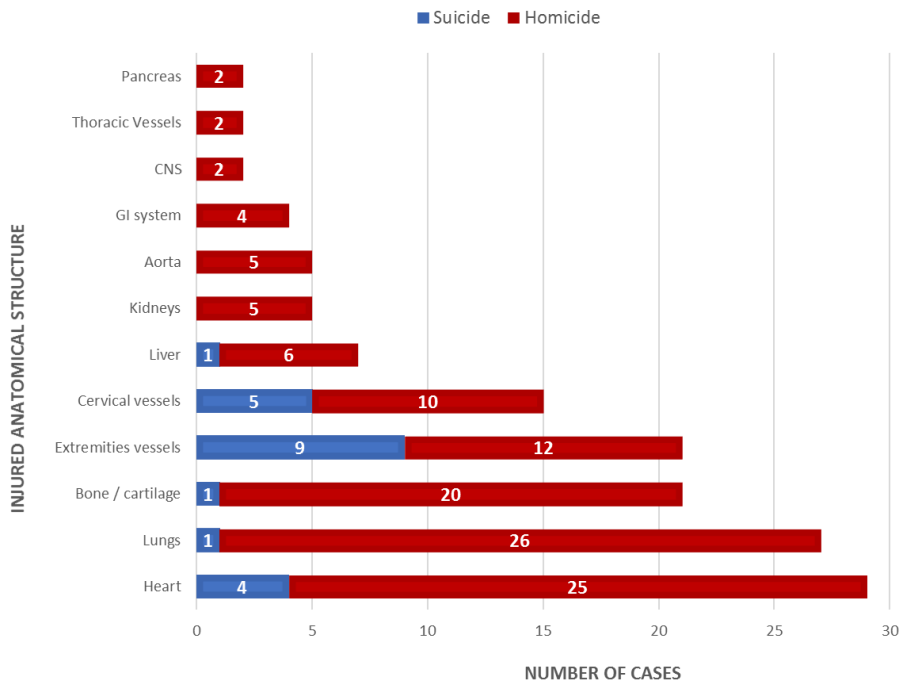


Figure 12 – Distribution of injured anatomical structure by manner of death and number of cases, INMLCF I.P. *GI: Gastrointestinal; CNS: Central Nervous System*

TOXICOLOGY INFORMATION

Out of all 77 cases, 71 (92.2%) had underwent toxicological analysis with available report. When performed most cases had no substances detected. When a substance was detected the most common was alcohol, followed by psychiatric drugs and cocaine. All types of substances by manner of death are detailed in Table 13.

TABLE 13 – TOXICOLOGY REPORT BY MANNER OF DEATH. INMLCF, I.P.

Type of substance	Suicide (n=20)	Homicide (n=57)	p-value
Alcohol (n = 27)	1 (5%)	26 (45.6%)	**0.001***
Psychiatric drugs (n = 6)	6 (30%)	0	**<0.001‡**
Methamphetamines (n = 1)	0	1 (1.8%)	1.000‡
Cannabinoids (n = 15)	2 (10%)	13 (22.8%)	0.328‡
Opioids (n = 2)	1 (5%)	1 (1.8%)	0.455‡
Cocaine (n = 4)	1 (5%)	3 (5.3%)	1.000‡
No substances found (n = 34)	10 (50%)	24 (42.1%)	0.374*

* Chi-square test; ‡ Fisher's exact test

BINARY LOGISTIC REGRESSION

A backward binomial logistic regression was performed to ascertain the effects of the following autopsy variables: presence of clothing lacerations, thoracic stab wounds, neck lethal wounds, thoracic lethal wounds, upper limb lethal wounds and the presence of additional lesions on the likelihood that the victims had a homicidal manner of death.

The logistic regression model was statistically significant, $\chi2(4) = 31.387$, $p<0.001$. The model explained 65.9% (Nagelkerke R^2) of the variance in manner of death and correctly classified 89.8% of cases. Sensitivity was 93.94%, specificity was 81.25%, positive predictive value was 91.2% and negative predictive value was 86.7%. Of the six predictor variables only four remained (clothing lacerations, upper limb lethal wound, neck lethal wound and additional traumatic lesions) with three being statistically significant: neck lethal wound (p=0.043), upper limb lethal wound (p=0.015) and the presence of additional lesions (p=0.032). The obtained model is detailed in Table 13.

TABLE 13 – BINARY LOGISTIC REGRESSION BY MANNER OF DEATH. INMLCF, I.P.

Variable	*p*-value	OR	95% CI
Clothing lacerations	0.087	5.471	0.783 – 38.244
Neck lethal wound	**0.043**	0.109	0.013 – 0.931
Upper limb lethal wound	**0.015**	0.022	0.001 – 0.477
Additional traumatic lesion	**0.032**	14.8	1.257 – 173.716
Constant	0.576	1.621	-

OR: Odds ratio; CI: Confidence interval

DISCUSSION

In comparison with other international studies, for the given timeline of 7 years, the present study documented an appreciable number of sharp force fatalities. Despite this, a greater number would be desirable to further consolidate statistical analysis given the documented rarity of sharp force suicides (1.91% of all suicides in the observed timeline).

This may be achieved in the future by expanding the present timeline or by promoting multicentric collaboration within Portugal's other Forensic Pathology units.

DEMOGRAPHIC AND CIRCUMSTANTIAL INFORMATION

SEX AND AGE

In the observed population the majority of both sharp force homicidal and suicidal victims was male, which is consistent with previous identical studies(Au & Beh, 2011; Brunel et al., 2010; Burke et al., 2018; Hunt & Cowling, 1991; Karlsson, 1998a; Kemal et al., 2013; Kranioti & Kastanaki, 2017; Krywanczyk & Shapiro, 2015; Mazzolo & Desinan, 2005; Scolan et al., 2004; Terranova et al., 2020; Vassalini et al., 2014). Regarding sex, these findings are consistent with the literature(Au & Beh, 2011; Brunel et al., 2010; Burke et al., 2018; Hunt & Cowling, 1991; Karlsson, 1998a; Kemal et al., 2013; Kranioti & Kastanaki, 2017; Krywanczyk & Shapiro, 2015; Mazzolo & Desinan, 2005; Scolan et al., 2004; Terranova et al., 2020; Vassalini et al., 2014) with men being more frequent victims of violent deaths overall, with the same being true of the Portuguese reality in 2017 with 63.6% of all violent death victims being male.(Portuguese National Institute of Statistics, n.d.) A difference was noted regarding the male-to-female ratio which was acknowledged to be greater in suicidal deaths (5.7 vs 4.2), failing, however, to reach statistical significance likewise to other studies(Brunel et al., 2010; Terranova et al., 2020). This ratio is highly variable in the literature with some describing 1.7(Assunção et al., 2009) to 27(Vassalini et al., 2014) for suicides, this being most likely attributable to sampling issues.

In respect to age, the average age of suicide victims (56.2 ± 18.6) was significantly higher than homicide victims (38.4 ± 17.1), reaching statistical significance. Similarly to other studies(Kemal et al., 2013; Scolan et al., 2004), our study determined the inclusion of far younger homicide victims, namely a 5 month old victim which skewed the mean age to a lower value. Not only this, but 60% (n = 12) of the suicide victims had an age over 50 years old.

PLACE OF BIRTH

A total of 27 foreigners were identified, with 25 being homicide victims. Most of these victims were from Brazil and PALOP (Portuguese-speaking African countries) countries which include Cape Verde, Angola and Guinea-Bissau, among others. This difference was sufficient to reach statistical significance, indicating that a foreign sharp force victim may raise suspicion for a homicidal manner of death.

LOCATION OF THE BODY

In a minority of cases the original location of the body could not be ascertained due to incomplete information in the records. However, most cases (87%) had a determined location, with most deaths occurring inside a residential unit. When comparing both manners of death suicide victims were more often found inside a home when compared to homicide victims (73.7% vs 54.2%), which is in line with other studies(Scolan et al., 2004; Terranova et al., 2020; Vassalini et al., 2014). This difference reached statistical significance.

Concerning the divisions in which the body was found, suicides presented the bathroom and bedroom as the most frequent divisions. In three out of the four observed bathroom suicides the body was found inside the bathtub, likewise to what has been reported by previous authors.(Assunção et al., 2009; Fukube et al., 2008; Gill & Catanese, 2002; Karlsson, 1998a)

DATE OF DEATH

In the specific case of sharp force suicides, a peak of cases was in fact observed in the summer as displayed in Figure 2 as suggested by other reports(Galvão et al., 2018; Hawton & van Heeringen, 2009) concerning suicides in general. Nevertheless, the number of suicides and their distribution through the seasons is insufficient to draw out any meaningful conclusions.

The distribution of sharp force fatalities, in general, also varies markedly by year with sharp force homicides being generally more prevalent than suicides, which further attests to the overall rarity of these events.

The low specificity and apparent randomness of this parameter renders it unlikely to be a reliable predictor of a given manner of death.

TYPE AND LOCATION OF WEAPON

The majority of weapons were not identified (54 out of 77 cases) due to their absence from the scene, with this scenario being more common in homicides in which concealment of the weapon is often a concern. Thus, the weapon not being found near the body revealed itself as a statistically significant predictor of a homicidal death.

The choice of weapon is dependent upon its accessibility, occupational and cultural context. The present study found a definite preponderance in the accessibility factor with the kitchen knife being the most found weapon in both homicides and suicides. Other weapons were identified, with a greater variability present in suicides, namely through the usage of a razor, a boxcutter and an electric saw. This greater variability may attest to the more planned nature of suicidal deaths thus allowing weapon choice according to other factors other than availability such as its perceived lethality.

The usage of an electric saw in a suicide was observed and this is a distinctly unusual choice of weapon with only a few case reports being present in the literature.(Fernie, Gibson, & Newton, 1994; Stojanović, Milić, Antović, Todorović, & Jovanović, 2013; Tournel et al., 2008) It also corresponded to the only suicide case with present chop

wounds – a rarity given that chop wounds are, by definition, associated with greater kinetic energy due to either greater mass or velocity. These characteristics make classic chop wound related weapons (such as the axe or the chainsaw) rare choices for suicide due to their more difficult manoeuvrability.

PSYCHIATRIC BACKGROUND AND SUICIDE NOTES

A positive psychiatric background was only determined in 9 out of the 77 cases (11.7%). This percentage is significantly lower than what has been previously reported in the literature which ranges from 32% to 70%(Assunção et al., 2009; Terranova et al., 2020; Vassalini et al., 2014). This may be explained by the incompleteness of the supplied records as well by the forensic pathologist's impossibility to access the victim's electronic health records, which highlights the importance of facilitating communication between medico-legal investigators and healthcare structures. The presence of suicide notes was also infrequent (total of 4 out of 20 suicides) and in line with antecedent research in which these were found in less than half of the cases(Assunção et al., 2009; Burke et al., 2018; Karlsson, 1998a; Mazzolo & Desinan, 2005).

Whenever mental illness was documented (almost all of them suicides except for one case) the most frequent illness was the presence of suicidal ideation and/or previous suicide attempt. Both constitute established major risk factors for suicide documented(Bachmann, 2018; Hawton et al., 2013; Hawton & van Heeringen, 2009; Yoshimasu et al., 2008)(Hawton & van Heeringen, 2009), again emphasizing the importance of supplying thorough health records to the forensic pathologist. The only identified psychiatric disease in a homicide was alcohol abuse, which may support the role of alcohol as a catalyst for violent behavior as described by Knight(Knight & Saukko, 2004) and Shepherd(Shepherd, 2003).

Despite their low numbers, both elements reached statistical significance as predictors of homicidal death when absent.

These are both relevant medico-legal elements as determined by their statistical significance along with the established value as predictors of suicidal deaths. Their usefulness, however, is lessened by their questionable attainability.

AUTOPSY INFORMATION

CLOTHING LACERATIONS

Clothing was available for analysis in most cases (49 out of 77) with lacerations being present in 29. Clothing is sometimes missing due to it being removed by medical personnel and not being stored for later deliver to the forensic pathologist, which again emphasizes the pertinence of multidisciplinary collaboration. Nevertheless, in the 33 homicidal deaths with available clothing, lacerations were present in the majority (26 cases) whilst these were only present in a select minority of suicides (3 out of 16).

The presence of clothing lacerations is a prominent predictor of a homicidal death in sharp force fatalities in the literature(Burke et al., 2018; Karlsson, 1998c; Scolan et al., 2004; Terranova et al., 2020), and our results abet these findings.

NUMBER AND DISTRIBUTION OF DIFFERENT WOUND TYPES

In line with the main objective to determine factors that contributed to the differentiation of manner of death in sharp force fatalities our study sought out to provide a particularly comprehensive analysis of sharp force wound characteristics. This is due to three main reasons: the wound characteristics are routinely competently defined and widely available in all autopsy reports; these elements are not dependent upon circumstantial data collected by other parties and they are the most specific investigative element related to sharp force injury itself.

NUMBER OF DIFFERENT WOUND TYPES

A greater total number of sharp force wounds (regardless of type) was observed in homicides when compared to suicides (mean number 7.51 vs 2.85) which is

clearly in line with other reports.(Brunel et al., 2010; Kemal et al., 2013; Terranova et al., 2020) Stab and cut wounds, on absolute terms, were also greater in homicides; however, similar means were obtained in the total number of cut wounds (2.53 vs 2.35). This finding is contrary to some authors(Kemal et al., 2013) who have reported a higher average number of cut wounds in suicides.

DISTRIBUTION OF DIFFERENT WOUND TYPES

STAB WOUNDS:

Suicidal stab wounds had a far more limited distribution comparatively to homicidal stab wounds, with only the neck (20%), thorax (15%) and abdomen (1%) being struck – very similarly to what has been described(Fukube et al., 2008; Start et al., 1992).

Homicides on the other hand had virtually every anatomical area affected with a clear predominance on thorax (57.9%), limbs (31.9%) and neck (31.6%) followed by the abdomen (21.1%), back (17.5%) and head (12.3%). This greater heterogeneity in the distribution and clear predominance on thoracic topography is well established in previous reports.(Kemal et al., 2013; Mazzolo & Desinan, 2005)

CUT WOUNDS:

Cut wounds, contrarily to stab wounds, revealed an explicit presence on limbs (60%) followed by the neck (20%) and head (5%).

Homicides, again fared with a broader distribution of lesions with all body segments being affected, despite a greater presence being found on the limbs (43.9%), head (21.1%), thorax (12.3%) followed by neck (7%), abdomen (3.5%) and back (1.8%). This distribution is in accordance with previous data(Fukube et al., 2008; Kemal et al., 2013; Mazzolo & Desinan, 2005), as cut wounds are more prevalent in the limbs and necks of suicide victims both as hesitation wounds as well as lethal wounds due to the superficial position of major vessels.

CHOP WOUNDS:

Chop wounds were found only in one suicide in which an electric saw was used on the neck, as previously described. Chop wounds were present in 2 homicides, with one having used an axe and the other weapon remaining unidentified – in these two cases wounds were found in the head, neck, thorax, and upper limbs.

LETHAL WOUNDS:

The distribution of homicidal lethal wounds was similar to the distribution of homicidal stab wounds with the thorax (59.6%), back (12.3%), neck (12.3%) and limbs (10.6%) being most commonly affected. This parallel is understandable given the increased lethality of stab wounds as these are able to reach vital organs with worsened outcomes.

Lethal wound distribution in suicidal deaths did not parallel stab wound distribution in such victims, being more alike to cut wound topography with the anterior aspects of the limbs (60%) and neck (40%) being most affected. This is due to the superficiality of important vessels in these anatomical regions which may be injured through reasonably superficial cut wounds. These findings are in accordance to Vassalini(Vassalini et al., 2014), with our study additionally reporting a statistical association between the presence of lethal thoracic wounds and homicide and the presence of lethal neck and upper limb wounds to suicide.

It should be noted that the absence of lethal neck (OR 0.109, p=0.043) and upper limb (OR 0.022, p=0.015) wounds were predictive of homicide following binary logistic regression.

HESITATION WOUNDS:

The total percentage of observed hesitation wounds (50%) was slightly lower than what is reported in the literature(Assunção et al., 2009; Fukube et al., 2008; Karlsson, 1998a; Racette et al., 2008; Terranova et al., 2020; Vassalini et al., 2014) in which most studies report a prevalence over 50%. These results were

most likely due to the strict adopted definition of a hesitation wound which predicts it always being a cut wound. This definition may exclude far more common wounds such as abrasions which may be caused by the tangential impact of a sharp object upon the skin and might be factored in by other authors as cut wounds and therefore, hesitation wounds. The anatomical distribution reflects that of suicidal cut wounds with forearms (30%) and neck (20%) preponderance being noted. Unlike Vassalini and Desjarlais no hesitation wounds were found on the hands.

DEFENSE WOUNDS:

Defense wounds incidence (33.3%) fits into the wide range present in the literature describing 31% to 64.5%(Karlsson, 1998a; Kemal et al., 2013; Terranova et al., 2020; Vassalini et al., 2014). In terms of distribution, the hands and forearms were mostly affected – particularly the right and posterior aspects of these regions, which may translate a slight predominance of passive defense wounds, contrasting with Vassalini's predominance of anterior limb aspects and being more in line with Racette(Racette et al., 2008).

ORIENTATION OF THORACIC STAB WOUND

As suggested by Karlsson(Karlsson, 1998b), this element is highly informative of the manoeuvrability of the knife. General orientation of all sharp force wounds was not a feasible feature to ascertain given that in cases that present with a plethora of sharp force wounds it may prove difficult to assess the 'dominant' orientation of the wounds. Thus, thoracic stab wounds were analysed for their orientation. Oblique orientation was the most overall commonly found orientation, being clearly predominant in homicides with vertical stab wounds also being an exclusive feature of homicidal deaths. The sparsity of suicidal thoracic stab wounds (found only in 3 cases) renders it difficult to provide meaningful analysis.

PRESENCE OF OTHER TRAUMATIC LESIONS

None of the reviewed suicides appeared to be complex suicides – suicides in which two or more methods are employed to ensure the fatal demise of the victim. The additional traumatic lesions found in suicide victims were of a blunt force nature and were most likely accidental or altogether unrelated to the death. Such outcomes are akin to what has been described with some authors finding no additional injuries(Brunel et al., 2010).

With respect to homicides, a majority presented with additional traumatic lesions (a total of 47.4% which fits into the wide range described in the literature (7.1% to 76%))(Brunel et al., 2010; Karlsson, 1998c; Kemal et al., 2013; Krywanczyk & Shapiro, 2015; Scolan et al., 2004). Further in agreement with the literature, the most frequent additional injury was of a blunt force nature (45.6%) followed by asphyxic and thermal injuries being present in two cases each.

Both thermal injuries were observed in likely attempts to conceal criminal misconduct while both asphyxic injuries were by strangulation and seemingly concomitant with the sharp force wounds.

Given this wide difference between manners of death it was found that the presence of other traumatic lesions was associated with a homicidal manner of death.

INJURED ANATOMICAL STRUCTURES

Paralleling the previously described predominance of cut wounds in the limbs and necks of suicide victims, extremities and cervical vessels were identified as the most injured anatomical structures followed by the heart, lungs, bone/cartilage, and abdominal organs (all with one identified case each). This explains why the presence of injured vessels of extremities could be a good predictor of a suicidal death.

Homicides presented with a far more heterogeneous distribution of lesions with the thoracic organs being involved in over 89% of homicides – lungs in 26 and heart in 25, with these being injured in 1 and 4 suicide cases only, respectively. Suicidal stab wounds are more deliberate when compared to homicidal stab wounds which may explain the

heart being targeted whenever the chest is affected. Lungs, however, are usually avoided in suicidal deaths (likely due to a lesser perceived lethality of such injury) while in homicides, being more haphazard in their thoracic distribution and given their topographically large area, lungs are at a greater risk of suffering traumatic injury thus being good predictors of a homicidal manner of death. An identical reasoning is used to bone and cartilage damage as justified by the literature(Banasr et al., 2003; Brunel et al., 2010; Krywanczyk & Shapiro, 2015).

Injured cervical and extremity vessels were also found in homicides albeit in a lesser proportion when compared to suicides (25% vs 17,5% and 45% vs 21%, respectively), which would be expected given the preferential topographic distribution of lesions observed in homicides.

Abdominal structures were found to be injured with a great preponderance in homicidal deaths (14 homicide cases vs 1 suicide case). Some injured abdominal structures were only found in homicides, namely the kidneys, pancreas, abdominal aorta and the gastrointestinal system with the liver being the only abdominal organ found to be injured in both manner of deaths. Central nervous system injury was also an exclusive element of homicidal deaths, being observed in two homicides.

TOXICOLOGY INFORMATION

A large majority of the cases (92.2%) underwent toxicological analysis since it is protocol for it to be performed at this unit. The remaining 7.8% of cases were likely cases that did not have an autopsy performed (only external examination); had a hospital stay longer than 24 hours or the toxicology reports were missing from the records. The routine screening includes alcohol, cocaine, opioids, psychiatric drugs, cannabinoids and methamphetamines. The most frequently detected substances were alcohol and cannabinoids followed by psychiatric drugs. Most of the literature(Burke et al., 2018; Karlsson, 1998c, 1998a; Krywanczyk & Shapiro, 2015; Vassalini et al., 2014) reports alcohol being more frequently found in sharp force homicide victims comparatively to suicide victims, which is corroborated by our study's findings.

Concerning psychiatric drugs these were uncovered exclusively in suicide victims, albeit being present only in a minority of these victims (30%). This percentage is coherent with previous reports, including Assunção's report finding it present in 4 out of 7 cases.

A pertinent aspect when reporting these substances is to specify the exact concentration namely if it is high enough to influence behaviour – mere dichotomic reporting of its presence or absence may erroneously skew statistical analysis and yield an incorrect predictive value. This point is important not only to determine a sufficient concentration of illicit substances to influence behaviour but parallelly an insufficient concentration of psychiatric drugs to exert a therapeutic effect.

Despite this, the mere presence of alcohol in sharp force victims appeared to be statistically significant to be associated with a homicidal death.

CONCLUSIONS

To classify manner of death, the forensic pathologist must analyse a multitude of demographic, circumstantial, necroscopic and toxicological information.

Some of the demographic and circumstantial information is often collected by third parties which makes the reporting of such elements frequently incomplete or imprecise to the forensic pathologist. Therefore, it is imperative that collaboration by forensic practitioners with medical personnel and law enforcement be accomplished: be it by thoroughly communicating health records or by properly storing material evidence and deliver it for forensic examination.

In this domain our findings attest that the most discriminative (yet not necessarily the most common) profile of the sharp force homicide victim is a young foreign male whose body is found outside home, with no weapon nearby and without a known psychiatric background.

Necroscopic findings are highly valuable and entirely within the forensic pathologist's realm. Characterizing the type, distribution and number of observed wounds is a routine as it is essential to determine manner of death with sharp force injury related deaths being no exception.

In terms of wound characteristics, homicides observe a greater total number of sharp force wounds (with more stab wounds than cut wounds) and a more heterogeneous anatomical distribution of wounds regardless of type (with a special mention being made to thoracic stab wounds). Conversely, suicides present more cut wounds than stab wounds with the former being critically present in the anterior neck and anterior aspects of the upper limbs, especially as injuries capable of causing death. In terms of orientation, vertical or oblique thoracic stab wounds convey a homicidal manner of death.

Other useful autopsy elements that may hint towards a homicide include the presence of clothing lacerations, additional traumatic lesions and injured lungs as well as bone and cartilaginous structures.

Toxicological analysis is ubiquitous in medico-legal investigations and in sharp force deaths the presence of alcohol was suggestive of homicide while the presence of psychiatric drugs contrarily pointed towards suicide.

Our model of autopsy variables identified the presence of additional traumatic lesions (OR 14.8, *p*=0.032) and the absence of lethal neck (OR 0.109, *p*=0.043) and upper limb (OR 0.022, *p*=0.015) wounds as independent predictors of a homicidal death in sharp force fatalities with a sensitivity of 93.9% and a specificity of 81.3%, correctly identifying 89.8% of the cases.

Despite the abundance and variable predictive value of these medico-legal elements, no single element is infallible in establishing manner of death.

To achieve a well-founded conclusion, all investigative elements must be considered in a cogent and integrated fashion and attending to the specifics of each case whilst keeping in mind the forensic proverb put forward by Knight – "*seldom say never, seldom say always*".

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