Examining Suicide: Imaging’s Contributions

Elizabeth J Church, JD

For many people, the death of hope leads inexorably to the conclusion that the only viable solution, the only way to put an end to unendurable pain, is suicide. What leads a person to commit this final, desperate act, and how might we predict, intervene, and prevent suicide? Health care workers, including radiologic technologists, can play an important role in detecting warning signs in patients and in better understanding what factors may lead to suicide. Although certain forms of suicide such as suicide bombings and assisted suicide are beyond its scope, this article explores medical imaging’s contributions to the study of this phenomenon.

After completing this article, the reader should be able to:
- Define suicide and describe its prevalence in specific populations.
- Discuss the numerous, complex factors that contribute to suicide.
- Identify cultural and environmental influences as well as sex differences associated with suicide.
- Understand current theories as to causation of suicide.
- Explain how imaging contributes to the study of suicidal behavior.
- List the risk factors, triggers, and warning signs for suicide.

His occupational specialty in the U.S. Marine Corps was 1833 Amphibious Assault Vehicle Crewman. He was twice deployed to Iraq, where he was assigned to mechanized mobile patrols and an entry control point. During his deployments, he was exposed to combat, mortar blasts, and blasts from improvised explosive devices. When a vehicle in his patrol was blown up, he saw fellow Marines killed and wounded. He witnessed destruction by an improvised explosive device of a school bus filled with Iraqi citizens, including children. He played in a base football league and during a game was hit so hard that he had trouble standing and experienced mental confusion. During his second deployment, he began to be disciplined for insubordination, fighting, hazing, and assault.

After 4 years, he was honorably discharged. When he began forgetting dates, conversations, and whether he had completed tasks, he was referred for neuropsychological screening. He reported difficulty making decisions and believed he was “grumpy,” that he snapped too readily at his children. He also reported headaches and hearing problems, dizziness when he woke at night, and insomnia. He was uncomfortable in crowds, had a pronounced startle response, and was emotionally numb and detached. He received a diagnosis of posttraumatic stress disorder.

The former Marine had trouble finding employment, and then his wife and children left him; the couple began divorce proceedings. He lost his driver’s license following a motor vehicle accident during which he lost consciousness, although it was not clear whether the loss of consciousness was due to alcohol or the accident.

Then, at last, he seemed to find his footing. At a Veterans Affairs Medical Center, he reported that he had begun attending a community college, that
his driving under the influence charges had been dismissed, and that he had a new job as a football coach at his former high school. Nevertheless, the day after visiting the veterans’ center and only 8 months following his discharge from the Marine Corps, the 27-year-old man hanged himself with a braided leather belt in a stairwell.³

Veterans are killing themselves at alarming, unprecedented rates. Since 2002, more than 2600 active-duty soldiers, guardsmen, and reservists have committed suicide.³ In the past 12 years, the United States has lost more soldiers to suicide than to combat in Afghanistan.³ A veteran commits suicide every 65 minutes; every day, 22 veterans die by their own hands—and these figures are likely low because tracking efforts are flawed, and many states, including California, Texas, and Illinois, do not make figures available to the Department of Veterans Affairs.³ In addition, female veterans who die by suicide often escape notice, as their death certificates do not always accurately reflect their status as veterans.³

People do not have to go to war to find reasons to end their lives. In November 2013, a woman leaped from the third deck of a coliseum after the Oakland Raiders lost a game.⁴ That same month, a man hired a helicopter to take a 30-minute scenic tour of the southern California coast and then unbuckled his seat belt and jumped to his death.⁴ His brother reported that the dead man had been unable to obtain surgery for a chronic health condition he had struggled with for 15 years.

The myriad stories are heartbreaking. Even a simple list of occupations can be made poignant by suicide. A 15-year report (1994-2009) of suicide demographics for the Golden Gate Bridge in San Francisco Bay lists the last known occupations for those who died by jumping from the bridge. The record includes accountants, engineers, homemakers, psychologists, students, teachers, and writers.⁶

Although it is most often completed in solitude, suicide also can be accomplished by agreement. In Japan in 2004, 2 suicide pacts formed between strangers over the Internet resulted in the deaths of 9 people.⁷ Suicide can take the form of murder-suicide between 2 people, or it can be large in scale, such as the murder-suicides of the followers of Jim Jones who drank or were forcibly injected with a cyanide-laced fruit drink on November 18, 1978. The final death toll in Jonestown, Guyana, exceeded 900, with 131 of 304 dead children younger than 10 years of age.⁸ In another example of mass suicide, 18 years after Jonestown, Marshall Herff Applewhite of the Heaven’s Gate religious group convinced his 39 followers to “exit their vehicles” by consuming lethal doses of phenobarbital.⁹

In 2010 suicide ranked No. 10 as a cause of death in the United States.¹⁰ One of the leading causes of death in children and middle-aged adults, suicide is a worldwide problem, with suicidal behaviors occurring at similar rates in developing and developed countries.¹¹,¹² In South Africa, for example, one suicide per hour is completed at the same time as 20 or more attempts are made.¹³ Worldwide, suicide is the second most common cause of death in young people, and for girls aged 15 to 19 years, it is the most common cause of death.¹⁴

The World Health Organization reported that 1 million people die by suicide each year, although experts agree that number is likely a low estimate given errors in identifying which deaths result from suicide, differing and inadequate procedures for tracking numbers, and numerous cultural disincentives to identify deaths as suicides.¹⁵,¹⁶

In the past 45 years, suicide death rates have increased by approximately 60% worldwide; people kill themselves at the rate of 1 every 40 seconds.¹⁷ In particular, suicide rates for middle-aged Americans have increased in the past 10 years, generating concerns that the baby boomer generation might be particularly vulnerable to self-harm.¹⁸ Current trends indicate that in 2020, 1.5 million people will die by suicide.¹⁹

There is a clear sex disparity in attempted suicide rates, with young women making an estimated 100 or more suicide attempts for every completed suicide than men.¹⁹ In the United States, men are 4 times more likely to die by suicide than are women.¹⁹ Present estimates indicate that among youth, the ratio of attempted to completed suicide is 24:1.¹⁹ Other countries present a different picture. In China, for example, more women than men complete suicide.¹⁵

Sex affects not only rates of suicide and attempted suicide, it also affects risk factors for suicide. In a Brazilian study of people who attempted suicide, 68.1%
were women.\textsuperscript{20} They reported more extensive histories of sexual and physical abuse than did men, who reported more use of psychoactive substances, including during the act of attempted suicide.\textsuperscript{20}

Predictably, suicide affects those who are left in its wake—wives, husbands, partners, children, parents, and friends—all of whom are left wondering why and what might have been done. Even bystanders can suffer lasting emotional repercussions.\textsuperscript{6}

\ldots several pedestrian witnesses saw the subject remove her shoes, set her purse down on the walkway and climb over the rail \ldots

\ldots he was approximately thirty feet away. He dismounted his bike and went over to her to try to stop her, but she quickly jumped \ldots

\ldots a tourist from England was walking on the Golden Gate Bridge. She saw the decedent had jumped from the bridge \ldots A Jet Ski unit of the [San Francisco Fire Department] heard the call and found the decedent floating in the water \ldots\textsuperscript{6}

The emotional toll exacted by suicide is both obvious and immeasurable. In terms of economics, suicide costs the United States approximately $34 billion each year.\textsuperscript{19} The Centers for Disease Control and Prevention collects hospital data on nonfatal injuries attributable to self-harm behavior, and it reported that in 2010, the most recent year for which data are available, 464,995 people visited a hospital for injuries due to self-harm.\textsuperscript{19} Combined with completed suicides, attempted suicides and self-harm incidents resulted in more than 700,000 hospital visits and an estimated additional $3 billion in medical care costs. Lost wages and productivity associated with nonfatal self-injury added approximately $5 billion to that tally.\textsuperscript{10,19}

The health care community can play an important, broad role in preventing suicide. In one large study, 45% of those who completed suicide had seen a primary care provider within a month before death, and 77% had contact with a health care provider in the year prior to suicide.\textsuperscript{14} These figures likely represent numerous lost opportunities for intervention, and physicians can be more vigilant in identifying attempted suicides and directing their patients to resources. While experts note that patients often avoid mentioning suicidal ideation, people are far more likely to discuss the matter if asked specific questions about their suicidal thoughts.\textsuperscript{17} More training for health care workers, teachers, parents, and all those who are most likely to come into contact with at-risk individuals could prove helpful in reducing numbers of completed suicides and in helping suicidal individuals find the support they need.

Imaging also can play a role in decoding and reducing suicide. Before the development of sensitive imaging technologies, scientists who studied suicide were confined to postmortem examination of brains and coroners’ records, which are arguably rather insensitive methods of investigation.\textsuperscript{21} Now, imaging studies can detect evidence of suicide attempts, with certain radiologic findings confirming attempted suicide and other self-injurious behaviors (see Figure 1).\textsuperscript{15} Imaging can improve treatment by more quickly helping to make a diagnosis and identifying or confirming suicide attempts. In addition, imaging can aid forensic examiners in distinguishing between fatal injuries resulting from suicide vs those that point to homicide.\textsuperscript{15}

Numerous disciplines put suicide under the microscope. Sociologists look at the influences of society, how certain social conditions such as loneliness and social

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\caption{Radiograph of an intracerebral projectile from an attempted suicide. Used with permission from Royonx under the Creative Commons Attribution-ShareAlike license.}
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isolation might affect levels of suicide. They observe the influences of family and romance, of loss and experiences such as sexual abuse, rape, or domestic violence. Loneliness and social isolation can increase the likelihood of suicide just as a strong support network can buffer against suicide. In a Norwegian study, for example, women with 6 or more children had only one-fifth the risk of suicide when compared with other women. Some experts believe that marriage and parenthood are of particular importance to women, and statistics support this theory: In the United States, widowed and divorced women kill themselves at a higher rate than do married women. Culture, too, affects suicide rates. Historically, some forms of ritual suicide were accepted: Seppuku, a method of atonement for a Japanese samurai, was lauded, as was sati, a practice in which a Hindu widow would throw herself on her husband’s funeral pyre.

Psychologists examine the function of the human mind, the processing of emotions and management of conflicts; they look closely at mental disorders and personality characteristics to determine how those factors might contribute to or protect against suicidal tendencies. Biologists and geneticists work on a minute scale, examining the contributions of genetics, neurotransmitters, and hormones. Imaging permits these researchers more refined approaches to their studies.

Suicide is the result of complex sociocultural, biological, and genetic factors. An underlying vulnerability to suicide based on biological and psychological traits might be heightened or triggered under the pressure of certain stressors, such as joblessness, physical illness, marital rancor, or the death of a loved one. Despite the dire costs of suicide, our knowledge of what lies beneath the suicidal act is markedly less than our understanding of other life-threatening illnesses. Certainly, there is a stigma associated with suicide, and our inability or unwillingness to confront the problem has until now limited investment in suicide research. Advances possible through imaging could help to reverse this picture, reduce the stigma, and promote a better understanding of this complex phenomenon.

**Basic Facts, Dispelling Myths**

Simply defining suicide and attempted suicide poses a conundrum when it comes to understanding self-destructive behavior. In the absence of consistent definitions, both the gathering and interpretation of data can be flawed. Some suicidal acts are clear-cut attempts at self-annihilation: hanging, poisoning, or a gun in the mouth. Other acts are more nebulous. Is it a suicidal act to drink oneself to death? Is addiction a form of “chronic suicide,” as some have asserted? Some people might drink alcohol to give them the courage to commit suicide; others drink to relieve stress and thus avoid suicide. How do we distinguish between the 2 groups? What about driving a car into a tree? When is it an accident or a suicide attempt?

“Suicide by cop,” a situation in which someone wants to die and goads police into lethal action, can have clear suicidal intent. However, it is not an act identified as suicide for purposes of data keeping. Where does self-harm end and attempted suicide begin, and when are high-risk activities such as Russian roulette actually suicidal gestures? If whether a gesture is a suicidal act or not depends on the context, how do we define that context consistently so we can draw comparisons?

The Centers for Disease Control and Prevention acknowledge the need for better data based on consistent definitions of key concepts and in February 2011 released a publication titled “Self-directed Violence Surveillance: Uniform Definitions and Recommended Data Elements.” Self-directed violence falls into several categories, and distinguishing between the various forms of self-injury, including suicidal thoughts vs actions, is critical to a coherent discussion of the behaviors and their causes (see Box 1).

**Attempted Suicide**

Some people who engage in self-harm miscalculate and underestimate the lethality of their actions, leading to behavior more accurately described as a suicide attempt than as self-harm. Attempted suicide and the closely related behavior of self-harm might reveal a desire to relieve tension and anxiety or to express frustration, anger, and emotional pain. Traumatic life experiences, repeated injury and abuse, depression, anxiety, and mental disorders are associated with suicidal thoughts and suicide attempts. Attempts tend to go unreported and untreated, although some survey results indicate that at least 1 million people attempt suicide in the United States each year.
Most people who attempt suicide do not die by suicide. Rather, data indicate that only about 7% to 10% of those who attempt suicide actually go on to die by suicide in the 2 decades following the initial attempt. Attempted suicides occur at an estimated 10 to 40 times more than completed suicides, although of all possible warning signs, attempted suicide is the single best predictor of subsequent suicide. A history of attempted suicide can increase the risk for future suicide by a factor of 4, and studies have found that more than 50% of completed suicides had a history of at least one previous attempt.

Although attempted suicide does not result in death, it still brings with it a risk for serious injury, suffering, and an increased risk for future attempts. By itself, a suicide attempt can create a chain of undesirable repercussions. Because attempted suicide is considered a deviant act, it can lead to peer rejection, which in turn can cause the attempter to seek the company of others whom society has rejected or marginalized, such as substance abusers. Attempters might turn to alcohol or other substances in an effort to self-medicate. Often, following an attempt there might be significant changes in the environment or circumstances of the person who attempted suicide; one study showed that 58% of adolescents who had attempted suicide no longer lived in their parents’ home afterward, and 74% had reduced school performance. Many adolescents who attempt suicide become involved in violent acts, and college students who attempt suicide might not be permitted to remain in school because of fears of litigation.

Certain methods of attempted suicide can cause long-lasting physical problems. Ingestion of caustic substances can lead to severe burns and other complications, while self-inflicted cuts can result in infection and scar formation. Attempted suicide can also have psychological effects, such as depression and anxiety. It is important for healthcare providers to recognize the serious nature of attempted suicide and provide appropriate treatment and support to those who attempt suicide.
substances, such as drain cleaner or oven cleaner, can create a more than 100-fold increase in esophageal squamous carcinoma.\textsuperscript{15} Hanging can leave an attempter with serious neurological difficulties. In the case of a 10-year-old boy who attempted to hang himself from a handheld shower hose, the result was communication only through eye movements, abnormal muscle tone and spasticity, and dependence on a gastric feeding tube.\textsuperscript{18} For a 52-year-old man, near-hanging resulted in symptoms of acute stroke due to the severe narrowing of his internal carotid artery.\textsuperscript{18}

**Suicide by Demographic Groups**

Adolescents

Suicide rates differ across age categories. In the past 2 decades, rates of suicide in children aged 10 to 14 years have doubled.\textsuperscript{14} Rates of suicide increase throughout the teenage years, especially in boys.\textsuperscript{17} As with the sex differences seen in adult men and women, more girls attempt suicide, although boys are more likely to die from suicide.\textsuperscript{25} The United States has one of the highest rates of suicidality in youth; an average of 1 in every 5 youths reports serious suicidal ideation or behavior.\textsuperscript{19} Experts report ethnic differences in the rates of adolescent suicide attempts; Native Americans/Alaskan Natives and Hispanic adolescent girls make more attempts than do their peers.\textsuperscript{32} Because adolescence tends to be a time of particular turbulence and emotional changes, experts theorize that high levels of stress, combined with developmental issues and some psychopathology, are likely responsible for the greater incidence of suicidal thoughts and actions.\textsuperscript{14} Substance abuse and separation anxiety also are likely to predispose adolescents to suicidal thoughts.\textsuperscript{32}

A sobering 40% of adolescents who do not complete their first attempt repeat the attempt to end their lives.\textsuperscript{17} A long-term study of pediatric cases referred to the New Mexico Office of the Medical Investigator between 1979 and 2005 rendered an age-adjusted suicide rate of 4.8 per 100 000 per year.\textsuperscript{17} Three-quarters of all suicides occurred in the child’s home or yard, with shooting as the most common method, followed by hanging. The risk of suicide increases with alcohol use; one-fourth of the New Mexico adolescents who committed suicide had alcohol or other drugs in their systems.\textsuperscript{17}

Reportedly nearly 70% of adolescents see their primary care physician at least annually, and they express a willingness to talk with their physicians about their mental health.\textsuperscript{32} Experts urge physicians to take seriously suicidal gestures such as superficial cutting or consumption of extra pills or benign medications; any episode of self-inflicted harm might signal suicidal tendencies.\textsuperscript{23} Frank, direct questions such as “Do you believe that things would be better if you were dead?” are encouraged, and physicians are asked to assess the risk to rescue ratio of any suicidal act. For example:

*The child who overdoses on a medication late at night, tells no one, and goes to sleep hoping never to wake up is different from the child who takes a handful of pills while standing in the kitchen arguing with a parent.*\textsuperscript{32}

But what about the power of suggestion? Does referencing suicide tacitly encourage suicidal thoughts in teens? Numerous myths abound when it comes to suicide, some of them encouraged by Hollywood portrayals and media hype. Among those myths is the fear that by asking about suicide, one will plant the seed (see *Box 2*).

**Veterans**

Veterans often live with horrendous images that refuse to fade. Levi Derby, who hanged himself in April 2007, was haunted by his memory of an Afghan girl’s death. Derby had offered the girl a bottle of water, and when she stepped forward to take it, she stepped on a land mine.\textsuperscript{3} Now more than 69% of veteran suicides are by individuals aged 50 years and older; Vietnam veterans have long lived with the ghosts in their heads, and treatment options for this population have been miniscule. Although mostly older veterans are killing themselves, younger veterans of the Iraq and Afghanistan wars could create “a tidal wave of suicides.”\textsuperscript{3}

Veterans kill themselves for many of the same reasons as do civilians, although they have the added burden of combat stress and, in many cases, military sexual assault. One psychologist who studies veteran suicides reported that military victims of violent assault or rape are 6 times more likely to attempt suicide than nonmilitary victims.\textsuperscript{3} Some veterans suffer from “vicarious traumatization,” which is described as a combination of survivor’s guilt
and empathetic identification with dead comrades.\textsuperscript{2} Unemployment is a recognized triggering event for suicide, and unemployment rates are higher for veterans—by some measurements running as high as 30%.\textsuperscript{36}

Some experts believe traumatic brain injury could be a primary culprit in veteran suicide. The Marine whose story is described at the beginning of this article had numerous head traumas: football and hockey blows, as well as concussive explosions from mortars and improvised explosive devices. A postmortem examination of his brain revealed marked congestive brain swelling.\textsuperscript{7} Diffusion tensor imaging (DTI) studies of veterans who have been exposed to blasts reveal traumatic injury to the extensions of brain nerve cells responsible for transmitting impulses outward from the nerve cell.\textsuperscript{1} Follow-up DTI studies performed 6 to 12 months after initial examinations confirmed the continued existence of nerve injury abnormalities. Many refer to traumatic brain injury as “the signature injury of Operation Enduring Freedom and Operation Iraqi Freedom,” with an estimated 15% to 30% of returning troops suffering concussions and subconcussions.\textsuperscript{1}

These brain injuries might account for the cognitive impairments and levels of posttraumatic stress disorder seen in veterans.\textsuperscript{1} Some recent studies of veterans suggest that traumatic brain injury might explain the increasing rates of veteran suicides; experts hypothesize that such injuries create a neurobiological vulnerability to suicide by triggering a degree of impulsive and suicidal behavior not present before the head trauma.\textsuperscript{28} Although the mechanisms by which brain damage occurs and elicits behavioral changes are not well understood, researchers are pursuing numerous hypotheses in an effort to address this apparent, pronounced vulnerability to suicide.\textsuperscript{1}

### Box 2

**Suicide Myths\textsuperscript{7,32-35}

**Most people leave a suicide note.** Only about 1 out of every 4 people who commit suicide leaves a note. When notes are left and reasons are given, they tend to be vague: “I could no longer bear it,” or “I’m tired of living.” Often, specific instructions and requests are given, including what to tell children or parents or what should be done with a cherished pet. Younger people who commit suicide are less likely to leave notes; however, when they do, they often try to relieve parents and siblings of any feelings of guilt. Participants in suicide pacts tend to leave jointly signed notes.

**Suicides occur more often during winter holidays.** Suicides more frequently occur during the spring. Suicide rates peak in April and are below average during the winter months. The month with the lowest suicide rate is December.

**Asking someone—especially a child or adolescent—if he or she is contemplating suicide is likely to plant the idea.** Evidence suggests that the opposite is true. People do not begin to think about suicide simply because someone mentions it. A direct, nonjudgmental question such as asking a friend if she is thinking about suicide or has a specific plan is actually an appropriate, caring act.

**Suicide rates for lesbian, gay, bisexual, and transgender people are identical to those of heterosexuals.** Evidence is somewhat unclear, given that death certificates, a primary source for mortality rates and causes, do not provide information about sexual orientation. However, numerous studies suggest that suicide rates among lesbian, gay, bisexual, and transgender populations are higher. Experts believe that stigma, discrimination, greater incidence of mental illness, and alcohol and drug abuse contribute to higher suicide rates.

**More people commit suicide on the weekends.** Most suicides occur at the beginning of the work week, with a recent study pointing to Monday as the peak day for suicides.

**People in poor, developing countries are more likely to kill themselves.** Rich countries have higher suicide rates. Latin American countries have some of the lowest suicide rates. Countries with higher gross domestic product per capita, such as Russia, Japan, and France, have the highest suicide rates, with numbers 2 to 3 times higher than those reported in the United States.
However, traumatic brain injury does not explain why teenagers with family members in the military are more likely to consider suicide when their relatives are sent into combat on multiple deployments overseas. Military-connected 9th and 11th graders with a parent or sibling deployed were 36% more likely to report suicidal ideation than their peers, and girls were more likely to report poor well-being than were boys.

Prisoners

Prisoners have an increased risk of suicide. In high-income countries, male inmates kill themselves 3 to 7 times more often than their nonincarcerated counterparts. Inmates present a particularly instructive study population because of the high incidence of psychiatric disorders that either precede or develop during confinement, significant stressors found in the prison environment, and the social isolation of a prison setting. In addition, prisoners are often bullied, another factor that apparently increases the likelihood of suicide. When compared with nonprison populations, prisoners demonstrate higher levels of depression, hopelessness, impulsivity, and aggression, and lower levels of self-esteem.

For the most part, experts believe that inmates carry an underlying vulnerability to suicide because of the complex interaction of several biological and psychological traits and social, environmental, familial personality, and mental health factors. Stress increases the existing vulnerability, and the correctional setting imposes numerous stressors. Inmates must:

- Adapt to the prison regimen, including loss of freedom and familiar home environment.
- Adjust to a lack of purposeful activity.
- Withdraw from drugs or alcohol.
- Receive bad news (divorce, death of loved ones on the outside).
- Suffer boredom, victimization, and isolation.

Research demonstrates that a large percentage of prisoners who kill themselves do so while held in isolation, with some statistics indicating that 2 out of every 3 prison suicides are completed in solitary confinement.

Approximately 90% of completed suicides are committed by people with a diagnosable psychiatric disorder, with major depressive disorder being the most significant diagnosis connected to suicide. Other psychiatric disorders linked to suicide include mood disorders, borderline personality disorder, substance abuse disorders (including alcohol), anxiety disorders, anorexia nervosa, and schizophrenia. The high rate of mental disorders seen in prison populations, combined with the stressful prison environment, presents researchers with unique opportunities to examine how psychological characteristics implicated in suicide risk, such as depression, impulsivity, aggression, and hostility, differ between prisoners who attempt suicide and those who do not. Childhood trauma, including physical and sexual abuse, the loss of a parent, and recent life events such as unemployment and divorce, also can be studied, as can the preventive aspects of a prisoner’s social network.

Community-based offenders (ie, those who have been released from prison but are still under some form of supervision) are at an even greater risk of dying by suicide than are incarcerated individuals. Studies have shown that compared with the general population, newly released offenders were 8 times more likely to die by suicide if they were men and 36 times more likely to die by suicide if they were women. This population also permits researchers to consider theories about how unemployment, substance abuse, lack of social support, mental illness, child abuse and trauma, antisocial personality, and previous incidents of self-harm might affect suicide rates. Experts in this particular area of suicide research theorize that when anxiety and psychopathy combine with frustration and aggression, they form a particularly potent brew that ends in an impulsive suicidal act meant to release unbearable tension.

Elderly Individuals

Depression is strongly associated with suicide in elderly populations. Some experts propose that across the human lifespan, suicide is a different phenomenon, that it has a “different natural history,” a different meaning, and a different set of risk factors in youth vs later years. Research that focuses on these differences is far from plentiful, but it appears that major depression is much more common among older people who commit suicide than in younger people in whom other
disorders, particularly substance abuse disorders, are more prevalent. In keeping with general statistics, a large proportion of elderly people who commit suicide have a history of previous suicide attempt, but these older people are decidedly more determined to die, engage in more significant planning of their self-destructive acts, and choose less violent methods of suicide. They also express fewer warnings of their intent. In comparison, youths demonstrate more impulsive-aggressive behaviors and are more likely to kill themselves under the influence of alcohol or drugs and in response to some stressful life event. Elderly people who commit suicide plan, are far less impulsive, and are often both physically ill and depressed.

The highest suicide rate among all suicide populations is that of men aged 75 years or older. Elderly people kill themselves at twice the rate as do youths, and they make few nonfatal attempts. Their greater rate of completed suicide is attributable, in part, to their relative physical frailty and physical illnesses, but their well-planned suicides also are accomplished by highly lethal means. Some medications used to treat disease in the elderly cause or exacerbate depressive symptoms, and bereavement and alcohol misuse also can contribute to suicidal tendencies.

In care facilities in particular, elderly individuals are prone to engage in self-injurious behaviors that run the gamut from refusing to eat or drink to cutting and head banging. Experts report divergent results concerning the prevalence of such behaviors. Australian researchers found a 61% rate of residents engaging in self-injurious behaviors, while studies in the Netherlands reported a rate of 22%. What these studies do not reveal are the conditions of the facilities, the level of staff care and competence, the attention paid to residents, family support networks, and other factors that clearly would affect mood, hopelessness, and desire to live. The parallels between this institutionalized population and prisoners are inescapable. Given the aging of the U.S. population, care facilities and their connection to elderly suicide is an issue that should be addressed in concrete, thoughtful, and effective ways.

Dementia also could play some role in elderly suicides. It appears that the risk for suicide is highest shortly after a diagnosis of dementia, when a person not only has awareness of the effect of cognitive difficulties but also an ability to plan and carry through with a suicidal plan. To date, however, studies have not demonstrated a higher rate of suicide among dementia patients.

It is easy to imagine that loneliness, isolation, and a sense of abandonment would have an enormous effect on elderly suicide rates. This kind of isolation, in which people are not only socially marginalized but also increasingly isolated in their homes by mobility issues or living in care facilities that are themselves isolated from the community, creates an atmosphere ripe for despair. By itself, age isolates, as friends and relatives die. Furthermore, many elderly people come to see themselves as ineffective and burdensome, and burdensomeness has been identified as a specific predictor of suicide-related symptoms. As the authors of one study observed: “To perceive oneself as ineffective is painful, and it is even more painful to perceive oneself as so ineffective that loved ones are threatened and burdened.” Many suicides are motivated at least in part by a desire to make others better off, to remove the burden on others.

In 2012, researchers studied the connection between cognitive decline and social isolation. Study participants aged 60 years and older were asked to interpret facial expressions in photographs depicting complex social emotions such as suspiciousness, flirtatiousness, and irritation. One test group was depressed and had a history of suicide attempts; the other group was deemed healthy. The performance of the suicide-attempter group was impaired, with error rates similar to that of young adults with high-functioning autism, who manifest significant deficits in the ability to read accurately others’ social cues. The study authors proposed that such deficits in social cognition might cause miscommunication and otherwise disrupt and undermine social support and interpersonal relationships, thus further isolating people who are elderly.

**Suicide Methods**

The sometimes creative, desperate ways in which people choose to end their lives can vary by culture and geographic location, by wealth, and accessibility of a chosen method. Expeditious diagnosis of patients’
injuries can improve treatment and survival rates, and imaging is an important contributor to this process. Because many trauma patterns are indicative of suicide as opposed to some other injury mechanism, imaging can identify those patterns and alert treatment providers to look for additional injuries that might otherwise be overlooked. Imaging’s ability to characterize injuries as the result of a suicide attempt rather than an accident also increases the likelihood that patients receive psychiatric intervention.

Firearms

The most common suicide mechanism in the United States is firearms. The use of these weapons accounts for more than 55% of all suicides and has a reported fatality rate of more than 95%. Rifles, which generate higher velocity than handguns, result in more tissue damage. Other factors that affect the lethality of guns include the distance that the weapon is held from the target and bullet construction (eg, hollow-point bullets deform on impact and disperse more destructive energy into tissues). Shotguns fire numerous pellets and combustion gases into victims, thus adding to the destructive potential of this weapon.

Hanging

Hanging is the most common means of suicide in many parts of the world, and in the United States it is the second most common method. Among people with a posttraumatic stress disorder diagnosis, hanging is one of the most common methods of suicide. The fatality rate is more than 70%, although for those who reach the hospital, the survival rate is between 80% and 90%.

Poison

In China, where there are many small farms, insecticides are the leading means of suicide, and in the United States, poisoning is the third most common method of suicide. Carbon monoxide poisoning is a less accessible means of suicide than it once was because of the development of catalytic converters, which remove 99% of the carbon monoxide from automobile exhaust. In the Far East, however, carbon monoxide from charcoal in barbecue grills has become a common suicide method referred to as “death by hibachi.”

Jumping

Another suicide method with clear ties to availability is jumping, which is considered an aggressive, severe form of suicide. Not surprisingly, urban societies have higher rates of this form of suicide. For example, jumping accounts for nearly 50% of suicides in Hong Kong, and up to 60% of Singapore suicides are accomplished by jumping. Sex differences vary by country; the United Kingdom reports an equal division between male and female jumpers, while other parts of the world report that jumping is 3 to 5 times more common in men.

Additional Methods

In the United States, intentional, self-inflicted burns, including self-immolation, are uncommon, but the prevalence of this type of injury is higher in the Middle East and Asia. Burns account for up to 70% of suicides in Iran and 20% in India.

Sex Differences

Sex affects choice of suicide method in the United States, with 56% of male suicides involving firearms compared with 30% of female suicides. Poisoning, and in particular medication overdose, is the most common method for women. By contrast, poisoning accounts for only 12% of male suicides. The lethality of method—firearms at 80% to 90% vs 1.5% to 4% for overdoses—explains the 4:1 rate of male to female completed suicides.

Imaging’s Role

Imaging is used to assess the injuries of patients who arrive at the emergency department. It often can be used to distinguish between jumpers and those who have been pushed or fallen accidentally, as injury patterns differ between the groups. Jumpers have more pelvic injuries, more fractures per person, and fewer head injuries than those who fall or are pushed. No single fracture is diagnostic for jumping, but fractures of the calcaneus are common, as are spinal fractures and fractures of the pelvis and tibia. Physical forces are transmitted throughout the body when it slows and stops, and organs distant from the site of impact might be injured. Shearing and torsion forces can tear vascular...
networks, so experts recommend computed tomography (CT) scanning of the head, neck, thorax, abdomen, and pelvis, in addition to radiographs. For those who survive a jump, treatment of numerous, massive injuries can be challenging. In one case report, a 35-year-old woman who jumped from a height of 10 meters suffered multiple vertebral fractures, including one complete burst fracture, and paraplegia. She underwent numerous surgeries, endured serious complications including deep wound infection, and a suffered a collapsed vertebra one year following initial extensive spinal surgery. CT, radiography, and magnetic resonance imaging scans all contributed to assessment of her injuries, review of the healing process, confirmation of correct placement and positioning of spinal implants, and diagnosis of postoperative complications. Two and one-half years following her attempted suicide, her spine was stable and she was able to walk with crutches.

Suicide by sharp force injury is rare, but it is an instance in which imaging proves particularly valuable in distinguishing accidental from purposeful injury as well as homicide from suicide (see Figures 2-4). Location of the injury helps to determine the imaging test of choice. Suicidal stabbing usually involves the front of the neck, abdomen, or left side of the chest; eyes, lips, nipples, and genitalia are usually avoided. In contrast with homicide, suicidal wounds to the chest are usually aligned horizontally. A large number of wounds suggest homicide, while wounds found in a limited area suggest suicide. In one instance of sharp force injury, an Italian man aged 62 years attempted to commit suicide by using a nail gun to shoot 7 nails into his head. He appeared in the emergency department with complaints of a headache, handed the nail gun to the physicians, and told them of his suicide attempt. Radiographs showed a “martyr’s crown” of nails in the right and left temporal regions of the man’s skull, and CT images confirmed location of the nails within brain matter. Postsurgical CT images revealed brain trauma outlasting surgical removal of the nails. The man died 6 days after surgery.

Where access to firearms is more restricted than in the United States, similar mechanisms of suicide nevertheless can be found. In a case reported by Greek researchers, an 80-year-old former cattle breeder used a...
captive bolt gun, also known as a “slaughterer’s gun,” to kill himself. The gun, which is used by butchers and veterinarians to kill large animals, kills in a manner similar to firearms by shooting a projectile that cuts skin and soft tissues, breaks bone, and then is pulled back into the gun by a spring. Although use of this type of gun in suicide is rare, in central European countries where these suicides are seen, there is a mortality rate of 60% to 90%. In this case, CT images assisted treatment efforts by showing the location of the wound canal, the entry point, bony fragments, hemorrhage, and brain swelling. CT provided characteristic imaging findings that allowed an accurate diagnosis, evaluation of the injury and damage, and guided appropriate treatment measures. Despite staff efforts, the man died a few hours after surgery.

Early radiologic evaluation of patients who present in the emergency department with unconsciousness is a long-standing, accepted practice. CT findings can be of particular assistance in facilitating the rapid diagnosis and treatment of intracranial pathologies associated with altered mental status, poisoning, or drug overdose. Overdose and poisoning can result in loss of brain substance and subsequent brain atrophy, ischemia, or necrosis. Researchers in Iran, who noted that opium is the most common substance abused in their country, found CT of particular assistance for early diagnosis of potentially life-threatening intracranial pathologies resulting from overdoses.

Some poisons, such as the herbicide paraquat, cause death through respiratory failure. Ingestion of a significant quantity of the herbicide can result in death within 2 to 3 weeks due to acute renal failure, hepatitis, and respiratory failure caused by pulmonary inflammation and fibrosis or the development of excess fibrous connective tissue in the lungs. In a case reported by physicians in Brazil, a 22-year-old man attempted suicide by ingesting 50 mL of a paraquat solution. At a first facility, the young man—who had a previous suicide attempt—was treated with gastric lavage and activated

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Figure 3. Sharp-force self-inflicted injury in a depressed 55-year-old woman who initially claimed she had been stabbed during a robbery. This CT image shows a superficial wound (arrow) to the abdomen that is more consistent with self-inflicted, tentative wounding. Excellent bowel enhancement was obtained with both oral and rectal contrast material, a process recommended for imaging evaluation of stabbing victims to evaluate possible bowel injury. A psychiatrist later confirmed the patient attempted suicide after failing to pay her rent. Reprinted with permission from DiPoe J, Guelfguat M, DiPoe J. Radiologic findings in cases of attempted suicide and other self-injurious behavior. Radiographics. 2012;32(7):2005-2024. doi:10.1148/rg.327125035.

Figure 4. Fluid-weighted magnetic resonance image depicting the knife trajectory (arrow) in a 31-year-old man who wounded himself in the right side of the neck with a kitchen knife. High-signal intensity reveals the trajectory of the knife extends from the base of his right neck to the top of his right lung. The man suffered nerve damage leading to right upper extremity weakness. Reprinted with permission from DiPoe J, Guelfguat M, DiPoe J. Radiologic findings in cases of attempted suicide and other self-injurious behavior. Radiographics. 2012;32(7):2005-2024. doi:10.1148/rg.327125035.
charcoal. Four days later, he was seen in the emergency department of another facility; a chest radiograph was normal. Over the course of his stay, subsequent radiographs and chest CT scans showed development of pulmonary fibrosis, with radiological findings including diffuse ground-glass opacities (see Figure 5). The young man recovered from the moderately severe poisoning, an outcome the case report authors characterized as rare.

**Triggers and Causes**

Reasons for attempting suicide are many, and certain triggers cross cultural and geographic barriers (see Box 3). Events seen as more innocuous in some societies can be powerful triggers in other cultures. A study of suicide in Zimbabwe included the following reasons for attempted and completed suicide:

- Avenging spirits. (According to the study, “There is a family in this village where every year a
member of this family commits suicide. Unless they appease an avenging spirit of a stranger murdered by their forefathers a long time ago, this will continue to happen.”

- Impregnating a girl or becoming pregnant.
- Husband taking another wife. (“Some men unilaterally decide to marry second wives without consulting their first wives. The first wives may not accept this and decide to take their own lives.”)
- Mother’s refusal to name her son’s father.
- Family disputes over inherited property and other land disputes.
- Husband squandering harvest proceeds.

Given the worldwide phenomenon of suicide, one question stands out: Why do some people commit suicide while others resist? Experts think that a genetic predisposition to suicide combines with certain environmental stressors to result in hopelessness, pessimism, mental disorders, and ultimately suicidal behavior.17

**Genetic Influences**

Twin studies have shown that major depression, childhood physical abuse, social phobia (an anxiety disorder), African American ethnicity, alcohol dependence, and conduct disorder all are strong predictors of suicide attempts.22 Depressive disorder, for example, carries with it a lifetime risk of dying by suicide of 2% to 12%.46 Still, although mental disorders are present in approximately 90% of those who attempt suicide, mental disorders do not sufficiently explain the phenomenon.22 Indeed, most people who suffer from a mental disorder do not attempt or die by suicide.22

Current research indicates that the genetic contribution to suicide risk is between 30% and 50%.22 Family studies that looked at suicide patterns among the Old Order Amish spanning a 100-year period found that the majority of suicides came from only 4 families, a finding that supports the theory that there is a genetic component to suicide. The Amish study also found that a family history of suicide created a 2-fold increase in the risk for suicide.22 Other studies examining parent-child transmission of suicide risk have shown as much as a 6-fold increase in suicide risk for the children of suicide attempters.22 Another family-transmitted trait, a personality tending toward impulsive aggression, predicted not only familial transmission of suicide but also an earlier age for the first suicide attempt.22

One of the genes associated with suicide risk is the transporter gene that maintains control over the availability of serotonin, a neurotransmitter associated with feelings of happiness and well-being.17 Low brain levels of serotonin are linked to suicide.23 Other genes that have been linked to suicidal tendencies control synthesis and uptake of serotonin and so are responsible for the amount of serotonin in circulation.22 Diminished activity in the serotonin system might influence depression, aggression, impulsivity, and the degree of lethality of suicide attempts.17,22,14,18 Evidence for this link comes from postmortem brain studies and, with increasing frequency, brain imaging studies.18

Functional imaging techniques such as positron emission tomography, single-photon emission...
computed tomography, and functional magnetic resonance imaging contribute in major ways to the study of neurotransmitters and their effect on suicidal behavior. Researchers’ ability to visualize in vivo brain function not only permits a better understanding of the serotonergic system's role in suicide but also the effectiveness of pharmacological inventions, particularly drugs designed to normalize serotonin function.

Some observed brain alterations appear to be characteristic of suicidal behavior. Advances in magnetic resonance neuroimaging provide researchers with tools that permit them to discern alterations in gray and white matter, including observation on a microstructural level. Two Chinese studies used magnetic resonance DTI to examine differences in the integrity of white matter in the brains of people with major depressive disorder. One group had a history of suicide attempts and the other did not. White brain matter includes nerve fiber tracts and supports the network of connections between gray matter information processing centers. DTI quantifies water diffusion within the brain and can indicate the degree to which diffusion is directionally hindered. In other words, DTI detects the integrity of the brain’s communication system.

Results of the Chinese studies revealed white matter abnormalities and lowered connectivity between key areas of the brain between the 2 groups of major depressive disorder patients. The microstructure abnormalities observed in DTI images likely reflected damage that could trigger malfunctions in areas of the brain’s circuitry responsible for emotional regulation. Furthermore, affected areas could explain disturbances in decision making and problem solving commonly seen in suicidal people. Study authors suggested that the lesions and disrupted connections in brain regions responsible for regulating affect and behaviors might create a biological vulnerability that, when combined with environmental stressors, leads to suicidal behaviors. Study authors theorized that people with these impairments would be less able to plan in response to stressful circumstances.

However, these experts cautioned that their studies cannot answer the chicken or the egg question: Do these brain alterations cause a predisposition toward suicidal behavior, or are they the result of suicidal behaviors? This promising branch of research not only illuminates microstructural brain abnormalities in individuals with a history of suicide attempts but also could be a means of early identification of people at high risk of suicide.

**Alcohol’s Influence**

Alcohol abuse, with its well-established heritability, is a powerful environmental trigger. Suicide rates are substantially elevated among alcoholics, and those who consume large amounts of alcohol have a 5 times greater risk of suicide than social drinkers. Approximately 40% of patients who seek help for alcohol dependence report at least one suicide attempt. Because alcohol lowers inhibitions, heavy use of alcohol might create fertile ground for impulsive suicide attempts and completions. It also engenders poor judgment and planning and impaired attention, and increased use might result in social isolation. Cognitive impairments resulting from alcohol consumption reduce a person’s ability to see potential solutions, a form of “alcohol myopia.” Postmortem analyses have shown alcohol in the blood of a significant percentage of suicide victims in Europe and the United States; in the latter, the percentage was 28% to 29%.

The social fallout typically connected to heavy alcohol consumption is particularly devastating for those inclined toward suicide. People with drug-use disorders, including alcohol abuse, behave in ways that often destroy family life and in particular marital relationships. These individuals destroy their support network, and their suicidal threats are generally not taken seriously by their partners, even when there is a history of previous suicide attempts. In a study that pitted 2 competing hypotheses against each other, researchers asked, does alcohol use disrupt and end marriage, or is alcohol abuse secondary to marital dysfunction and thus a stabilizing factor that prevents divorce? The results were conclusive: Alcohol use does not permit partners to tolerate each other and stay together. Rather, alcohol use is “maladaptive, associated with dissatisfaction, negative marital interaction patterns and higher levels of marital violence.”

Further bolstering theories about the effect of serotonin levels on suicidal behavior is the finding that serotonin function is reduced in alcohol-dependent patients. Imaging results provide evidence for these observed
differences in the brains of those who are alcohol addicted. Autoradiography, which uses radioactive materials to observe cell structures, has been used in experiments in postmortem brain tissue to reveal deficiencies in the serotonin system of people with alcoholism who have completed suicide. In addition, structural neuroimaging studies in alcoholics have detected subtle abnormalities, particularly in white matter. Together, these various imaging findings suggest a neurobiological link between alcohol abuse and suicidal behavior.7

Prior to death, the abuse of alcohol exacerbates tension and conflicts in close relationships, but its effect on personal relationships survives the suicide act. Affective responses of partners and children who are left behind can be complicated, and they might exhibit complex grief and mourning responses. Widowed spouses might feel abandoned and angry; parents of individuals who commit suicide might be immersed not only in their sorrow but also in feelings of powerlessness and guilt.7

**The Family’s Role**

To study how home environments might affect human behavior, researchers often look both at twins (raised separately and apart) and at adoptees and their biological and adoptive parents and siblings. These approaches permit insight into what behaviors might be attributed to genetics vs environment. For example, the Swedish Multi-Generation Register has been used to identify adoptees and to track their risk of suicide. A strong genetic influence was demonstrated by a 2-fold increase in risk of suicide for adoptees whose biological parent died by suicide. Results of a study comparing environment to genetic inheritance through the use of a Danish adoption registry also showed clear evidence of genetic transmission of suicide risk but no evidence of adoptive family environmental influence. However, other experts report that evidence instead points to environmental factors as having a stronger influence on suicidal behavior than do genetic factors.29

What happens to suicidal tendencies if the home environment includes physical or sexual child abuse? Some experts associate attempted suicide with a history of early physical and sexual abuse and report an earlier age of onset of suicidal behavior in people who have suffered abuse in childhood.28 A Canadian study compared

...
authors that health care providers be alerted to the need for screening for the presence and accumulation of traumatic exposures as a risk factor for suicide.\textsuperscript{29}

What might explain study results that fail to support a connection between trauma, childhood abuse, and suicide? Could it be that the true variable is whether brain development was affected, whether brain injury occurred? That theory has been posited by some psychiatrists.\textsuperscript{28} In a study of criminal offenders living in the community, researchers found associations between suicidal behavior and childhood trauma, traumatic brain injury, and depression. Current research indicates that child abuse resulting in altered serotonergic activity might explain a connection between childhood abuse and aggression toward the self. Similarly, brain injuries in veterans have been associated with impulsivity and suicidal behavior, and so such injuries might create a neurobiological vulnerability to suicide risk.\textsuperscript{28}

**Society, the Media, and the Internet**

A 16-year-old girl hanged herself on September 10, 2012, in a bathroom at her mother’s home, 8 days after she attended a party in Saratoga, California, with other students. At the party, she drank an alcohol-laced fruit drink and fell asleep; when she awoke, her shorts had been removed and mocking words were written on her body. Over the next several days, she learned that cell-phone pictures had been taken of her while at least 3 boys digitally penetrated her. The photos were being shared through text messages.\textsuperscript{52}

*Cybersuicide* refers to suicidal behavior influenced by the Internet.\textsuperscript{7} Although the California incident involved a different form of technology, the Internet has been implicated in suicides, and some experts are concerned that predisposed individuals, particularly adolescents, will be encouraged to commit suicide because of a technology that facilitates widespread public humiliation (cyberbullying) and Web sites that provide detailed information about effective suicide methods.\textsuperscript{7} Yet, how much of a real problem is the Internet? What evidence exists to guide society’s efforts to reduce suicide and yet maintain First Amendment rights online?

For some time, the media have been criticized for contributing to suicide by glamorizing, publicizing, and aggrandizing suicide.\textsuperscript{14} The dynamic has come to be known as *copycat* or *contagion suicide*.\textsuperscript{14,53} The existence of contagion suicide is supported by what some experts characterize as “strong evidence,” but the connection between the Internet and contagion suicide is not clear.\textsuperscript{14} In part, this is because the field of study is new, technology is changing at such a rapid rate, and what studies exist are quickly outdated.

A recently published study that purports to be “the first systematic review of empirical evidence on potential influences of the Internet on adolescents at risk of self-harm or suicide” reviewed published studies from Western countries and Asia.\textsuperscript{14} The authors reported that the Internet exerts both positive and negative influences. For example, it can normalize self-harm and provide access to suicide content, and it can create a forum for bullying and harassment. At the same time, the Internet can provide a support network, helping those who are socially isolated to form connections.\textsuperscript{14} These mixed results underscore the complexity of the suicide phenomenon and cultural influences on suicidal behavior.

Copycat suicides are thought to be caused, at least in part, by exposure to another person’s suicide. In other words, suicidal behavior is imitated.\textsuperscript{54,55} Estimates are that in the United States, approximately 2% to 15% of suicides of adolescents between 15 and 19 years of age are copycat suicides.\textsuperscript{54} Mass clusters, or copycat suicides reflecting a temporary increase in the total frequency of suicides within an entire population, are usually associated with widely publicized celebrity suicides. Observed increases in suicides are proportional to the amount of media coverage, and evidence indicates that people are more likely to imitate celebrities who share their sex and nationality.\textsuperscript{54}

Satellite television and the Internet increase the range of coverage and viewers’ exposure to these types of stories, and celebrities, including pop singers, are increasingly touted as important cultural symbols of success. Intellectuals, on the other hand, are not so promoted, and their suicides do not elicit copycat behaviors.\textsuperscript{54} This form of imitative suicide is believed to be the result of social learning dynamics, including prestige bias, in which a person copies the behavior of prestigious or high-status models, and similarity bias,
in which individuals copy the behavior of models who are similar to them in language or dress.\textsuperscript{44} This kind of learning is believed to be an evolutionary adaptation—a way in which humans acquire information without the need to engage in costly trial-and-error learning. In other words, prestigious people have gained advantages and become successful because their behavior has proven adaptive; copying that adaptive behavior can only lead to similar success.

Sensationalized reporting about suicide epidemics or selectively edited expert opinion and statistics indisputably add to society’s suicide burden.\textsuperscript{53} To combat this trend, the Suicide Prevention Resource Center issued guidelines for reporters on “safe” reporting of suicide.\textsuperscript{56} The organization suggested using certain descriptive language and discouraged other language. For example, “died by suicide” is preferable to “successful suicide.” Media representatives also are encouraged to include referral numbers of crisis intervention services, avoid giving prominent placement to stories about suicide, and avoid describing or showing pictures of the suicide.\textsuperscript{56}

Addressing Suicide

Predicting suicide is difficult, and the complexity of the phenomenon as well as the individuality of suicide victims often result in high rates of false positives.\textsuperscript{37} Nevertheless, as knowledge grows, experts refine recommended approaches to identifying vulnerable individuals. In addition to widely accepted warning signs (see Box 4), risk assessments look at\textsuperscript{12,57}:

- Parental influences, including mental disorders and parent histories of attempted and completed suicides.
- Childhood adversities, including losses (parental death, divorce, and other major losses), family dysfunction (parental criminal behavior, physical and sexual abuse, family violence, and economic adversity), and serious physical illness.
- Past suicidal behaviors, including a history of suicidal ideation, plans, and attempts.
- Presence of a mental disorder.
- Presence of a serious medical condition, pain, or both.

Box 4

**Warning Signs for Suicide\textsuperscript{57}**

Approximately 50% to 75% of people who attempt suicide tell others beforehand of their intentions, making it important to know what clues to be alert to, including:

- Talking about wanting to die or expressing a wish for death.
- Hoarding medicine or buying a gun—looking for a means by which to die.
- Hopelessness, the lack of a reason to live.
- Talking about a specific plan for suicide.
- Expressing feelings of feeling trapped, desperate, needing to escape from an intolerable situation, and seeing no solutions.
- Feeling burdensome to others.
- Humiliation.
- Anxiety, panic attacks, or both.
- Losing the ability to experience pleasure.
- Insomnia.
- Social isolation, withdrawal from others.
- Irritability and agitation.
- Rage or wanting to seek revenge for being victimized or rejected.

In the presence of someone who is making specific plans for suicide, experts recommend:

- Do not leave the person alone.
- Remove firearms, drugs, and sharp objects.
- Take the person to a mental health clinic or emergency department.
- Call 911 or the National Suicide Prevention Lifeline at 1-800-273-TALK (8255).
- Refer to the Centers for Disease Control and Prevention’s Suicide Prevention Web site, https://www.cdc.gov/violenceprevention/suicide.
• Substance disorders, including alcohol and other drugs.

Conclusion

For people whose genetic inheritance, family experiences, and life traumas combine to create a rich soil for suicidal expression, the battle against suicide can be a lifelong challenge. Mariel Hemingway’s legacy is an especially dark one: her grandfather, author Ernest Hemingway, famously drank heavily, suffered from depression, and committed suicide at 61 years of age. Her older sister, Margaux, struggled with drug addiction, bulimia, and alcohol-induced epilepsy; at age 41, the day before the anniversary of her grandfather’s suicide, she purposefully overdosed on phenobarbital. Mariel Hemingway’s oldest sister is bipolar and schizophrenic. Ernest Hemingway’s father, uncle, and aunt also killed themselves. Mariel’s maternal great-grandfather killed himself. So prevalent is suicide in the family (along with creative talent), that the term Hemingway curse has been used to describe the family’s combination of mental illness, addiction, and suicide.

Mariel Hemingway has adopted numerous strategies to combat the family curse, such as a healthy lifestyle, including exercise. A 2013 documentary film Running From Crazy explores her family history, her attempts to “outrun the crazy” of her genetic inheritance, and her efforts to break the curse for the next Hemingway generation, her daughters.

Hemingway’s legacy is particularly daunting, but many people fight similar histories. Although imaging will continue to provide more clues to this puzzling, distressing phenomenon, it has limitations. Imaging can be costly, and testing is unsuitable under some circumstances, such as emergencies or with noncooperative, emotionally distressed patients. No single discipline provides all of the answers, but what we do know is that genetic and family experiences, mental disorders such as depression, and life events create a vulnerability to suicide. Whether a desire for death is carried out might depend on whether a person perceives himself or herself as burdensome, a failure at belonging, hopeless, and socially isolated. Certainly, society can act to remedy such circumstances.
Examining Suicide: Imaging’s Contributions


Examinaing Suicide: Imaging’s Contributions

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Read the preceding Directed Reading and choose the answer that is most correct based on the article.

1. Statistics indicate that in the United States, a veteran dies by suicide every ______ minutes.
   a. 15
   b. 30
   c. 45
   d. 65

2. Worldwide, for girls aged ______ years, suicide is the most common cause of death.
   a. 5 to 9
   b. 10 to 12
   c. 13 to 14
   d. 15 to 19

3. Rates of suicide have increased for ______ Americans in the past 10 years.
   a. preteen
   b. teenage
   c. middle-aged
   d. elderly

4. In the United States, men are ______ times more likely to die by suicide than are women.
   a. 2
   b. 3
   c. 4
   d. 5

5. Prior to the advent of ______, scientists who studied suicide were confined to postmortem examination of brains and coroners’ records.
   a. sensitive imaging technologies
   b. microscopes
   c. histology techniques
   d. cryogenic technology

6. In the United States, ______ women kill themselves at higher rates than do ______ women.
   a. childless and divorced; widowed
   b. widowed and divorced; married
   c. childless and married; divorced
   d. childless and divorced; married

continued on next page
7. A ______ is an agreement between 2 or more people to die by suicide together, at a specific place and time.
   a. suicide pact
   b. mass suicide
   c. murder-suicide
   d. cluster suicide

8. Of all possible warning signs, ______ is the single best predictor of subsequent suicide.
   a. traumatic brain injury
   b. child abuse
   c. depression
   d. prior attempted suicide

9. In the past 2 decades, rates of suicide in children aged 10 to 14 years have:
   a. halved.
   b. doubled.
   c. tripled.
   d. quadrupled.

10. Suicide rates peak in:
    b. April.
    c. October.
    d. December.

11. Most suicides happen on the weekends.
   a. true
   b. false

12. Military victims of violent assault or rape are ______ times more likely to attempt suicide than nonmilitary victims.
   a. 2
   b. 4
   c. 6
   d. 8

13. ______ studies of veterans who have been exposed to blasts reveal traumatic injury to brain nerve cells.
    a. Diffusion tensor imaging (DTI)
    b. Computed tomography (CT)
    c. Positron emission tomography (PET)
    d. Functional magnetic resonance imaging

14. In prison populations, ______ is the most significant diagnosis connected to suicide.
    a. traumatic brain injury
    b. major depressive disorder
    c. bipolar disorder
    d. posttraumatic stress disorder

15. The highest suicide rate is among:
    a. boys aged 13 to 14 years.
    b. boys aged 15 to 19 years.
    c. middle-aged adults.
    d. men aged 75 or older.

16. When used in suicide, guns have a fatality rate of greater than ______ %.
    a. 25
    b. 50
    c. 75
    d. 95

17. Radiographic imaging can distinguish between:
    1. jumpers and those who have been pushed or fallen accidentally.
    2. accidental and purposeful stabbing injuries.
    3. voluntary and coerced suicides.
    a. 1 and 2
    b. 1 and 3
    c. 2 and 3
    d. 1, 2, and 3
18. Suicidal stabbing usually involves the:
   a. lips, eyes, and nipples.
   b. genitalia and abdomen.
   c. neck, abdomen, and left side of the chest.
   d. eyes, neck, and chest.

19. According to the article, which imaging modality provided characteristic findings in the diagnosis, evaluation, and treatment of a man who attempted suicide with a captive bolt gun?
   a. PET
   b. radiography
   c. CT
   d. magnetic resonance

20. Overdose and poisoning can result in:
   1. disruption of the serotonergic system.
   2. necrosis.
   3. ischemia.
   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3

21. Low brain levels of _______ are linked to suicide.
   a. serotonin
   b. cortisol
   c. testosterone
   d. adrenaline

22. DTI can detect differences in the integrity of _______ in the brains of people with major depressive disorder.
   a. gray matter volume
   b. white matter
   c. the cerebral cortex
   d. the hypothalamus

23. _______ uses radioactive materials to observe cell structures.
   a. Radiography
   b. Autoradiography
   c. Electroencephalography
   d. Electrocardiography

24. Studies of prisoners have shown a clear connection between near-lethal suicide attempts and all of the following except:
   a. length of incarceration and lack of conjugal visits.
   b. physical abuse and neglect.
   c. bullying, homelessness, and a history of foster care.
   d. experiencing the death of a parent or sibling.

25. Warning signs for suicide include:
   1. talking about wanting to die.
   2. insomnia.
   3. social isolation and withdrawal from others.
   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3