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Suicide in the Elderly

A literature review

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To be or not to be, that is the question.

- *William Shakespeare* in *Hamlet*

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Abstract

Suicide is a significant public health problem worldwide with a positive correlation identified between suicide and increasing age. It embodies a category of preventable death, constituting an important subject-matter in forensic practice. Elderly suicide is a complex and understudied subject within suicidology, carrying with it several peculiarities in relation to other age cohorts which are important to consider in distinguishing suicide as mode of death in this population. Several risk and protective factors have been studied and identified in elderly suicide with preventive strategies targeting these. This literature review aims to compile and synthesise the scientific knowledge published since the year 2000 regarding pertinent aspects to suicide in the elderly.

Key Words

Suicide, elderly, late life, epidemiology, risk factors, prevention

Resumo

O suicídio é um problema de saúde pública importante a nível mundial, com uma correlação positiva identificada entre o suicídio e o aumento da idade. Encarna uma categoria de morte evitável, constituindo um tema considerável na prática forense. O suicídio no idoso é um tema complexo e pouco estudado dentro da área da suicidologia, com várias especificidades em relação às outras faixas etárias, que importa considerar ao distinguir o suicídio como modo de morte nesta população. Diversos fatores de risco e de proteção foram estudados e identificados em idosos com estratégias preventivas dirigidas a estes. Esta revisão da literatura tem por objetivo compilar e sintetizar o conhecimento científico publicado desde o ano 2000 sobre todos os aspetos relevantes ao suicídio nos idosos.

Palavras-chave

Suicídio, idoso, vida tardia, epidemiologia, fatores de risco, prevenção

Introduction

Suicide takes a high toll with over 800, 000 people dying due to suicide every year[1] and although a relationship between suicide and increasing age has been documented, elderly suicide remains a complex and understudied subject.[2] Due to the rapid expansion of the elderly population and this positive relationship between suicide and increasing age, suicide in the elderly proves to become an even more significant public health problem likely to grow in severity and speed in the foreseeable future.[3–5] This calls upon a need to correctly understand suicide in the elderly so that interventions can be put in motion to halt the rise and prevent future deaths.

Within the many roles of forensic medicine, lies the responsibility in determining cause and assisting in differentiating between manner of death through interpretation and understanding of widely varying elements such as intention, motive and circumstance. Though simplistic in description, this task is by no means as straightforward, underlining the importance of comprehending conditions which surround any case investigated, especially pertaining to suicide. By conducting psychological autopsy (PA) studies, consulting coroner cases, performing postmortem examinations and toxicology analysis, the mysteries that shroud this obscure area of suicidology can begin to be uncovered with special implications in future therapeutic interventions and preventive strategies.

This review aims to depict an overview of the complex reality that is suicide in the elderly. No review, to the author's knowledge, touches upon all aspects present in scientific literature. Herein contained, are generalized descriptions of the epidemiology, associated risk and protective factors, peculiarities of elder suicide, as well as a brief discussion on the controversial topic of physician assisted suicide, along with a brief outline of detection methods, treatment and prevention of elderly suicide. This review endeavors to serve as a

basis for future explorations into the further understanding of this phenomena which affects, and promises to continue to affect, a significant and ever rising number of elders.

Abbreviations

5-HIAA – 5-Hydroxyindoleacetic Acid

5-HTT – Serotonin Transporter Gene

AD – Alzheimer's Disease

ApoE4 – Apolipoprotein E4

CNS – Central Nervous System

COPD – Chronic Obstructive Pulmonary Disease

CSF – Cerebrospinal Fluid

CVD – Cerebrovascular Disease

DSM-V – Diagnostic and Statistical Manual of Mental Disorders (5^{th} Edition)

D1 – Dopamine Receptor 1

D2 – Dopamine Receptor 2

ECT – Electroconvulsive Therapy

FTD – Frontotemporal Dementia

GDP – Gross Domestic Product

GP – General Practitioner

IADLs – Instrumental Activities of Daily Living

LBD – Lewy Body dementia

MRI – Magnetic Resonance Imaging

PA – Psychological Autopsy

PAS – Physician Assisted Suicide

SSRI – Selective Serotonin Reuptake Inhibitor

UK – United Kingdom

U.S. – United States of America

WHO – World Health Organization

Sources and Selection Criteria

The present literature review on suicide in the elderly was developed by consulting published articles on Medline/Pubmed, ScienceDirect and Medscape databases through the use of auxiliary services offered at the library of the University Hospitals of Coimbra (CHUC). The key words used in the search, either in isolation or combination, included: *suicide, old, elderly, late life and geriatric.* Advanced filters were used in the search with preferences set for articles published since the year 2000 and written in the English or Portuguese language. The primary phase of article selection was based on perusal of abstracts, with a subsequent phase of careful reading and examination of publications selected in the first phase. Those containing subject matter most relevant to the above mentioned topic and related themes were selected. Publications mentioned in the reference lists of initially identified articles, including those with publication dates prior to the initial search strategy were used when justified by their original and/or relevant content. Studies consulted in this work included: meta-analyses, reviews, journal articles, textbooks, data banks and seminars.

I. Definitions

Suicide

The term suicide derives from Latin and is coined from *sui* (of oneself) and *cidium* (from *caedere* to kill or *caedes* meaning murder), where *suicidium* denotes the act and *suicidia* the self-killer.[6] Put simply, it is the act of killing oneself. A classic definition of suicide is provided by French sociologist Émile Durkheim in his 1897 work entitled *Le Suicide*. He states that:

> "*Suicide* is the term applied to any case of death resulting directly or indirectly from a positive or negative act, carried out by the victim himself, which he was aware would produce this result."[116]

Drawing parallels from Durkheim's definition, the Centers for Disease Control[7] (CDC) defines suicide "as death from injury, poisoning, or suffocation where there is evidence (either explicit or implicit) that the injury was self-inflicted and that the decedent intended to kill themselves." Therefore, three components, when collectively present constitute a suicide: "(1) *death* as the result of injury of some sort which is both (2) *self-inflicted,* and (3) *intentionally* inflicted", and are fundamental in distinguishing suicide from other manners of death in the NASH classification (*n*atural, *a*ccident, *s*uicide and *h*omicide).[7]

Suicide is a major public health problem and an important cause of death across the entire lifespan, affecting both developing and industrialised countries and leaving no culture or social class untouched.[1] This characteristically human act of self-destruction, serves as an indicator of the mental health and social well being of societies,[8] existing as a complex and multifaceted phenomenon, fruit of the various interactions between factors of philosophical, anthropological, psychological, biological and social order.[9] Many areas of human study contribute to the fervent discussion and abundant body of questions surrounding the subject of

suicide. According to French philosopher Albert Camus,[10] "There is but one truly serious philosophical problem, and that is suicide."

Though intrigue related to suicide is common across areas of human study, its definition is by no means as straightforward. Suicide-related behaviour is a broad and flexible term, encompassing a set of several behavioural patterns such as: suicidal ideation and communication, self-harm, parasuicide, suicide attempt and completion.[3,11] Completed suicide is generally the result of a long process referred to as a *continuum*, where passage from low lethality behaviours, like suicidal ideation to other suicidal acts of increasing degrees of lethality occurs before culminating in the ultimate fatal end.[4,12]

Suicide registration is a complicated, multilevel procedure that includes medico-legal concerns, involves several responsible authorities and can vary from country to country.[1] Ambiguity in both use of terms and their significance along with a lacking globally accepted nomenclature[7] further contributes to the complexity involved in studying suicide. Consequently, a limited number of studies have adequately considered all phenomena of the continuum, with uncertainty on its role in elders remaining unclear.[4]

Suicide is ultimately a form of communication by a person feeling great desperation, subjected to suffering which renders them unable to fathom any other solution to their condition. Edwin Shneidman, a prominent suicidologist, stated that "[each] suicidal drama occurs in the *mind* of a unique individual [. . .] [and in] almost every case, suicide is caused by pain, a certain kind of pain – *psychological* pain, which I call *psychache*."[13]

Despite hundreds of years of writing and thinking about suicide, and many decades focused on suicide research[7] there remains much to be unveiled about the phenomenon.

Elderly

Ageing is the closing period of the lifespan and cannot be exactly defined because its meaning varies across different societies.[14] It consists of progressive changes of biological, psychological and social order, culminating into challenges that the aging individual must face: acceptance of a less potent sense of self, loss of close relationships, independence and identity.[15] Unsurprisingly, aged individuals make up a group of people for which unfavourable assumptions and stereotypes have been created.

Chronological age is generally considered as the defining marker for seniors, based mainly on the age at which people become eligible to retire: 65 years old. This is not consistent among nations[14] resulting in varying ranges of age defining the elderly cohort in literature, with different inclusion criteria stretching from 50 to 75 years and over.[3]

It is evident that not only suicide presents with obstacles in reaching a generally consented definition; the term elderly also fails in the ability to be strictly described with impacts on interpretation and generalization of data found. In this review, the population ranging from 65 years of age and older will be the main focus, unless otherwise stated.

II. Epidemiology

Suicide takes a staggering toll on global public health with approximately one million people dying from suicide worldwide each year.[16–18] It is reported that every 40 seconds a person dies by suicide and that for every person that dies of suicide there are 20 or more attempting.[19] With these numbers, it is not surprising to find that suicide exists alongside the top causes of death for all ages worldwide.[9] This phenomenon demonstrates a constant and global rise that, according to a report by the WHO,[20] is estimated to double in rate by the year 2020.

Since the mid-twentieth century, the total world population has been undergoing significant ageing, fuelled by a demographic transition where the elderly population constitute the fastest growing segment.[21] This rapid greying of the population has been attributed to the existence of a longer life expectancy, declining fertility rates and the cohort effect.[4,22]

Declines in fertility rates have been a main contributing factor to the rapidly ageing population with global rates declining from 5,0 births per woman in 1960 to 2,5 births in 2014.[23] Additional positive influence on the increasing population age is the elevation in life expectancy at birth, a great human achievement, registered in major regions of the world. Data from the WHO[24] demonstrates that global life expectancy at birth in 2015 was 71,4 years, with an increase by 5 years between 2000 and 2015; the fastest increase since the 1960s. Women live longer than men all around the world (73,8 years for females and 69,1 years for males), with the gap in life expectancy between both sexes of 4,5 years in 1990 with the gap remaining similar in 2015 with 4,6 years.

Between 1946 and 1964 a dramatic increase in birth rates was observed and those born during this time period make up the ‘baby boom generation’, which in turn explains the cohort effect that further fuels increasing proportions of people reaching old age.[25]

Suicide rates are unequally distributed, varying according to numerous factors ranging from region, sex, age, time, ethnic origin, as well as practices of death registration.[26,27] With specific focus on the relationship between suicide and age, the surprising reality is that it exists as a significant problem in older people, so much so, that the highest rates are generally found in this demographic.[28,29] Old age is a predictor of completed suicide.[30] Possessing alarmingly high rates, elderly people generally pose a higher risk of suicide than any other age group,[3,14,31] with approximately one in every eight people who take their own life being aged 65 years or older.[32] In 2013, an estimated 8,2% of the world population was aged 65 years and over, however, this group accounted for approximately 17% of all suicide deaths reported to the WHO.[30,33]

Late-life rates of completed suicide have increased throughout the last two decades of the 20th century, with some evidence of declining suicide rates among this group at the beginning of the 21st century.[8,32,34] The reduction in suicide rates among older adults is ascribed to improved economic well-being of seniors, improved access to health care and effective treatments for depressive illness and although encouraging, the recent rise in rates by those in the middle years is a cause for serious concern.[25,35] An increased rate can be anticipated by explanation of the cohort effect effected by the *baby boomers* which constitute the fastest growing population segment, which carries a propensity to suicide as it ages.[25,31] Furthermore, this group traditionally possesses higher rates of suicide than earlier or subsequent birth cohorts with sociological studies indicating that suicide rates tend to be higher in age groups constituting the largest part of the population.[3,31] These findings suggest that as this vulnerable group with historically high suicide rates reaches third age, which has already begun in 2011, suicide rates will likely rise.[5]

Country

High rates of suicide are reported in elderly populations in most countries,[36] however remarkable differences between nations are present.[37] A cross-national study of 62 countries reported an increase in suicide rates with ageing in males and females in 25 and 27 countries, respectively.[38] Shah and colleagues, report low suicide rates in the Caribbean, Central and South America and Arabic/Islamic countries with the highest rates found mainly in Central and Eastern European countries emerging from the former Soviet Union, with midrange rates in the U.S., Canada, Western Europe and some Asian countries.[3,10,39] For the WHO[40] data bank, there is almost no data available from the African region. Despite recent suicide rate declines in some regions, such as Australia and other Anglo-Saxon countries, suicide in elders remains an important public health issue due to the highest risk remaining in those over the age of 65.[3,37,41]

Among western developed nations, suicide rates for over 70 year olds in the United Kingdom are 6,3 per 100, 000 while in the U.S., there is an average of 10,8/100, 000 deaths by suicide in the general population with an average of 20/100, 000 deaths at 85 years of age and above.[2,11,39] For the same age bracket, France presents particularly high rates, reaching 148/100, 000 for men and 24/100, 000 for women.[2] Despite suicide completion rates being lower in Portugal compared to other European countries (8,2/100, 000 in 2010), it has been increasing steadily throughout the past few years.[10]

Suicide rates among the elderly population are particularly high in many East Asian countries including China and Korea.[42] In Korea, the suicide rate in a group consisting of people aged 75 years and above, surpassed the 15-24 age bracket ten-fold.[43] Among citizens in Taiwan, people aged 65 and above have had the highest suicide rates for the past 20 years; the annual suicide rates in this age group having consistently exceeded 40/100, 000 persons.[42] The pattern is similar for elders over 65 years of age in China, presenting a suicide rate which

is four to five times superior to that of the general population, with a suicide mortality rate of 44,3-200/100, 000 reported annually.[2,11,30,39] Between 2001 and 2010, men over the age of 85 in New Zealand, possessed the highest average suicide rate among all age groups with a rate of 34,0/100, 000.[15] In Brazil, the suicide rate in 2008 was lower than the above described countries with 9/100, 000 deaths by suicide.[39]

Gender and Race

Most developed countries report that the highest suicide rates are found in men aged 75 and older with the WHO[40] estimating that in 2000 the suicide rates in men and women, aged 75 years and older, to be 50 and 16 per 100, 000, respectively; clearly indicating a gender gap.[44] It has already been evidenced that global suicide rates are highest among older people but these rates are especially elevated in males older than 75 years of age.[37] Older men are at particularly elevated risk, accounting for considerably more suicide deaths than do older women, with male to female ratios ranging from 3:1 to 7,5:1.[39,45,46] Exceptions to this include China and India, where the gender gap is less pronounced.[39,45,47] In a study carried out by Vasiliadis and colleagues,[48] older adult males were 14 times more likely to die by suicide than females.

Regarding race, Caucasians have the highest suicide rates. Asians and Caucasians present higher rates of suicidal ideation and African-Americans the lowest.[31] Caucasian men demonstrate completed suicide rates of 23,9/100, 000 in the 65-69 age group and 49,7/100, 000 in the age group above 85 years, accounting for the major rise in suicide risk for older adults in the U.S..[35,39] Caucasians are four times more likely to commit suicide than African-Americans in the U.S..[2] African-American men experience two peaks of suicide risk with one present during old age.[25] In a study conducted by Ciulla et al.,[2] Brazilian indigenous people were found to have an increased risk of suicide when compared to other racial groups.

Suicidal Behaviour

Older adults commit a fifth of all completed suicides.[30] Non-fatal suicidal acts tend to be less common in this age group[45] and the elderly have a greater chance of carrying out successful suicide attempts than any other age.[49] In many countries, older adult suicidal behavior is highly lethal,[45] reflecting a powerful determination to die.[30] In the general population, 8 to 15 episodes of deliberate self-harm occur in relation to every suicide, whereas in the younger population the ratio can reach up to 200:1.[35,50] Attempted suicide is far less frequent among the elderly, with the ratio ranging from four to two attempts for every completed suicide.[27,30] A study conducted by WHO/EURO Multicentre Study of Suicidal Behaviour[27] in 13 European countries, showed that the average suicide rate among people who are older than 65 years in these societies is 29,3/100, 000 and suicide attempt rates, 61,4/100, 000. Fatal and non-fatal suicidal behavior reveal opposite tendencies in regards to age.[30] The rate ratio of deliberate self-harm to suicide is shown to decrease markedly with increasing age,[51] likely due to the more lethal methods selected,[50] increased planning and physical frailty present in the elderly population.[45]

III. Particularities of Elderly Suicide

Prior Suicidal Behaviour

History of suicidal behaviour is often considered a potent risk factor for eventual completed suicide, however, elders are generally less likely to attempt suicide than younger age cohorts,[11,33,43,52–54] with approximately 75% of elders never having made a prior attempt to suicide death.[35] This low attempt history may be explained by the fact that elderly attempts are usually met with more intent and frequently result in completion.[10,11] Therefore, elderly suicide attempts are often considered as 'failed suicide', especially in men.[4] Results from a study conducted by Almeida and colleagues[32] showed that a history of a past attempt is not a robust predictor of future suicide completion, although strongly associated with future attempts. Suicidal thoughts and behaviours are considered rare in mentally healthy elderly people; the risk of attempted suicide is increased roughly 58-fold if any mental disorder is present, and 10-fold by the diagnosis of an affective disorder.[4]

Medical Contact

Literature is consistent in reporting that elderly suicide victims are likely to have visited a GP prior to death.[3,33,55,56] Approximately 75%[57] contacted GPs in the year prior to suicide, while roughly two thirds or more are seen within a month of deaths and up to one half within the week.[5,35,58] Compared to younger patients, older patients missed their last appointment less often than younger individuals and alleged urgent reasons for the final contact.[59] A smaller portion of elders were under psychiatric care at the time of death,[15] with females more likely to have consulted them in the prior year than males.[48,57] Given the large proportion of contact with the population at risk, this setting offers opportunity for GPs to identify and implement preventive interventions.[35,60]

Method, Lethality, Intent and Planning

The method of suicide employed tends to vary with time, age, sex, country, and social factors.[47] Generally, elderly men adopt more violent methods than women,[3] which include firearm use (60%[47] – 80,7%[61]) and hanging (30%[50]-50,7%[32]) as most commonly employed methods.[32,47,54]

In the U.S., with exception to Honolulu and New York City,[40] firearms play a central role in suicide,[47,50,61] in both men and women[61] with the majority inflicting gunshot wounds to the head.[61,62] In England and Wales, hanging is the most common method employed by men, while self-poisoning is most often used by women.[40,47] According to Cheung et al.,[15] densely populated areas such as Singapore, New York City and Madrid recorded falling from heights as the most frequently used method. Firearm use, hanging and overdose were used similarly in Australia, Canada, Norway and Honolulu.

Drug overdose, carbon monoxide poisoning, incised wounds, asphyxia, drowning and jumping from heights accounted for cause of death in less cases.[3,56,61] The most commonly used drugs amongst older people are paracetamol and paracetamol-based compounds, combination analgesics and antidepressants.[8,11]

Subtle behaviours with conscious or unconscious intent to die, often leading to premature death, are common in certain settings such as nursing homes, where more immediate means to commit suicide are limited.[62] These behaviours, culminating in *passive suicide*, include self-starvation and treatment non-compliance.[4,33] Such passive suicidal behaviour is often not considered when studying elderly suicide and the true prevalence is unknown.[4,63]

Elderly suicide is not more successful solely due to increased lethality of methods chosen, but also to the fewer warnings given, greater planning, higher degrees of intent (which are correlated to attempt lethality), and less impulsivity and ambivalence.[3,4,53–55,64]

Older people's frailer conditions put them at greater risk of death from self-inflicted injury[42] contributing to decreased likelihood of rescue.[63] Older adults are also more likely to live alone therefore, making it less likely that they be discovered in time to be saved.[55]

Physician-Assisted Suicide (PAS) and Euthanasia

A discussion of suicide in the elderly, especially in the context of forensic medicine, cannot progress without mention of PAS and/or euthanasia, particularly when the qualities describing those individuals considering these options bear striking similarities to seniors who engage in suicidal behaviours. Although a detailed examination of these acts is beyond the scope of this review, a brief contextualization is merited and readers are encouraged to consult the vast body of available scientific literature for further clarification.

News about patients who want to end their suffering and advances in palliative medicine have increased public awareness of the nuances of dying with discussion centering around the controversial legal and ethical implications.[65,66] Euthanasia involves direct, active and intentional participation of a person, most often a physician, in ending a patient's life.[66] PAS is distinguished from euthanasia as it refers to the provision, by the physician, of the means to end life which the patient utilizes in order to bring about death with strict conditions and safeguards (e.g. intact decision-making capacity, ability to self-administer the lethal medication, and life expectancy of less than 6 months).[65]

Currently, euthanasia or PAS can be legally practiced in the Netherlands, Belgium, Luxembourg, Colombia, and Canada while PAS, excluding euthanasia, is legal in 5 U.S. states (Oregon, Washington, Montana, Vermont, and California) and Switzerland.[66] Patients requesting PAS from Oregon and Washington are predominantly male, elderly, Caucasian, well-educated and married,[65] features coinciding with what is observed in elderly suicide, with the exception of education level and marital status.

Decisions to end life often mirror the motivators described in elders engaging in suicidal behaviours, frequently including: loss of autonomy, decreased dignity and bodily function, inadequate pain control and suffering, hopelessness, rage and revenge, feelings of guilt, mental anguish and depression, inability to accept losses and changes accompanying illness as well as burden and dependence on family.[4,65]

IV. Risk Factors

Understanding of suicide among older people is often oversimplified,[67] yet, factors of vast diversity have been demonstrated to be involved in suicidal behaviour in the elderly,[54] with evidence strongly suggesting that no single risk factor can account solely for suicide in this group,[68] largely due to the complex etiology and varying interplay of factors collected throughout the lifespan participating in the self-destructive act.[33]

Suicide can be conceptualized as the outcome of straying off the expected developmental path in response to the presence of risk factors and absence of protective factors.[5] It is conceivable to argue that the taking of one's own life is the most extreme representation of aging unsuccessfully.[15] It can be further characterized as a fatal outcome of an interdependent network of numerous and diverse circumstances which climax together in a single time and place.[69] These exercise their influence uniquely upon each victim, contributing to an already complex reality of the attempt to understand suicide.[67] By comprehending and identifying these important players, the misconceived myths regarding suicide existing as a random act with a single causal explanation can be dispelled.[70]

In suicidology, *risk factors* describe factors that correlate with suicidality thus predisposing the individual to suicide with considerable differences in these across the life-span.[62] Current knowledge about these factors and their impact on late-life suicide is predominately obtained by case-control studies, using the PA,[42,54] which is a research method by which comprehensive retrospective information is collected to offer insight into the process and related factors pertaining to suicide.[40] Through this research, several factors bestowing the elderly with increased suicide risk have been identified. These can be broadly described as demographic,[71] psychiatric,[41] psychological, physical, and social factors.[54] Such factors are either modifiable, such as physical and psychiatric illness or non-modifiable, such as sex and social class.[54] Ascertaining the cause of such a multifaceted, rare and grim outcome

such as suicide is an intimidating task.[25] However, by identifying risk and protective suicide factors in the elderly population, a crucial step towards the development and implementation of suitable risk assessment, management and suicide prevention strategies can be taken.[40,64]

i. Socio-Demographic Factors

Age and Sex

Globally, suicide rates increase with age, reaching their peak in older adults.[29] This age bracket presents a higher chance of carrying out a successful suicide attempt.[49] Among centenarians, suicide rates have been demonstrated as sufficiently large to constitute a public health concern.[72]

Suicide is typically associated with men in most regions of the world.[2] This gender effect remains true for the elderly cohort,[3,11] with the male to female ratio increasing with advancing age.[33] Since the tendency for females to live longer than males exists, the expectation may be that females would constitute the majority gender in completed elderly suicides, however the opposite emerges true with males aged over 75 years possessing the highest rates.[14,56] This gender difference may be partly explained by men utilizing greater lethal means (e.g. hanging and use of firearms), reporting stronger suicide intent and acting more decisively upon it, possessing low prior attempts, and being less likely to be referred to psychiatric services.[8,31]

Marital Status

An association between elderly suicide and not being married, being recently bereaved, living alone, and being socially isolated has been reported.[60] Suicide behaviour has been demonstrated to be affected by marital status, with its influence on suicide rates of men and women differing greatly. The loss of a partner leads to an increased risk of suicide, particularly in men.[73] Kiosses et al.,[31] demonstrated that widowed men had an approximate three-fold increase in suicide risk compared to married men, whereas married and widowed women possessed comparable rates. The highest rates of suicide in women were found in those who were divorced or separated. Paraschakis et al.,[30] conducted a PA case study in the

population of Greece and found that decedents over the age of 75 years were more frequently widowed and those between 60 and 75 years of age were found to be more frequently single or separated. Evidence about whether suicidal behaviour is more common in those that are divorced or widowed remains inconsistent.[33]

The devastating consequences on mental health, associated with the loss of a spouse coupled with the prospect of living one's remaining years alone demonstrates the influence marital status bears on elder suicide.[30] Epidemiological studies provide strong evidence that unmarried conjugal status confers risk for suicide;[69] however, a study conducted in India did not find this, as more elderly married subjects were reported in the suicide attempters group.[64] Another study conducted in Hong Kong reported older married Chinese women as having a higher risk of suicide than women who were widowed, single, or divorced.[14] The findings could be explained by influence of intermediate factors dependent on the couple's relationship such as interpersonal stressors and perceived burden on the spouse due to mental or physical illness.[14,64] The inconsistent findings regarding the relationship between marital status and elderly suicide demonstrates the complexity in ascertaining the influential weight of selected risk factors on late-life suicide and merits further exploration.

Residence

Regional variation within countries exists with higher rates cited in rural areas,[33] with research hailing from various geographical regions demonstrating this positive association between elder suicide and rural dwellings. In Portugal, regional asymmetries exist with the highest suicide rates in rural areas of Alentejo.[10] A study conducted in India reports the elderly group containing a larger proportion of attempters resided in rural areas.[64] Dong et al.,[74] state that older adults living in rural areas of China may be at higher risk of suicide when compared to their urban counterparts. High rates associated with living in rural areas may be

reflective of the vulnerability to social isolation, which in itself is a contributing risk factor to suicide in seniors.[64]

Race and Ethnicity

Heterogeneity of suicide rates between countries exists with race and cultural factors appearing to be significant in explaining different regional and cross-national trends in elder suicide rates.[31,33,60] Elderly Caucasian men present particularly high suicide rates[69] compared with other demographic groups in the U.S..[5] Suicidal ideation is increased in Asians and demonstrates a lesser association with African-Americans.[71] Cohen et al.[75] studied racial differences in North American urban areas, reporting that similar risk factors exist between Caucasian and African-American seniors.[8]

Studies reporting on ethnic influence on elderly suicide in multicultural societies vary in their findings. Immigrants hailing from countries with high suicide rates generally maintain those high rates in the host country, reflecting the influence of pre-migrant social and cultural experiences on elder suicide.[8] Shah et al.,[76] report that men aged 75 and over from most migrant groups held higher suicide rates than those native to England and Wales.[8] In a study by Dong et al.,[74] Chinese-Americans over the age of 65 presented the highest rates of completed suicide in the U.S. when compared to other racial groups. High suicide rates in Asian countries may be explained by the diminished importance given to mental illness, opposing that which is exhibited in Western countries.[42] Distress originating from loss of tradition coupled with lack of acculturation and ageing, leave the older migrant population in the host country isolated[74] and at increased risk for suicide. Late-life suicide rates in some migrant groups are found to converge with those observed in host countries including Canada, Australia, the U.S. and England and Wales,[76] challenging the significance of culture in senior suicide.

Suicide rates among non-white Americans, Indians, Indian immigrants to the UK and Eastern European countries decline with increasing age.[60] Scarce data exist classifying senior suicide rates according to ethnicity.[2] Elderly immigrants and racial minorities may be at increased risk for suicide, justifying clarification through future exploration of the individual and interacting influences of culture, race and migration on senior suicide. Clinicians should be aware of the impact that cultural background and societal attitudes may have on patients.[5]

Education

A study conducted in India revealed that the majority of elderly attempters were less educated than their younger counterparts.[64] Findings from a Chinese population based study demonstrated similar findings, suggesting that lower education increased suicide risk in elders.[74] Poor emphasis on education and scarce resources in previous decades offer possible explanations to the low education rates observed in senior decedents.[64] In Korea, the prevalence of suicidal ideation without a plan or previous attempt was elevated in less educated elderly individuals, whereas an existing plan or previous attempt were associated with higher education.[43]

Economic Status

The significant level of unemployment in elderly suicide is expected as the majority is retired.[64] Unemployment, lack of stable outcome[64] and financial constraint [74] are significant risk factors associated with suicidal behaviour in elders. In mixed age group studies carried out in London, suicide rates were found to be elevated in regions with high socioeconomic deprivation.[60] A cross-sectional study of a Brazilian sample over the age of 60 reported that older people without income and with no paid activity had an increased suicide risk, further emphasizing the relationship between economic hardship and suicide in the elderly.[2] Elders who committed suicide were more likely to have experienced financial issues within the two

years preceding death.[35] However, the influence of unemployment on suicide decreased when mediated for mental illness.[35,71] The protective power of financial security is demonstrated through the decrease in elderly suicide rates over time in England and Wales as the GDP increased.[60] Effects of retirement on senior suicide might be mediated by factors including poverty, reduced social status, loss of interpersonal relationships, domestic discord, feelings of hopelessness, fear of being a burden and depression which may accompany this late-life change.[2]

Succinctly, demographic characteristics associated with augmented risk for suicide include older age, male gender, Caucasian race, and low socioeconomic status, with discrepancies found between various studies regarding marital status, ethnicity and educational level.

ii. Psychosocial Factors

Psychosocial factors constitute risk factors for elder suicide with stressful life events and social disconnectedness mentioned most often. Stressful life events cluster in the weeks and months before suicide attempts in the elderly.[53] Family discord, social isolation and living alone, and bereavement contribute independently to increased risk of suicidal behaviours.[37,41]

Elderly victims of suicide are more likely than other community dwelling seniors to live alone,[53] suggesting a significant role in consequent social isolation and loneliness. Living alone is associated with a five-fold increase in suicide risk[36] and linked to suicide attempts in elders aged 70 years and older.[5] Living alone has been shown to be an independent predictor of suicide for elders,[37] affecting mainly men.[27] Loss of social support and increased social isolation, which frequently accompany those living alone, are often linked to more frequent suicidal ideation.[73]

The negative effects of living alone can breed depression which thrives in isolation.[30] The validity of the link between living alone and suicide is not clear, as the elderly cohort is the most likely to live alone, signifying that living alone is not necessarily synonymous with social isolation.[4] Furthermore, the effects of living alone may be mediated by other variables which contribute to the haziness regarding this relationship.[44,53]

Feeling isolated from family members, experiencing chronic interpersonal discord, and perceiving oneself to be a burden on family are posited as relevant factors of elderly suicide etiology.[5,54,77] Family discord remained predictive of late-life suicide when depressive symptoms were statistically controlled for.[25,69] Perceived burdensomeness, a factor less explored in suicide research, is associated with more severe suicidal ideation.[25,77]

Bereavement is documented as a precipitating and predictive factor, especially in men who are at a three-fold increase risk for suicide following loss of a spouse.[36,44,54] Suicide notes left by elders included greater references of grief related to spousal loss.[15] Complicated grief

in reaction to loss of spouse or descendants, is diagnosed after six months and has been implicated in suicidality.[2,78] Frequency and timing of the losses have been implicated as differentiators of a suicidal reaction from a non-suicidal one.[25] The first 6 months of bereavement pose the greatest risk,[4] remaining elevated for years after the loss in men aged 80 and above.[36,79] Only a minority of bereaved people consider suicide however, with research demonstrating that those with psychiatric complications of bereavement, such as major depression or complicated grief, are at most serious risk.[62]

Hopelessness, 'characterized by an overwhelming feeling of being trapped in a situation with no foreseeable way out', places elders at risk of transiting from initial stages of the suicide continuum to the end.[73] Hopelessness remains significantly elevated after resolution of major depression in elders who have a history of suicide attempts.[35] Predictive significance of suicide ideation is not as clear as in adult populations, with hopelessness seeming to be mediated by mental illness.[3] In institutionalized elderly patients and those living in retirement communities, hopelessness has been noted to be predictive of suicidal ideation and completion, respectively.[62] Although literature supports the association between hopelessness and suicidal behavior in seniors, more research is needed to examine the mediating role of other variables.[67]

iii. Psychiatric Disorder

Suicidal thoughts and behaviours are particularly rare in mentally healthy seniors.[52] Psychiatric disorders are estimated to be present in roughly 90% of people that commit suicide[2,31,37,43,57,67] with reports indicating this critical risk factor to hold similar percentages in elderly suicide.[4,58,74,77,80,81]

Elders depicting suicidal behaviour have higher rates of past psychiatric illness and family history of psychiatric illness in first degree relatives than younger cohorts.[64] Those with a lone psychiatric diagnosis are at increased risk of suicide with particular vulnerability to suicide and suicidal self-injury when more than one mental disorder is present.[48,70]

Depressive Disorder

Suicidal phenomena are strongly related with the presence of psychological suffering, particularly that of depressive connotation and this association has generated an enormous amount of literature.[52] Major affective illness, especially major depressive disorder, is a significant predisposing factor associated with the highest population attributable risk and most common diagnosis in elderly suicide[25,31,41,57] increasing the risk of death by suicide by 20%.[2] The majority of what is known about risk factors associated with suicide originate from PA studies, with depression and other mood disorders associated in approximately 54% to 90% of cases.[5,11,35,36,39,60,63,67,71]

Depression, a cornerstone in elderly suicide, has been identified as the strongest diagnostic correlate significantly increasing risk[36,73] with its severity assuming more relevant proportions than in younger cohorts.[10] The risk of developing an episode of major depression in the course of a lifetime is of approximately 10-20% with incidence increasing as age rises.[4] Rates of depression in seniors who commit suicide are greater than those observed in younger samples with the gender difference being less pronounced above 65 years of age.[36,56] Strong

correlations exist between suicidal thoughts and presence of mental disorder, especially major depression, with roughly 30% expressing pessimistic thoughts and death wishes.[14,47] Undiagnosed and untreated, depression can cause physical, social and functional impairment, thus contributing to decreased quality of life and tragically, suicide.[56] Given that depressive illness and poor quality of life are important contributors for suicide in old age[72] and that depression is the most common mental disorder in the elderly with an increasing prevalence throughout the world,[2] an understanding of the function that depressive illness plays in elder suicide is imperative. Depressive conditions in the elderly must be considered as a bio-psychosocial disturbance, heavily influenced by common stressors accompanying the ageing process.[82]

Distinction between bereavement and depressive illness in elders ought to be clarified. Bereavement, which presents with depressive symptoms but is excluded from major depression diagnosis due to its lack of functional impairment and shorter lived period, includes transitory sadness, grief and mourning that are considered typical and usually affiliated with a precipitating event, such as the death of a spouse.[58] Elders suffering from clinical depression feel as if their world has narrowed with persistent symptoms, not necessarily associated with an external stressor, negatively impacting daily activities such as eating and sleeping and often having biochemical origins.[58,71]

The incorrect perception that it is *normal* for elders to be depressed and that little can be done is prominent[33] and hinders effective treatment and preventive efforts as telltale signs are often easily dismissed.[64] Adding to the lack of recognition, is the fact that depression often presents differently in the elderly and can be easily confounded with other medical conditions.[64]

Affective syndromes may be milder in older adults with depression often masked by somatisation and various cognitive changes such as memory loss, distractibility, irritability,

lack of initiative and disorientation[35,58,64,71] Depression in seniors may present with anxiety, possibly precipitating suicide attempts through associated severe psychomotor agitation.[10] Wongpakaran et al.,[49] demonstrate that depressed elderly people display more physical symptoms than their non-depressed counterparts and younger depressed individuals. Complaints of insomnia, weight changes, feelings of guilt and hypochondriasis were more typical in seniors whereas decreased libido and depersonalization were less common.[47] Frailty also contributes to the arduous task of recognizing depression in elders. Clinical presentations of depression and frailty are similar and circular in nature occulting the underlying condition with physiologic frailty adding to depressive symptoms and frailty increased by depression.[58]

A prospective, non-clinical cohort study of retirement community resident suicides suggests that depressive symptom severity is a predictor of suicide[54,63,69] with risk appearing to be proportional to symptom severity.[83] Similar results among Chinese elders were found, with a significant correlation existing between depressive symptoms, suicide attempts, and suicide mortality.[74] Hung et al.,[42] report that depression alone is limited as a predictor of suicide whereas depressive symptoms contributed strongly to their predictive model for elder suicide.

Elderly also underreport depressed mood and minimize psychological distress, being less likely to express suicidal ideation compared to younger sufferers whilst emphasizing somatic illness.[47,62] Masking is prominent in men who are less inclined to acknowledge melancholic feelings and typically do not recognize depressive symptoms such as increasing fatigue, loss of appetite and decreased interest in daily social activities[58] consequently, contributing to the low detection of depressive disorders.

Few studies have explored the association between suicide risk and depressive subtype in elders. Waern et al.,[84] have demonstrated that although recurrent major depression possesses greater suicide risk, subjects with dysthymic disorder and minor depression also

present elevated risk, underlining the need for evaluation in elders who do not meet all criteria for major depressive disorder.[53,69,85] Research examining the structure of late-life depression suggests that depressive symptoms in the context of death and suicidal ideation may represent a specific subtype of late-life depression.[5] Other types of depression in seniors often occur in association with co-morbid chronic physical illness, cognitive impairment and disability,[33] with a substantial number of senior citizens reporting depressive symptoms manifesting for the first time later in life.[4,58] The most common psychiatric syndrome of older suicide victims is a single episode of non-psychotic, unipolar major depression of moderate severity without co-morbid psychopathology,[53,67] which is also the most likely to respond to standard treatment.[44,53]

Although the relationship between specific depressive disorder subtypes and suicide continues vague,[36] what is clear, is that elderly persons who commit suicide are a heterogeneous group in regard to affective disorders, implying a need for differentiated detection and prevention strategies.[85]

While common, mood disorders often go undiagnosed and inadequately treated in primary-care practice.[55,62] In those presenting with affective disorder, up to 80% are expected to respond favourably to available therapies, including pharmacological and electroconvulsive therapy, or psychological treatments [67]. Older adults who go on to take their own lives escape adequate diagnosis and treatment of their affective disorders,[83] a problem further complicated by a lack of sensitization among primary care givers regarding geriatric mental health disorders.[64]

Diagnosis of depression is based on specific criteria described in the *Diagnostic and Statistical Manual of Mental Disorders*. However, a considerably greater proportion of the elderly possess depressive symptomatology that may go undetected by the DSM-V criteria, demonstrated by the prevalence of clinically diagnosed depression decreasing in contrast to

the increase of depressive states reported among the elderly.[4] Prevalence of diagnosed psychiatric disorders, psychiatric treatment and contact with mental health professionals in the three months prior to death was significantly less in older adults than in middle-aged individuals.[29] Of those that enter in contact with medical services, about a third of depressed patients commit suicide within a year of seeking psychiatric help.[57] Over half of the suicides in hospitalized elders with psychiatric illness occurred within a week of admission or discharge.[36] Elders with increased vulnerability immediately following hospital admission are likely to have history of inpatient treatment for depressive disorders or have diagnosis made in the last previous hospitalization.[5] This indicates crucial time periods and areas of access for implementing preventive strategies.

While psychiatric illness, particularly depression, is the most documented risk factor for late-life suicide, the majority of depressed elders neither think about nor attempt suicide. It is therefore, imperative to move beyond the oversimplified view that depression alone accounts for all cases of suicide in elders.[46]

Other Mental Disorders

Primary psychotic disorders (e.g. schizophrenia), anxiety, substance abuse and personality disorders are implicated risk factors in elder suicide, playing a significantly lesser important role when compared to depressive illnesses.[25,54,69]

Bipolar Disorder

A Brazilian cross-sectional study found that elderly individuals with current episodes of bipolar disorder presented a greater suicide risk, with those presenting depressive episodes being at greater risk than individuals with major depressive disorder diagnosis.[2] A cohort study of a community representative sample conducted by Almeida et al.[32] found that bipolar and depressive disorder were the most robust risk factors associated with past suicide attempts in men aged 65 years and over, accounting for 17% of all completed suicide cases.

Anxiety Disorder

A significant relationship between anxiety disorder and suicide in older adults exists, having been shown to be involved in one of every six elders who took their own life.[35,59] Prevalence of anxiety disorders among those who died by suicide is significantly higher among older individuals compared to younger patients with its proportion increasing with age.[59] Co-morbid psychiatric disorder is common in elders who commit suicide and this frequent co-existence of depression and anxiety presents a difficulty in assessing the true potency of the latter in elder suicide, with studies finding an increased risk of suicide, but more so in the context of these mixed anxiety-depressive states.[4,33] A low percentage of patients (1,5%) had anxiety without any psychiatric co-morbidity.[59] A Swedish study conducted by Waern et al.,[36] identified anxiety disorders in 15% of the suicide cases contrasted by 4% in the comparison group. In the same study, it is important to underline that

anxiety disorder was never the sole diagnosis in those that committed suicide and was not found to be an independent factor associated with suicide when results were adjusted for psychiatric illness.[85]

Anxiety may indirectly increase suicide risk due to an impaired likelihood of recovery from depression when treatment is implemented.[62] In a study conducted by the WHO World Mental Health Survey, it was found that disorders characterized by anxiety could predict which individuals would undergo the transition from suicidal ideation to attempt.[86] Anxious distress is a prominent feature of bipolar and major depressive disorder in primary-care and specialized mental health settings, having been associated with higher suicide risk, longer duration of illness, and greater likelihood of treatment non-response.[87]

Data on suicide in late-life anxiety disorders are scarce and research concerning the influence of anxiety symptoms or disorders in the absence of other risk factors in senior suicide is ambiguous, indicating a potential area of future study which has not yet been completely elucidated.[59,62]

Personality Disorder and Traits

Personality disorders are less common in suicidal behaviour in lat- life compared with younger cohorts, being present in 2,5%-7% of older suicide attempters.[33] Although uncommon, such disorders were found to be more frequent among cases of suicide than among those in the comparison group who died of natural causes while in hospital.[36] A controlled study assessing personality disorder diagnosis, found that it was not over-represented in elderly suicide deaths.[54]

Pre-existing personality and emotional traits associated with increased risk of elderly suicide have not been extensively explored in literature. Consistent findings include: neuroticism, obsessional traits, 'low openness to experience' (LOE), timidity, tendency to

hypochondriasis, hostility, rigidity and fierce independence, inability to express or describe psychological pain, inability to form and maintain close relationships, loss of control, and having difficulties in depending on other people.[4,33,47,73]

LOE, 'a propensity to perceive problems in dichotomous terms', is widely cited as contributing to suicide risk.[47] Associated affective muting further occults the ability to detect suicide risk in elders.[67] Negative traits such as pessimism were stated as a significant predictor of suicidal behaviour in adults independent of depression symptoms.[46] A PA study found an inverse relationship between impulsive aggression and age,[78] suggesting that impulsivity plays a lesser role than in younger suicides. These personality traits hinder one's ability to accept and cope with age-related stresses and changes, as well as making recognition of risk difficult, which all contribute to increased vulnerability to suicidal behaviour.

The direct and indirect effects of these traits on depressive disorders, or vice versa, present a challenge to deciphering their exact role in elderly suicide[31,53] indicating a potential area of exploration.

Substance Abuse

Substance abuse is less frequently implicated in old age compared to younger suicides and is often associated with depressive illness.[33] In mixed-aged studies, alcohol and substance abuse disorders compromise the second most common diagnostic group, however, in studies focused primarily on the elderly these results are highly variable ranging from 3% to 46%.[36,39] Mixed results in elderly populations reflect differences in measures utilised, populations examined and socio-cultural context.[25]

In a study carried out on elders residing in a retirement community, drinking more than three alcoholic beverages a day was found to be predictive of completed suicide.[69] Substance related disorders were remarkably less frequent in older suicides when compared to

middle aged suicides (13,7% and 35,5%, respectively) nevertheless, alcohol abuse can be an important risk factor for older people in some countries (e.g. U.S. and Scandinavian countries).[37]

Kaplan et al.[88] studied the relation of acute alcohol consumption in suicide decedents compared to a living sample and reported an odds ratio of less than one for those over age 65, suggesting that alcohol ingestion *per se* does not elevate suicide risk. However, when heavy alcohol ingestion was taken into account, suicide decedents were not only more likely to drink, but also more heavily so relative to the living sample.[40,88] Alcoholic men who have survived into their 60s are especially vulnerable to precipitating suicide crisis due to a combination of chronic alcohol abuse, exhaustion of social supports and interpersonal stressors.[62]

Due to limited evidence available on the role of substance abuse in elderly suicide, diagnosis of substance use disorder may be a risk factor for suicide of lesser weight among the elderly than younger people.[62]

Schizophrenia and Schizoaffective Disorders

In later life, those with schizophrenia carry a high prevalence of suicide completion and ideation. A review carried out by Conwell & Thompson,[35] revealed that schizophrenic spectrum disorders were significantly associated with elderly suicide, albeit at low odds ratios. In a study conducted by Cohen et al.,[89] elders with schizophrenia were compared to an age equivalent community sample without schizophrenia or schizoaffective disorders. They found that the former possessed a significantly higher prevalence of current (10% vs. 2%) and lifetime (56% vs. 7%) suicide ideation, as well as previous suicide attempts (30% vs. 4%).[31,89] A Danish nationwide cohort study revealed risk factors for suicide in diagnoses of schizophrenia including multiple hospitalizations, recent admission or discharge, previous and recent suicide attempts, co-morbid mood disorders, personality disorders, and substance

abuse. This study demonstrated a two-fold increase of suicide risk in those with co-existing mood disorder and schizophrenia when compared to those with a lone diagnosis of schizophrenia.[90]

Pre-existing psychiatric disorders increase an elder's suicide risk, with one study indicating as much as a tenfold increase in suicide risk associated with psychotic disorder[36] yet, suicidal behaviour does not appear to be simply an extreme expression of depression or other mental illness.[91] It is a much more complex and multifaceted problem that contains an equally elaborate net of possible explanations and motivating factors. Researchers have begun to examine specific constructs that may explain exactly why psychiatric disorders are associated with suicidal behaviour.[74]

iv. Major Neurocognitive Disorders

Dementia is an umbrella term for loss of memory and other mental abilities severe enough to interfere with daily life, caused by physical changes in the brain.[92]

> "[It] is subsumed under the newly named entity *major neurocognitive disorder*, although the term *dementia* is not precluded from use in the etiological subtypes in which that term is standard. [. . .] The term *dementia* is retained in DSM-V for continuity and may be used in settings where physicians and patients are accustomed to this term. Although dementia is the customary term for disorders like the degenerative dementias that usually affect older adults, the term neurocognitive disorder is widely used and often preferred for condition affecting younger individuals [. . .]." pg.591[87]

Ascertainment of the role that dementia plays in the etiology of elderly suicide has generated inconsistencies; despite its devastating impact on the older population, dementia is infrequently diagnosed in retrospective clinical diagnoses of completed suicides.[11,67,93]

It has been postulated that late-onset depression is an early manifestation of neurodegeneration.[94] Decreased risk of suicide has been associated with dementia when cognitive deficits prevent the planning and implementation necessary to carry out suicidal behaviours, whereas increased risk has been associated with earlier stages of the illness due to preserved awareness of cognitive decline and preserved planning functions.[94] Frontal deficits in planning may serve as protective factors, whereas other frontal alterations such as poor impulse control and judgment may increase risk.[94]

The risk of suicide for those with mild-to-moderate dementia must be considered, particularly if evidence of depression and anxiety are present in the context of a recent diagnosis.[65,71] Other issues other than cognitive deficits can be implicit in the increased suicide risk in those with dementia, such as the fear of becoming dependent on others as well as the negative emotional impact at the prospect of being placed into nursing care.[47]

Depression is a potential consequence and often masked by symptoms of cognitive impairment of common elderly neurologic pathologies including vascular dementia, frontotemporal dementia (FTD), dementia with Lewy bodies (DLB), Alzheimer's disease (AD) and Parkinson's disease.[58] By studying the neuroanatomical changes related to neurodegenerative disease, the changes associated with increased vulnerability specific to elders can be identified and utilized in therapies and preventive interventions.[36]

Of the various subtypes of dementia, AD is the most often cited in literature. A case-control study demonstrated AD to be over-represented in a population of elders who committed suicide compared to a group of age and gender matched controls who died of natural causes.[95] Greater suicide risk is suggested to be present during the early stages of AD when individuals experience difficulties in daily living and still have preservation of insight about their cognitive deterioration.[3] Since the greatest burden in early AD is borne by the limbic system, it has been suggested that mood changes or other emotional symptoms may precede detectable cognitive decline and result in increased vulnerability to suicidal behaviours.[94] Postmortem neuropathological findings consistent with AD are found significantly more often in the hippocampus of elderly suicide victims with history of depression than in age matched controls therefore, suggesting a possible interaction between major depression and AD neuropathology.[67,94]

The concept of vascular depression emerged from the association between cerebrovascular disease (CVD) and depression.[95] Underlying CVD might predispose to late-life depressive illness and suicidal behaviour.[25] The influence of vascular factors in elderly suicide etiology is demonstrated through subcortical infarcts being shown to contribute to increased risk of depressive symptoms and cognitive impairment, as well as in patients suffering from stroke possessing an increased risk of suicide.[96] The link between CVD and depression is possibly stronger in the elderly.[94]

Mood disturbances and executive dysfunction have been found in individuals with Lewy body disease manifesting as LBD and Parkinson's disease.[94] In patients diagnosed with the temporal variant of FTD increased suicidal behaviours prior to diagnosis, greater insight into cognitive decline and depression were present.[31]

Studies into dementia could further understanding of the underlying biological pathways present in elderly suicide with practical applications in preventing suicide in those showing early signs of neurodegenerative pathology.[67]

v. Therapeutic Factors

Sedatives and hypnotics have been shown to be associated with elevated suicide risk, even after adjusting for confounding factors such as psychiatric disorder.[5,36] A Canadian population-based case-control study in seniors over the age of 66 reported an increased suicide risk in individuals inappropriately prescribed benzodiazepines and in those utilizing potent narcotic analgesics.[97] Special consideration must be taken in the evaluation and monitoring of older adults prescribed these classes of medications.[5]

According to the American Psychological Association:

> "Several efficacious treatments are available for geriatric depression but seem to be underused. Pharmacotherapy and several versions of psychotherapy, including interpersonal, brief psychodynamic, problem-solving, and cognitive-behavioural, significantly reduce depressive symptoms. Interestingly, when given thorough descriptions of these treatments, older adults state a preference for receiving psychologically based treatments rather than medication."[117]

This statement is reflected in results from a UK study, where the authors found that psychological treatment, which is often considered as a first choice intervention, was poor (21%).[59] Although the exact protective nature that psychotherapy exerts on senior suicide is not yet established, evidence suggests a protective effect of sustained collaborative care intervention which couples psychotherapy and antidepressant prescription.[34]

Antidepressant treatment has been shown to reduce elder suicide risk as it focuses on treating depressive disorder, a key player in elevated suicide risk. Suicide rates in older patients who are on antidepressants vary with age, gender[31] and medical practitioner contact. Women are three times more likely to be treated than males, and those seeing psychiatrists were four times more likely to be treated with antidepressants than those seeing GPs.[70]

Regardless of class, antidepressants elicit more favourable response in elderly patients than in younger groups with studies showing improvement of depressive symptomatology in

approximately 60-70% of elderly patients.[62] Erlangesen et al.,[98] found that although an age-dependent decline in suicide rate for antidepressant recipients was identified, fewer persons who died of suicide aged 80 years or over had received antidepressant prescriptions during the last months of life. In patients with late-onset depression, less psychotropic drug classes were prescribed, which is interesting considering that resistance to initial antidepressant mono-therapy is documented in this particular condition, signifying that use of augmentation by pharmacological or psychological therapies should have been expected.[34]

Decline in elderly suicide rates in various countries (e.g. England and Wales, Sweden, and Australia) was associated with an increase in prescribing rates of antidepressants, particularly selective serotonin reuptake inhibitors (SSRIs).[60] SSRIs have been associated with reduced risk of suicide in elderly people, contrasting with the possibility of suicidal behaviour induction in younger cohorts.[36]

Contrasting the findings aforementioned, an independent association between suicidal ideation and current antidepressant use has been found.[37,46] This could partially be explained by the high proportion of elders over 80 years old with co-morbid cognitive impairment, which is associated with poor or slow response to antidepressants.[31]

Electroconvulsive therapy (ECT) is applied in cases of antidepressant and neuroleptic resistant psychotic depression, severely depressed elderly with co-morbid physical condition or poor tolerance of psychotropic medication, or for severely depressed patients who are at high risk for suicide and non-responsive to adequate antidepressant treatment.[62] ECT has been demonstrated as leading to improved mood and cognition in depression in dementia.[99] Although ECT often exerts a profound short-term beneficial effect on suicidality, little evidence supports a long-term positive effect of ECT on suicide rates, indicating the importance of continued antidepressant treatment following ECT.[100]

vi. Physical Illness and Function

Somatic illness becomes much more common with ageing, therefore it is not surprising to find that elders who die by suicide have a significantly higher prevalence of health related life events when compared to middle aged adults.[29] An association between poor physical health, functional impairment and suicide in the elderly has been reported in various studies[25,27,64] indicating that physical illness may play a contributing role in senior suicide.[33] Four reasons for why an association between physical illness and suicide might be expected have been noted by authors Harris and Barraclough:

> "1. Psychiatric illnesses that predispose to suicide may be independently associated with high levels of medical illness, for example, through self-neglect by depressive persons or the toxic effects of chronic substance abuse.
> 2. Psychiatric illness leading to suicide may be due to the medical illness, for example, brain metastases of cancer or the affective and cognitive sequelae of thyroid disease.
> 3. Disability or disfigurement resulting from a medical illness may lead to social withdrawal and isolation, pre-disposing to depression and other psychiatric illnesses.
> 4. Individuals facing terminal illnesses may choose to preempt the frightening course and inevitable outcome."[55]

Compared with the strength of association between suicide and psychiatric illness, the added risk for medical illness is small.[35] Although physical illness has been repeatedly referred to as a risk factor of late-life suicide, the limited number of case-control studies investigating this association render mixed results, causing evidence in the literature supporting this general relation to vary.[4,53,69,101]

Various studies support the association between existent physical ailments and suicide. Complaints of physical illness and functional disability are common antecedents to suicide in elderly people, distinguishing elderly suicides from younger cases, though with widely varying prevalence figures (34% to 94%).[47,78,84] It has been identified as a stressor in suicide attempts and ideation among the elderly.[4] Studies have shown that physical illness is

present in 25 to 75% of all suicide victims.[61] Uncontrolled PA studies estimate that physical illness directly contributes to suicide in approximately 60% to 70% of victims over 60 years of age.[47,53] In a PA study carried out by Paraschakis and colleagues,[30] an expected high incidence of physical illness (81,6%), with elders over 75 years of age having more physical problems, was observed. In this same study, the correlation between suicide and physical illness was strongest in the *old-old* group. A recent review of international late-life suicide studies carried out by Cheung et al.,[15,40] reported that physical illnesses played a significant role, affecting an average of 55% late-life suicides. Suicide notes written by elderly suicide victims from the U.S., revealed poor physical health, pain and physical disability as motivating factors for suicide.[15] Of elderly psychiatric inpatients who committed suicide 7,5% were motivated by an acute illness, and 20% by a chronic incurable illness.[4] A ten year retrospective study conducted in the U.S. reported that of those suicide victims studied 46% had a chronic or debilitating illness and that 20% had a postmortem malignancy diagnosis.[61]

Based on a review of 235 prospective studies linking death records with disease registries, diverse conditions such as: HIV/AIDS, epilepsy, Huntington's Disease, multiple sclerosis, renal disease, peptic ulcer disease, cardiorespiratory diseases, spinal cord injury and systemic lupus erythematosus have been noted as being associated with increased suicide risk.[25,35,54,55] The relative risk for suicide is 1,5 to 4 times greater if one of these is present.[35] The effect of physical illness after adjusting for co-morbid affective disorders or other psychopathologies in multivariate analyses is unknown in the aforementioned study.[53] Epilepsy (particularly temporal lobe foci epilepsy)[55] and other central nervous system disorders, malignant neoplasm (excluding skin cancer), cardiopulmonary complications, gastrointestinal illnesses, and genitourinary disease in men have also been implicated in elderly suicide.[27,35,53] Chronic somatic conditions such as cardiovascular disease, cancer and diabetes mellitus are also associated with increased risk of suicide.[41,57,59] A study carried out

in Hong Kong affirms the association between chronic illness and increased likelihood of suicide.[74]

A Canadian based case-control study found cancer, prostatic disorder (prostate hyperplasia accounting for the majority) and chronic pulmonary disease among the married to be associated with suicide among the elderly.[101] This study also found no evidence demonstrating the effect of ischemic heart disease, diabetes mellitus, peptic ulcer or cerebrovascular disease on senior suicide. In a retrospective case study carried out by Bennett & Collins,[61] the most common malignancy found was adenocarcinoma of the prostate. Juurlink et al.[102] report that physical disorders including congestive heart failure, COPD, urinary incontinence, moderate/severe pain and seizure disorders are associated with increased suicide risk. A recent review by Fässberg et al.[45] found specific physical conditions such as cancer, neurologic disorders, pain, COPD, liver disease, male genital disorders and arthritis/arthrosis as being associated with elderly suicide. Results from a Québec based case-control study[48] revealed that female suicide decedents were more likely to have been diagnosed with cerebral vascular accident therefore supporting the association between stroke and increased suicide risk. A population based case-control study found that visual impairment, neurological disorders, and malignant disease were independent risk factors.[84] The authors also affirmed that serious physical illness may be a stronger risk factor for suicide in men than in women,[84] implying that elderly males may be more vulnerable to the effects of physical health problems[54] thus suggesting that there are gender differences in coping with such age-normative stressors.[47] Evidence demonstrates that elderly males display higher rates of somatic illness compared with elderly females (55 versus 31%).[47] Males over the age of 75 years and having a physical disability are at greater risk of committing suicide than their female counterparts.[73]

Terminal Illness

The interplay between terminal illness and senior suicide has been explored. It might be surprising to find that terminal illness is associated with a relatively minute proportion of late-life suicide.[40] The majority of terminally ill patients fight for life to the end, with 2-4% of suicides occurring in the context of terminal illness.[4] In a sample of 44 terminally ill elderly patients, a quarter of them expressed suicidal ideation.[27] However, 25% possessed a depressive disorder diagnosis, underlining that mental health problems, which generally occur in the context of severe physical suffering, are potent risk factors[27] with potential mediating effects.

Pain

Relatively little research has examined associations between pain and suicide in seniors, however, existing studies suggest that it may play a particularly significant role in the pathway to suicide and in the fragilization of the elder.[8,25,39] The subjective reporting of pain symptoms prior to suicide has appeared as a fairly consistent finding and is worthy of emphasis.[47] Increased risk of suicidal behaviours are related with pain severity and duration as well as uncontrolled pain, especially in males.[25,33] When elderly suicides were compared with accidental death, pain was the only significant difference found in the physical factors studied, being more often reported in the suicide cohort.[40]

Impaired Function

The question of whether physical illness *per se* or the resulting functional limitation impacts suicide risk is[36] rising in importance and volume in literature.[5] Measurement of functional status is a core component of the geriatric clinical assessment because it is often a sensitive indicator of underlying physical and psychological problems.[35] A PA study on seniors who died by suicide suggested that burden of illness and functional decline resulting in loss of freedom of actions and self-determination, made life unbearable and played a key

role in the desire for suicide.[5,36,103] Chronic health issues with functional limitation increases suicide risk,[15] with results from a population based study in elders demonstrating that functional disability was independently associated with a wish to die.[104] Conwell and colleagues,[105] reported that deficits in instrumental activities of daily living (IADLs) significantly increased risk of suicide independent of depression.[5,36] IADLs among 66 elderly suicide attempters, 67 suicide completers, and 91 community-dwelling comparisons were analysed and revealed that attempters and completers had significantly greater functional impairment than the control group.[35] Greater physical illness burden accompanying serious physical illness coupled with functional impairment, distinguished elderly suicides from age-matched controls in primary-care practices, however, after adjusting for affective disorders, physical illness and functional measures no longer remained significant.[69,83] These results suggest that although physical illness and functional impairment are linked to suicide in older adults, the primary brunt of associated risk with physical health factors is mediated by their interaction with affective disorder.[53,69]

Prevalence of functional disability increases with age[72] and the prospect of facing old age suffering from chronic illness with potential loss of functional capacity may prove to be particularly challenging, especially for *young-old* men and for those with neurotic and extraverted personality traits.[32] The loss of autonomy that may stem from functional disability rooted in physical illness may originate a perception of being a burden on others[72,78] which is a reported motivating reason for suicide in elders.

Further studies of functional capacity are needed as defining the complex associations between functional decrement and physical illness in elderly suicidal behavior may aid in identifying those in need of further assessment and intervention.[35]

Number of Illnesses

The relative risk for suicide associated with any specific condition may be considered small, especially when compared to the influence of mental health problems, however, as the number of an individual's acute and chronic conditions increases, so does the risk for suicide.[25] Juurlink and colleagues,[102] conducted a case-control analysis of all residents in Ontario, Canada, aged 65 years and older and found that patients with 3 physical illnesses had an approximately threefold increase in estimated relative risk for suicide compared with subjects who had no diagnosis, whereas older adults who had seven or more illnesses had approximately nine times greater risk for suicide.[25,106] Erlandsen et al.,[98] found that multiple physical diseases increased the risk of suicide in old age in a registry based cohort study in Denmark, after adjusting for period, age, conjugal status, income, physical co-morbidity, and psychiatric disorders.[29] In a cohort study of a large community representative sample of men aged 65–85, Almeida et al.[32] found that having 5 or more health systems affected by illness increased the risk of suicide by more than 11 times and that the presence of the numerous morbidities accounted for approximately 75% of deaths by suicide.

Perception of the Illness

As important as objective observations of physical health are shown to be, sight cannot be lost upon the influence of the subjective experience as well.[59] It is probable that the perceived meaning of the illness along with its impact on function, pain and threat to autonomy and personal integrity, plays a pivotal role and has great salience in elderly suicide as well.[25] Perceived physical illness is reported to be a significant risk factor for suicide in older people.[15,104] Elderly suicide decedents have been noted to commonly communicate a belief to others that they have a catastrophic illness such as cancer, that on autopsy is unconfirmed.[25,40]

Affective Disorder and Physical Illness

Although the association between physical illness, level of functioning and suicide in later life has been demonstrated to be important,[106] controlled studies strongly suggest their influence on senior suicide to be mediated by mental health factors, particularly depressive disorders.[54,73] Depression is a consistent finding as an independent risk factor for suicidal behaviour, contributing to elder's difficulty in coping with the impacts of physical ill health and functional impairment,[33] thus relegating physical illness to a secondary place in contributing factors to elderly suicide.[4] Research indicates that the experience of a serious physical illness may cause depression in elders.[27] Co-morbid depressive and somatic syndromes have been found in the majority of elderly suicidal individuals.[4] Death wishes were highly present in a sample of elderly patients attending their GPs for psychopathology and associated with high co-morbidity.[54] Elderly suicide decedents are more likely to present with co-morbid psychiatric disorders and less likely to present with physical disorders alone than controls.[48]

The interaction between physical illness, depression and suicide was explored in Barraclough's 1987 classic study on late-life suicide, which proposed that the relationship among physical illness and suicide is seldom direct and largely mediated through affective disorder.[40] Suicidal ideation in seriously ill people is extremely uncommon in the absence of clinically significant affective psychopathology.[53,55,67] A PA study conducted by Harwood et al.,[106] concluded that a minority of suicides occurred secondary to lone standing severe or life threatening physical illness. In the study carried out by Waern and colleagues,[84] somatic illness was found to be an independent risk factor for suicide but the strength of the association was modest compared with that for mental disorder.

Physical illnesses are common in elders, however, the exact influence on suicide remains unclear because few controlled studies exist.[40] Despite the complex interplay between

physical illness, functional impairment, mental disorder and senior suicide,[41,67] this powerful bond has important implications for detection of elders at high risk and management of those identified, underscoring the importance of psychiatric evaluation, especially in exploring potential coexistent depressive disorder in elders suffering from physical disorders.[30,47,54] More research is needed to determine the exact nature of the influence that poor physical health and disability have on suicide in elders.[73,84]

vii. Neurobiological Factors

Among the aforementioned constellation of risk factors, a mounting body of compelling evidence demonstrates that altered neurobiological, neurochemical and cognitive processes underlie the suicidal state and may predispose some individuals to an increased likelihood of that state occurring.[5,55,96] Numerous reports on the association between suicidal behaviour and vast neurobiological parameters have emerged almost exclusively from a younger population, with the elderly receiving inadequate attention.[25,47] Age-related effects on neurobiological processes, possibly superimposed on innate (e.g. affect regulation deficits) or acquired (e.g., stress axis abnormalities due to early life trauma) vulnerabilities may contribute to the observable global increase of elderly suicide.[25]

This represents an emerging area of suicide research, with relatively scarce information available regarding either normal aging of neurochemical systems or differences in the neurobiological profile of younger and older suicide victims.[5,55] This may be partially explained by the inherent and often contradictory data on the effect of ageing on the CNS neurotransmitter pathways[47] as well as high rates of medication use and medical co-morbidity further complicating findings in related studies.[25] Identifying the pattern and distribution of neuropathology specific to depression and suicide is fundamental in deciphering the underlying pathophysiology of late-life suicide.[94]

Neurochemical and Genetic Alterations

Various neurochemical and neurogenetic correlates have been identified in suicidal behaviours, however studies specific to seniors are limited. Early studies report increased risk with serotonergic neurotransmitter abnormalities, non-suppression of the dexamethasone suppression test, and apolipoprotein E4 (ApoE4) carrier status.[33] Elderly subjects show a decreased secretion of noradrenaline, serotonin, and dopamine along with deterioration of its receptors (D1 and D2), as well as an increase of vasopressin, somatostatine and galanine.[82] At

the biochemical level, cerebral neurotransmitters and neurotrophic factors decrease with ageing and could contribute to lower cognitive efficacy[96] consequently, increasing suicide risk in elders.

Genetic association studies have suggested that suicidal behaviours are related to genes including the serotonin transporter (5-HTT), ApoE4 allele gene, tryptophan hydroxylase (TPH1) gene, and brain-derived neurotrophic factor.[74,96] Depressed subjects who were ApoE4 carriers showed a higher suicide attempt history than those lacking the ApoE epsilon 4 allele.[74] A genetic vulnerability for increased suicidal behavior risk is the short allele of the 5-HTT promoter insertion/deletion variant. It has been found to be more common in Koreans (79%) than in Caucasians and other Asians, potentially explaining the high prevalence of suicide in Korea.[43] Late-onset depression has been associated with a mutation of the methylenetetrahydrofolate reductase enzyme gene (C677T-MTH), which raises plasma homocysteine levels, predisposing individuals to atheroscletotic and thromboembolic processes,[94] which subsequently increase risk of cerebral vascular damage. Catechol-O-methyltransferase (COMT) Val/Val 158/108 has also been identified as a susceptible genetic factor for attempted suicides.[74]

Serotonergic systems are among the most extensively investigated[55] and the most consistent findings regarding the biology of suicidal behaviour demonstrate deregulation of this system, revealed by reductions in brain-stem cerebrospinal fluid 5-hydroxyindoleacetic acid (CSF 5-HIAA) (pre-synaptic and non-transporter nerve terminal binding sites) from postmortem brain tissue studies of suicide victims.[44,47] As is found in younger populations, lower CSF 5-HIAA and homovanillic acid levels were detected in geriatric suicide attempts and completions than in non-suicidal depressed patients and unaffected controls.[54,62] These have been reported as having predictive value in determining future suicide attempts following a failed one.[47] Genetic background and prior traumatic life experiences can also

influence the serotonergic system, regardless of one's age, and can lead to an increased propensity towards suicide.[73]

Abnormalities in serotonergic function predisposes individuals to act impulsively and has been linked to decreased inhibition of inward and outward directed aggression in the face of dysphoria, hopelessness, and emergent suicidal ideation in the depressed state[35,62] ergo, increasing vulnerability to self-destructive behaviour. Age-related effects on serotenergic and other monoamine systems may be more pronounced in males.[53]

Future investigations into this area pertaining to suicide in elders raises the exciting prospect that genetically mediated abnormalities in CNS processes predispose individuals to act impulsively and aggressively in the face of environmental stressors[25] potentially becoming targets of future treatment and prevention strategies.

Neuroanatomy Alterations

Investigation of neuroanatomical alterations through structural and functional neuroimaging has garnered useful information regarding the pathological processes of elder suicide. Several investigators have explored whether measures of brain structure distinguish those at greater risk for suicide.[35]

A greater impairment of prefrontal, limbic and fronto-striatal regions might offer an explanation to late-life depression and suicide vulnerability.[94,96] Neuropsychological, functional imaging and neurochemical studies demonstrate an overlap between alterations at the striato-frontal and limbic region levels and locations of lesions associated with secondary mood disorders.[94] Therefore, pathology that disrupts these circuits may result in depression or impaired cognitive domains[94] which increase suicide risk.

Strategic infarcts specifically affecting frontal and subcortical circuitry have been associated with both depression and impulsivity.[54] Depressive elders with suicide attempt histories had significantly more subcortical grey matter hyperintensities on MRI than

carefully matched controls.[35] Findings of decreased glucose metabolism and cerebral blood flow in the prefrontal cortex further amplify the role of frontal region function in late-life depression and consequently, suicide.[94]

Through a functional MRI case-control study, impulsivity and a history of suicide attempts were found to be associated with a weakened expected reward signal in the paralimbic cortex.[33] Diffusion tensor imaging has revealed abnormal white matter anisotropy in widespread regions of the frontal and temporal lobes.[94] Neuroimaging studies show damaged fibre tracts in the uncinate fasciculus, which is the main tract connecting the orbitofrontal cortex to the amygdala and temporal lobe.[94]

Brain atrophy, consequent to ageing, involves cortico-striato-thalamic circuit loops connecting the frontal cortex to the basal ganglia and these loops play an important role in regulating behaviour and complex cognitive functions.[96] An alteration at the level of these loops confers greater suicide risk. MRI studies have demonstrated atrophy of the prefrontal lobes, medial temporal lobe, hippocampus and striatum in elderly depression,[94] in addition to discrete striatal lesions, particularly in the putamen.[33] Through utilization of voxel-based morphometry techniques on elderly Chinese subjects with depression and varying history of suicide attempts, Hwang and colleagues[107] examined differences in cortical and subcortical structures noting that the group with history of suicidal behaviors was characterized by decreased brain volume across several regions, most notably the dorsal medial prefrontal cortex.[5]

Age-related changes in neurobiological systems may account for the rise in suicide rates in later life,[25] and although optimism about new refinements and applications of neurobiological, neuroanatomical, and candidate gene markers to identify high-risk individuals exists, there are currently no specific biologic markers for suicidal behavior, thus emphasising the need for additional research before these can be identified and put into

practice.[44,55] Further investigation bringing together neuroimaging techniques, cognitive and biological approaches is required and encouraged, as insight into the neurobiological basis of elderly suicide may reveal potential therapeutic targets and improvement in future preventive strategies.[41,96]

Neurocognitive Alterations

Executive Function

The relationship between cognitive function and suicide among seniors is somewhat inconclusive and obscure[11,25] however, various studies have emerged focusing on the neurocognitive domain, emphasizing altered executive function, and its influence on senior suicide through impaired decision-making and reduced cognitive inhibition.[96] Neurocognition is the only domain where the number of studies in elders is considerable in size.[96] Research into cognitive function has focused on elders with major depression with and without history of suicide attempt,[33] indicating a future avenue that demands further exploration in elucidating the effects of neurocognitive alterations in elderly suicide. The relationship between the isolated effects of altered cognitive functioning on suicide versus the potential mediating effects associated with other risk factors such as mental illness is yet to be clarified.

Overall, impaired cognitive control is perhaps the most consistent cognitive deficit found among elderly suicide attempters, particularly in cases of high-lethality.[96] Poor cognitive functioning on tests of executive function, attention and memory is significantly associated with the presence of suicidal ideation, though this relationship may be mediated by depression and/or hopelessness.[3,36]

Abnormalities in frontal executive function, which are demonstrated in elderly suicide attempters performing poorly on frontal executive tasks, could result in impaired capacity to manage stressful circumstances effectively[25,35] thus, potentiating the vulnerability to suicide when confronted with age-related stresses. Cognitive control deficits related to the prefrontal-

parietal network, may lead to a lack of control of the provoked emotional response, a higher tendency for rumination and emergence of suicidal thoughts.[96]

Decision-making deficits due to cognitive decline, and in particular poor cognitive control, are more common in late-life, whereas pathways involving impulsive aggression are more common in younger cohorts.[31] Altered decision-making through overemphasis on present reward/punishment contingencies with exclusion and inability to use past experience, is more frequent in elders who attempt suicide and may be consequent to underlying age-related pathology in ventral prefrontal circuits.[25,41] A perception of life problems as threatening and unsolvable, with a tendency to ignore past experiences and neglect outcome probability when making decisions that are overly present-focused, coupled with an impulsive approach to problem solving, distinguished elderly suicide attempters from non-attempters.[5,33] Decision-making deficits may play a vital role in increased vulnerability to suicidal behaviour, especially in those with greater interpersonal matters, which in themselves are potential generators of suicidal crisis.[96]

Worse cognitive inhibition performance has been found in elderly depressed suicide attempters, as well as an inability to inhibit neutral information access to working memory and delete irrelevant information.[33] Interference control is very sensitive to ageing and has been linked to attempted suicide, especially in cases of increased lethality.[31] This inability to inhibit intrusive information may impair the capacity to respond adequately to stressful situations, predisposing an individual to suicide attempts.[33]

Lower capacities of mental sequencing, lower flexibility and planning are existent in depressed suicide attempters when compared with depressed non-attempters.[3] A increasingly rapid age-related decline in cognitive flexibility performances has been documented in suicide attempters compared to patient controls.[96]

Social Cognition, Learning and Memory Domains

Abnormal responses to social stimuli, lack of feeling connected to others and poor social problem solving capacity can amplify the risk for suicide.[31] Chronic interpersonal dysfunction and altered processing of emotional expressions are associated with a maladaptive approach to social problems, therefore influencing how individuals approach social conflict[91] and exacerbating vulnerability to suicidal behaviours.

Older suicide attempters commit significantly more errors in social emotion recognition and show poorer global cognitive performance than elders with no psychiatric history.[31] Investigations of neural processing of socioemotional stimuli demonstrate frontostriatal and paralimbic cortex alterations to be associated with altered encoding of rewards and abnormal self-referential processing, which are present in depressed and suicidal individuals.[91] Disruptions at a fundamental level of socioemotional processing possibly contribute to social problem-solving deficits experienced by more impulsive suicide attempters.[91]

Within the cognitive domain of learning and memory in older suicide attempters, deficits in reversal learning capacities in the context of uncertain environments have also been observed.[96] Additionally, difficulties in retrieving long-term autobiographical memory are documented and may consequently reduce the ability to solve problems[96] previously mentioned to be associated with at risk elders.

The vulnerability to suicide is suggested to comprise a set of biological dysfunctions possibly due to pathological ageing with impacts on neuroanatomical, neurocognitive, neurochemical and genetic domains. These alterations are hypothesized to underlie an individual's reduced ability to respond adequately to stressful environments, leading to increased risk of suicidal behaviours.[96] At this stage, a lacuna for research remains open, with

further investigation necessary to draw out valid conclusions in regards to the precipitating and mediating effects that these altered neurobiological mechanisms have on elderly suicide.

V. Protective Factors

A greater portion of suicide research tends to focus on identifying risk factors for suicide with minimal attention focusing on protective influences. Protective factors are societal or psychosocial conditions or individual behaviours that reduce the likelihood of suicidal behaviour.[108] A variety of internal and external *protective factors* make up part of an older adult's armamentarium.[71] A handful of research reports within the last decade have been published aiming to explore which variables serve a protective function in the development of suicidality.[3]

Most of the identified protective factors in elders focus on psychosocial aspects with common themes including: social connectedness and support,[27,77] high levels of self-esteem, high IADL score,[74] greater life satisfaction and perceived meaning,[109] sense of belonging,[3] cultural prohibitions, personality features,[52] among many others.

External resources are found within the community which can include religious institutions or affiliations as well as a supportive social network.[71] The attitudes that a society lends towards its elderly members play an important role in reducing elderly mortality,[110] especially by suicide.

Literature is consistent in regards to the protective nature of religious beliefs against suicide.[111] Religious activities often provide an important channel for social interaction,[77] fortifying sense of belonging and connectedness. Religiosity and higher spiritual wellbeing has been found to be an independent protective factor against suicidal ideation in African-Americans and terminally ill elders.[54]

It has been suggested that social support networks, family integration and a sense of social connectedness are protective against the impact of stressors and should be given high priority in elders.[108,110] Establishing and maintaining a sense of belonging, 'the experience of being personally involved and integrated within an environment or system'[3] is linked to a

senior citizen's reasons for living[108] and hence, reduced suicidality. Cultivation of friendships and relationships is an important protective factor both against depression and against suicidal behaviours.[27] Elders well integrated in the family have more positive emotions and sustained cognition (e.g. perceived health),[110] which contribute to reduced vulnerability to engaging in suicide behaviour.

Marriage appears to be protective against suicide, although more so in men.[54,112] It serves a protective function by providing social support, facilitating social participation, and increasing self-esteem.[112] A study in Hong Kong[14], demonstrated that older married women have a higher risk of suicide than those who are widowed, single or divorced, which might suggest that marriage *per se* is not as protective as might be the quality of the relationship.

Moving into a nursing home can also be a protecting factor against suicide, although the anticipation of moving can place one at increased suicide risk.[73] With respect to income, an increase in minimum wage is related to lower risk of suicide, potentially serving as a protective factor against suicide in elders.[2] Living with children was found to be protective among Chinese elders.[74]

Internal protective factors include the ability to analyse, understand, and benefit from experience, use knowledge, accept help, possess purpose and meaningfulness in one's life, as well as mastering adversity.[71] Experiencing adversity earlier in life has been recognized as a protective factor against suicide in old age.[72] High levels of agency which can be measured as 'socially desirable masculine traits', conferred protection against suicide, in contrast to the increased suicidal ideation in depression associated with low levels.[3]

In the context of terminal illness, a greater level of 'fighting spirit' is regarded as a protective factor.[100] Positive affect,[3] favourable coping strategies and efficacious problem-solving skills are additional factors mentioned as protective against elderly suicide.[89] Increasing and developing an elder's internal protective repertoire such as: sense of

empowerment, coping and adaptive strategies, flexibility, social skills, sense of hope and even humour could confer protection against suicide as well as being an innovative approach to suicide prevention in seniors.[113]

VI. Prevention

Preventive strategies against suicidal behaviours imply interaction and synergism at multisectoral, multicultural and multiprofessional levels, where the realm of health functions as the central nucleus in planning, organization, operation and evaluation.[9] Focus on this issue is imperative, and although not an easy task, prevention of suicide is possible through various proven effective strategies and interventions targeting different population groups and established risk factors.[114] Suicide prevention is understood as the collection of strategies that procure to reduce risk factors and promote protective ones.[12]

Different conceptual models have been developed in suicide prevention which generally operate through use of short and long term activities.[12] The WHO[1] describes three levels of prevention: *universal* prevention strategies, designed to target an entire population, *selective* prevention strategies targeting vulnerable groups, and *indicated* strategies that target specific vulnerable individuals.

Education of the population and healthcare professionals, identification of at risk individuals, primary care interventions, community-based outreach, telephone counselling, treatment of psychiatric illness, restriction of access to means, along with media awareness, are often cited as elements of effective prevention strategies in the elderly population.[113] The most effective interventions include those that consist of one or more coordinated universal, selective, and indicated components.[81]

Reduction of access to means is an evidence based suicide prevention strategy advocated as an important strategic initiative.[36,47] Legislative interventions on gun control, limiting pesticide usage, barbiturate sale and consumption restrictions, paracetamol package resizing, among many others, participate in preventing suicide.[9]

Public education about suicide is recognized as a form of preventing it.[12] Educating the general population on recognizing risk factors and warning signs in elders, dispelling the

myth that depression is *normal* in seniors, as well as diminishing the stigma associated with mental illness and seeking help, are all imperative in the combat against suicide.[9]

Given the well-documented patterns in elders seeking healthcare, especially prior to an attempt, the primary-care setting serves as a prime venue for the identification of at risk elders.[115] Slowed progress of suicide prevention can be attributed to inadequacies in knowledge, education and training of medical staff about elderly suicide.[115] Early identification and effective management of elders at risk are key to ensuring that people receive the care and support needed.[1] Although mental illness is frequently associated with increased risk for suicide, improvements in diagnosis and treatment, especially of depression, are imperative as mental illness is often rarely diagnosed and treated inadequately,[12] especially in this cohort.

Encouraging protective factors, such as strengthening of personal relationships and developing positive coping strategies are also reported as effective.[1] Positive societal attitudes toward older adults are associated with lower suicide rates, suggesting that individuals' internalization of attitudes toward older adults can function as protective.[5]

Among the unexplored areas of elderly prevention lies identifying interventions which will increase the success of preventing suicide in elderly men, who are less impacted by current preventive measures.[113] Developing positive ageing attitudes, improving coping skills, and increasing resilience still present as potential targets for elderly suicide prevention.[113]

In sum, the increased fragility of this population in consequence to diminished social and personal resources, increases the risk of suicide, and demands permanent care and vigilance through identification of personal needs, increased support, strengthening of social networks and focus on the early detection and adequate treatment of depressive disorder.[9]

VII. Concluding Remarks

It is evident that within the past decade, much progress has been made in the attempt to shed light on the dark horse of suicidology, which is elderly suicide. However, important areas remain poorly or completely unexplored, indicating that much remains to be done in order to properly explore this topic and reach practical conclusions. With basis on the findings of this review, a few areas are highlighted as fundamental in attaining a greater understanding of elderly suicide:

- Improved clarity in definitions of the elderly population, suicide and its many components should be developed and instituted in order to allow for adequate interpretation and application of future findings from emerging case-control studies on the ever-growing elderly population.
- A continuing study into the complex interplay among long established risk factors including mental health, physical illness and function, social factors and personality traits is crucial in clearly defining which risk factors hold greater influence with implications in focused preventive and treatment strategies.
- Comprehension of the relatively untouched topic of neurobiology and its role in the etiology of late-life suicide is evident, thus meriting further studies dedicated to unravelling not only its cause, but potential application to future preventive strategies.
- Increased awareness among public and healthcare professionals into the reality of elderly suicide is needed in order to hasten suicide rates. This is not a phenomenon that appears without warning and is beyond intervention; effective preventive measures exist and should be put into practice, with future implementations not only focusing on identifying and intervening on risk factors, but also fostering and developing protective ones.

Elderly suicide continues to exist as a subject with much left to uncover, demanding the attention and collaborative efforts of various disciplines. Although much progress has already been made into understanding its generalities, a continued effort is called upon to further develop insight into the dark lacunae of this tragic late-life human phenomenon.

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If I have seen a little further, it is by standing on the shoulders of Giants.

- *Sir Isaac Newton* (15 February 1676)

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