

# The timing of deliberate self harm behaviour

Paul Blenkiron

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## Abstract

**Objectives:** To critically review the scientific literature relating to the timing of deliberate self harm behaviour and completed suicide.

**Method:** A literature search of the Medline and CINAHL databases from 1970-2002 was performed, using deliberate self harm, overdose, self poisoning, suicide, parasuicide, and time, timing, day, week, month and season as key words. Relevant secondary references were retrieved and hand searching of important journals was done.

**Results:** The time of day of non-fatal self harm shows a marked diurnal variation, with an evening peak that is related to non-violent episodes, concomitant alcohol use, and a younger age. It is not conclusively linked to the degree of suicidal intent or particular psychiatric diagnoses. Completed suicides more commonly occur earlier in the day, at the beginning of the week and during springtime, but show no overall increase during many national events and holidays.

**Conclusions:** Circadian biological mechanisms involving the serotonin-melatonin axis, cortisol secretion and sleep abnormalities appear to be implicated. Psychosocial explanations for these epidemiological findings include alcohol use, a sense of personal isolation and the 'broken promise' effect.

**Key words:** Suicide; Self harm; Timing; Circadian; Seasonal.

## Introduction

An understanding of the timing of acts of deliberate self harm is important from both an epidemiological and a clinical perspective. Clinical risk assessment, the provision of appropriately staffed response services, and effective population based suicide prevention strategies are all influenced by variations in frequency of suicidal behaviour according to the time of day, season, and external events.<sup>1</sup> The time of day when deliberate self harm acts occur in particular remains under-researched and is seldom mentioned in standard psychiatric textbooks. Nevertheless, a popular conception exists amongst mental health professionals that the more seri-

ous suicide attempts tend to occur earlier in the day.<sup>2</sup> Conversely, evening self harm episodes, especially when associated with alcohol use, are often regarded as being of low suicide intent and less likely to be associated with a significant mental disorder such as depression. This review aims to summarise the epidemiological evidence regarding temporal variations in deliberate self harm and completed suicide. Biopsychosocial explanations that may account for the research findings are also presented.

## Method

A literature search of the MEDLINE and CINAHL databases from January 1970 to December 2002 was performed, using the following key words (including combinations): deliberate self harm, overdose, self poisoning, parasuicide or suicide, AND time, timing, day, week, month or season. This was supplemented by looking up relevant secondary references and important original research papers that were recommended by colleagues with a special interest in the field. The *British Medical Journal* and the *British Journal of Psychiatry* from January 1998 to December 2002 were also hand searched.

Articles were included in this review if they were written in English, and investigated the epidemiological evidence for variations in the timing of fatal and non-fatal self harm behaviour, or described possible biological or psychosocial mechanisms to explain the findings. No restriction was made upon sample size or methodology: both prospective and retrospective descriptive studies were included.

## Results

The number of original research papers found was: 12 for circadian variations in self harm and suicide, 10 for seasonal and monthly changes, 16 for external events (including one systematic review), and four investigating combinations of these themes. Thirteen articles and books were retrieved that described biological and psychosocial theories to explain the available epidemiological evidence. *Table 1* summarises the known temporal variations in self harm and suicidal behaviour.

### Timing of deliberate self harm

A large prospective study by Buckley et al<sup>3</sup> in the Hunter Valley of Australia looked at 2,215 cases of deliberate self-poisoning, and noted that over 6% of all admissions occurred in each of the hours between 6pm and 1am, compared with less than 2% an hour between 5am and 9am. Over half of all self-poisoning acts took place in the eight hours between 6pm and 2am. The peak time for overdosing occurred between 8pm and 10pm from Sunday to Thursday, and later

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Paul Blenkiron, MMedsc, MRCPsych, MRCPGP, Consultant in Adult Psychiatry, Bootham Park Hospital, York YO30 7BY, England, and Honorary Senior Lecturer, Academic Department of Psychiatry, University of Leeds, England.

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Table 1: Overview of the variations in timing of self harm and suicide

	Non-fatal deliberate self harm	Completed suicide
Time of day	Evening peak (4pm-midnight)	Daytime peak (6am-4pm)
Day of week	No consistent association	Monday/Tuesday peak Saturday/Sunday trough
Month/season	Men: no consistent association Women: late Spring peak, December/January trough	Men: Spring peak April to July (unimodal) Women: Spring & Autumn peaks (bimodal)
<b>National and religious events</b>		
Christmas and Easter Holidays	Fall on day of event, rise in following week	No consistent association
St Valentine's Day	No association	No consistent association
Ramadan	Fall	No consistent association
Funeral of Princess Diana	No association in 1997	No association
<b>Other</b>		
World Wars I and II	?	Significant fall in West
World Cup Football	No association in 1998	?
Weather	Rise in hot/cloudy conditions for women	?
Menstrual cycle	No association	?
Media portrayals of self harm	Increased after some events eg. fictional TV overdoses	Increased after some events eg. publication of book 'Final Exit'
Restricted access to specific methods	Reduced eg. smaller pack size for paracetamol 1998	Reduced eg. coal gas poisoning in 1960s

(10pm-12am) on a Friday and Saturday. Several investigators have analysed the time pattern of self harm acts using the sophisticated single cosinor method, specifically designed to study biological rhythms.

Manfredini<sup>4</sup> studied 212 overdoses in Italy, and defined a significant circadian rhythm with a mesor (rhythm adjusted mean for the extent of the rhythm) of 8.83 ( $p = 0.007$ ), and an acrophase (peak time of the cosine curve best fitting the data) of 5.45pm (95% confidence interval 2.32pm -10.58 pm).

Other studies have estimated the acrophase (peak) time as 3.48pm for 457 consecutive deliberate self harm episodes during a five year period,<sup>5</sup> between 5pm and 7pm for a retrospective investigation of 451 patients in Milan,<sup>6</sup> and 6.32pm for 630 overdoses including drugs of abuse presenting to a Chicago casualty department.<sup>7</sup> Taken together, these studies provide consistent evidence for a circadian rhythm of non-fatal deliberate self harm, with an incidence maximal in the evening.

### Patient characteristics for timing of self harm

The evening peak incidence of self harm is less evident in those aged over 40,<sup>6</sup> possibly because older patients may be less influenced by exogenous factors.<sup>7</sup>

No overall sex difference has been reported, although women are more likely to present during normal working hours.<sup>8</sup> For those diagnosed as having alcohol or drug dependence, deliberate self harm may be commoner in the afternoon or evening.<sup>2,5</sup>

In one study,<sup>5</sup> those who chose violent methods of self harm (such as hanging, cutting, crashing or jumping from a height) tended to do so earlier in the day (peaking at 2.31 pm). This finding is consistent with a shorter prodromal phase between decision making and execution for violent compared to non-violent attempts.<sup>9</sup>

### Psychiatric diagnosis and time of day of self harm

Caracciolo and colleagues<sup>5</sup> attempted to relate timing of 457 acts of deliberate self harm to standard diagnostic categories using the *Ninth Edition of the International Classification of Diseases (ICD-9)*. Self harm occurred more commonly in the afternoon and evening for those diagnosed with neurotic and personality disorders. Organic disorders were grouped with psychoactive substance use, resulting in a peak occurrence between 6am and 12pm, although this was based on a sample of only 14 subjects. The lack of variation in self harm behaviour over 24 hours for those with psychotic disorders did not reach statistical significance. A late morning peak was found (acrophase 11.31am) for those diagnosed with affective disorders. This contrasts with other research<sup>3</sup> where the pattern of an evening peak incidence for self harm amongst 2,215 subjects did not change when examined for the subgroup given a diagnosis of depression by the liaison psychiatric service. Numerical and statistical details of this subgroup analysis are however absent from the published paper.

In a prospective survey of 158 individuals referred for psychiatric assessment from the general hospital following deliberate self harm, Blenkinsop *et al*<sup>1</sup> investigated whether more serious suicide attempts tend to occur earlier in the day. They found that those who harmed themselves in the morning or early afternoon identified a greater number of practical problems, and were more likely to receive medical admission and psychiatric follow up, despite lower levels of ingested alcohol and tablets.

However, the time of day of self harm showed no significant relation with scores on the Beck Suicide Intent Scale. There was a trend for major depression to be diagnosed more often after early acts, although this only reached statistical significance in the post hoc subgroup analysis. The

absolute numbers of those diagnosed as depressed remained higher following late acts.

### The timing of completed suicide

Summaries of 19th century research and statistics by Morselli<sup>10</sup> and Durkheim<sup>11</sup> concluded that completed suicide was most common during the working day. Modern studies confirming this finding<sup>12,13</sup> have generally been of relatively small size. An attempt by Barraclough<sup>14</sup> to discover the variation in time of day chosen for 100 consecutive suicides was unsuccessful, largely because it proved too difficult to accurately estimate the likely time of the act for half of the sample.

A study of 6,090 suicides on railways in the former Federal Republic of Germany<sup>15</sup> found that most incidents occurred in the evening hours, especially after sunset. However, Williams and Tansella<sup>16</sup> analysed the national mortality statistics of Italy (where time of death is routinely assessed for all suicides) over the 10 year period from 1974-1983. They found a clear diurnal variation amongst 25,987 completed suicides, with death most commonly between 6am and 4pm.

### Variation in self harm by weekday and season

Several studies have found an increased incidence of completed suicide at the beginning of the week (Monday and Tuesday), declining to a trough on a Saturday or Sunday.<sup>15, 17,18</sup> For non-fatal deliberate self harm, no variations in incidence according to the weekday have been reported,<sup>3</sup> although this does not preclude the existence of a difference in reasons for committing the act.

A seasonal variation for completed suicide is well described. There is a rise in the monthly rate by nearly 10% amongst both sexes during April, May and June in the northern hemisphere, and maximal in November for suicides occurring in the southern hemisphere.<sup>19</sup> Some studies have also noted a lesser peak in the autumn amongst women in the Northern hemisphere.<sup>17</sup> An analysis of over 20,000 completed suicides in Finland<sup>20</sup> revealed an autumn peak for non-violent compared to violent cases, including a statistically significant September excess amongst those over 65 years of age.

The seasonal variation in non-fatal deliberate self harm behaviour has been less studied. Barker et al<sup>21</sup> in Oxford, England examined 12,000 cases retrospectively and concluded that for women but not men the greatest number of admissions occurred during May and June, with a trough in December/January. Masterton in Scotland<sup>22</sup> reached identical conclusions in a review of 22,169 deliberate self harm cases presenting over 20 years. A positive association has been found between self harm and the weather, with mean daily admission rates rising during hotter, cloudier, windless conditions, especially for women.<sup>21</sup> One study found the full moon protective against deliberate self harm for Australian women,<sup>3</sup> although the authors believed that a type one statistical error was the likely explanation.

### The influence of external events

It is well documented that completed suicide rates fell dramatically for both sexes during the first and second world wars.<sup>23</sup> Conversely, a trebling in suicides in Japan during the past decade has been attributed to economic factors as part

of a worsening Asian recession.<sup>24</sup> A temporal association exists between reducing access to particular methods of self harm and decreases in the suicide rate. Detoxification of domestic gas in the 1960s saved an estimated 6,700 lives,<sup>25</sup> and UK legislation in 1998 limiting pack sizes of paracetamol and salicylates sold over the counter has led to falls of 21% and 48% respectively in self poisoning episodes using these drugs.<sup>26</sup> However, substitution with other methods of suicide cannot be excluded.<sup>27</sup>

Contrary to popular perceptions, Cullum *et al*<sup>28</sup> found no correlation between the incidence of deliberate self harm and St Valentines Day, and described a negative association with Christmas Day. The WHO/EURO multicentre study of 24,388 deliberate self harm episodes<sup>29</sup> found fewer acts occurred before and on Christmas Day, followed by a 40% rise in incidence over the following seven days (including New Year's Day). Consistent with other research,<sup>22</sup> the study found a transposition of deliberate self harm acts from before and during major public holidays (Christmas, Easter and Whitsun) until immediately afterwards. Other investigators have reported no link with the menstrual cycle.<sup>30</sup> General elections may increase self harm acts in vulnerable individuals,<sup>31</sup> although other national events such as Ramadan are associated with a fall in self harm behaviour.<sup>32</sup>

The well publicised death and funeral of Diana, Princess of Wales in 1998 did not affect the number of self harm cases presenting to casualty in the United Kingdom (UK).<sup>33</sup> Similarly, Carroll *et al*<sup>34</sup> analysed 3,308 UK hospital admissions following deliberate self harm that occurred during the 1998 World Cup. Compared with other days, no excess admission rate was found within two days of a match win or loss by the England football team. However, the portrayal of a paracetamol overdose in the British television drama *Casualty* was associated with a 17% increase in self poisoning presentations to general hospitals in the following week.<sup>35</sup>

Stack<sup>36</sup> found evidence for a copycat effect involving death by asphyxiation which was recommended in the book *Final Exit*. In the 12 months following its publication, suicides in New York City increased by 31%. In 27% cases a copy of the book was found at the scene.

A recent systematic review<sup>29</sup> found solid evidence for influence of the media on self harm behaviour for newspaper, television and film reports concerning actual and fictional suicides. Imitation of media acts of self harm is more strongly associated with female gender, young age, low self esteem, repeated broadcasting and approval of the behaviour by others within the storyline.<sup>27</sup>

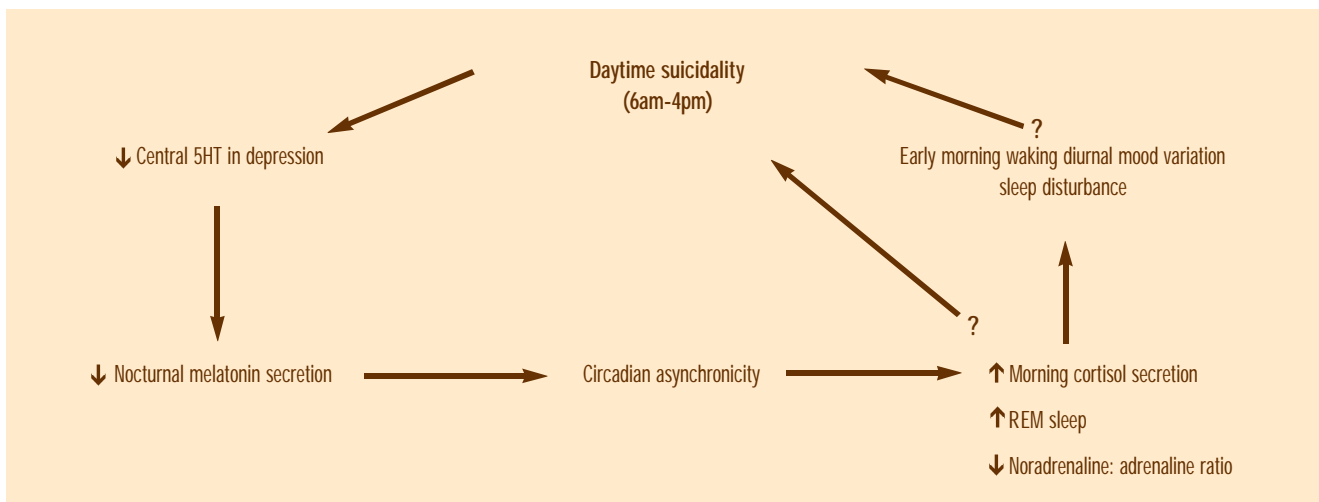
### Explaining the variations in timing of self harm behaviour

It is likely that several predisposing and precipitating factors interact to affect the timing of any individual's decision to take or endanger their life.<sup>21</sup> Current theories and research regarding fatal and non-fatal acts may be examined from biological and psychosocial perspectives.

### Biological explanations

Disturbances in circadian rhythmicity of biological functions that can influence behaviour have been observed in several mental disorders.<sup>39</sup> For example, Manfredini<sup>4</sup> has described

Table 2: Biological hypothesis to explain observed increase in suicides during the day



how body temperature, heart rate and secretion of cortisol, prolactin and melatonin differ in people with affective disorders compared to controls.

A major problem in evaluating the available research lies in differentiating cause and effect between biological parameters and suicidal behaviour. *Table 2* shows one possible mechanism<sup>40</sup> for explaining the observed increase in completed suicides earlier in the day.

### Serotonin, suicidal behaviour, and the pineal gland

Synthesis and release of the indole melatonin (N-acetyl-5-methoxytryptamine) by the pineal gland from its precursor serotonin (5hydroxytryptamine, 5HT) increases during the hours of darkness. Serum concentrations reach a peak between 2am and 4am, then gradually fall away upon re-exposure to light later in the morning. Melatonin is thought to be involved in the regulation of sleep-wake cycles and seasonal sexual behaviour, under hypothalamic control. Post mortem studies of completed suicide in different psychiatric disorders have revealed low levels of pineal melatonin, with corresponding reductions in the concentration of serotonin and its metabolites in the brain and cerebrospinal fluid.<sup>41</sup>

Sandyk and Awerbuch<sup>42</sup> similarly found significantly lower levels of nocturnal melatonin secretion in suicidal versus non-suicidal patients experiencing an exacerbation of their multiple sclerosis. One suggested hypothesis<sup>30</sup> is that a temporary increase in melatonin production at night in those with already low secretory levels further depletes central serotonin reserves, leading to a mood lowering in the morning. This could explain the diurnal variation of mood in severe depression as well as the excess of completed suicides before 4pm.

However, a criticism of this theory is the observation that the results of acute tryptophan depletion studies in depressed patients do not show a significant measurable worsening of depression, implying that the serotonergic system shows little acute variability within a particular individual.<sup>43</sup>

Serotonin function may also be related to seasonal variations in the frequency of self harm episodes: using [3H] imipramine binding as a proxy, Pine *et al*<sup>44</sup> showed that a low

point was reached in the late winter/early spring. However, there are as yet no studies that conclusively demonstrate seasonal variation in brain serotonin function.<sup>20</sup>

### Deliberate self harm and cortisol secretion

Self harm behaviour could be influenced via the hypothalamic-pituitary axis. It is known that the normal secretion of cortisol peaks in the early morning and is lowest in the late evening. Around 50% of patients with major depression show a longer and more pronounced morning cortisol peak. However, attempts to assess the severity of self harm episodes using the dexamethasone suppression test have shown no correlation with suicidal behaviour rating scales, type of attempt, alcoholism or a past history of self harm.<sup>45,46</sup> The authors believe that the general effects of stress and interference from ingested drugs may explain the negative findings. Prasad<sup>47</sup> compared violent and non-violent methods of self harm using neuroendocrine markers: the former had significantly higher 24 hour urinary cortisol levels and a lower 24-hour noradrenaline to adrenaline ratio.

### Suicidal behaviour and sleep abnormalities

Research using polysomnographic recordings of patients with major depression<sup>48</sup> and psychosis<sup>49</sup> has investigated differences between those with and without a history of deliberate self harm. Both depressed and psychotic past self-harming individuals showed an increase in early and total rapid eye movement (REM) sleep time, with a longer overall sleep latency and a decreased sleep efficiency. Because sleep deprivation is known to relieve depressive symptoms within 24 hours,<sup>50</sup> Rotenberg has suggested that REM sleep is functionally deficient in depression, increasing feelings of hopelessness instead of restoring mood.<sup>51</sup> Rockwell *et al*<sup>39</sup> examined the effect of a 12-hour photoperiod shift on 15 healthy male subjects. One subject committed suicide two weeks later: he was shown to differ for several hormonal and electroencephalographic parameters, reflecting a poor baseline circadian synchronicity.

### Psychosocial explanations

#### Excess of completed suicides earlier in the day

In his review of nineteenth century work on the hourly vari-

ation in suicide, Durkeim<sup>11</sup> concluded that "everything proves that if daytime is the part of the 24 hours most favourable to suicide it is because it is also the time when social life is at its height". Similarly, Morselli<sup>10</sup> observed that "the daily distribution of suicides is parallel to activity in business, to occupation and work, in short with the noise that characterises the life of modern society and not with quiet and isolation". Vollen and Watson<sup>13</sup> have suggested that the observed increase in completed suicide occurring on a Monday and Tuesday may result from a postponement of any suicidal decision from a Sunday, because of religious beliefs and greater contact with friends and family.

Another view is that the discrepancy between those contemplating self harm and the rest of the world (apparently engaged in normal pursuits) heightens the sense of personal isolation. A loss of social status and function can further exacerbate the feelings of hopelessness associated with ideas of self harm. Isolation from the rest of society is highlighted in Durkeim's descriptions of anomic and egoistic suicide.

Sainsbury<sup>52</sup> believed that "alienation and loss of social regulation emerge as conditions that predispose to suicide". Other more practical explanations may also be important, such as a decreased likelihood of being discovered during a suicide attempt if others are busy or out of the house at work or school. Patients often report an acute and unbearable state of mind as the main motive for self harm, and that during a suicidal crisis they were not prepared to accept help.<sup>53</sup>

Any variation in the timing of deliberate self harm in those with a depressive illness may be subject to conflicting behavioural factors. Although diurnal variation in mood is well described, it is not always worst in the morning. Greater psychomotor retardation and diminished suicidal volition could explain the lack of a consistent rise in deliberate self harm early in the day in depressed individuals.<sup>3</sup>

#### Peak incidence in deliberate self harm later in the day

In a study of ambulance records in Tokyo from 1978-1985, Motohashi<sup>54</sup> was able to relate the incidence of deliberate self harm acts (maximal around 6pm) to the daily variation in social activities of the individuals concerned. Social interaction with friends or relatives often rises in the evening, and interpersonal problems are the most commonly identified antecedent to self harm behaviour.<sup>55</sup>

Most people who self harm do not wish to die, and any cry for help is most likely to be heard at a time of day when others have returned home yet emergency medical services remain available. The disinhibiting effects of alcohol consumption may be contributing significantly to late evening alcohol-related self harm episodes.<sup>2</sup> However, in most of the studies reviewed above, the number of deliberate self harm cases peaked before 7pm – somewhat earlier than standard drinking hours.

#### Aetiology of seasonal variation in deliberate self harm and suicide

Barker *et al*<sup>1</sup> partly attribute the early summer rise in female acts of deliberate self harm to gender differences in thermoregulation: women sweat less than men, and respond to heat with a higher body temperature. How the seasonal variation in suicidal behaviour fits in with the winter mood

exacerbations of an estimated 4%-10% of the population said to have seasonal affective disorder<sup>55</sup> remains unexplained.

Durkeim<sup>11</sup> suggested that an increased incidence of non-fatal self harm behaviour in the spring could be attributed to new relationship problems at a time when courtship and greater socialisation occurs. The spring peak in suicidal behaviour may be related to an increase in episodes of affective disorder,<sup>21</sup> with a discrepancy noticed by depressed persons viewing their external world bursting into life when their internal world is lifeless.

Recently, Yip *et al*<sup>6</sup> found a greatly diminished seasonal effect for suicide in England and Wales for the period 1982-96 compared with 1960-1981. They suggest that this change may be linked to people in a modern technological society becoming more connected than before (via mobile phones, email and the internet). Gabennesch<sup>57</sup> has attempted to explain the known temporal variations in suicidal behaviour using the 'broken promise' effect. According to this unifying psychosocial theory, mornings, weekends, holidays, and Spring time tend to promote hope and expectation for vulnerable individuals ('things may get better soon'). However, these occasions often promise more than actually occurs, with resulting frustration and disappointment leading to increased numbers of acts of self harm occurring after the event.

#### Conclusions

The limitations of this review should be noted. It is a selective, rather than a systematic literature review: some electronic databases (which may contain additional studies) were not searched. There also remains a considerable gap between the observed variations in self harm behaviour and adequate evidence-based biological and social explanations to account for them. However, the diurnal variation in deliberate self harm behaviour is consistent, with a peak incidence between 4pm and midnight depending on the population studied.

Conversely, completed suicide episodes appear maximal earlier during the daytime: from 6am until 4pm in those studies with adequate sample size. However, evidence that the degree of suicidal intent, or particular psychiatric diagnoses (such as major depression) relate to self harm at a particular time of day is conflicting.

Although deliberate self harm does not follow a predictable day to day variation in frequency, completed suicide appears more common at the beginning of the week. Late spring peaks in incidence have been shown for completed suicide, and for non fatal self harm attempts in women. External events both major (war) and minor (public holidays) are associated with a decrease in the frequency of self harm episodes. It is likely that both biological variables (melatonin and serotonin levels, REM sleep disturbances, circadian asynchronicity) and psychosocial factors (isolation, daily events and alcohol use) are important in explaining the timing of self harm behaviour.

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