

# "Injuries Incompatible with Life" – Safe Signs of Death for Laypersons and Those Who Train Them

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## ABSTRACT

There are many different types of death. At the top of the international statistics for causes of death are ischemic heart disease, tumor diseases and cerebrovascular diseases such as strokes. These diseases are often accompanied by a long medical history and close doctor-patient contact. The situation is different with deaths resulting from accidents. These often happen outside medical facilities. In these situations first aid is essential for the outcome. However, the first people to reach the patient in such situations are usually not medical professionals. For this reason, the correct training of medical laypersons is of particular interest in emergency medicine. Part of this training is also the recognition of life-threatening or fatal injuries. This article deals with such injuries and discusses the certain signs of death. This article is not primarily addressed to emergency physicians and medical professionals, but to laypersons who offer first aid and instructors who offer first aid courses and train and educate these laypersons.

**Keywords:** Death, Emergency Service, First Aid Courses, Forensic Medicine, Injuries Incompatible with Life

## INTRODUCTION

Accidents are one of the most relevant causes of death in Germany. 2,782 people died on the roads in 2022. There were 220 more victims than 2021 (increase of 8.6%). The number of people injured also rose by 11% to around 358,000<sup>1</sup>. Accidents at work are also statistically relevant. In 2022, a total of 787,412 reportable workplace accidents occurred that resulted in incapacity to work for more than three days or death. There were 10,927 serious accidents at work that made it impossible to continue working (due to severe injuries or death)<sup>2</sup>. In these emergency situations, rapid assistance plays a crucial role. It is important to assess the situation correctly. It is important, on the one hand, to determine and assess one's own safety and, on the other, to take necessary first aid measures. However, the results are rather sobering. In the event of a cardiac arrest requiring chest compressions, the survival rate is only 11%. One of the reasons for this is that only 51.2% of cases involve a cardiac massage initiated by laypersons<sup>3</sup>. Education can improve these gaps. This is partly because it also increases the confidence of lay people present in emergency situations, making help more likely<sup>4-7</sup>.

Another important judgement to be made in the event of an accident is when first aid should be administered and when it is too late. Fatal injuries are obviously categorised as injuries that are incompatible with life - i.e. basically fatal injuries such as decapitations, impalements, chest injuries or very severe blood loss. However, the assessment of these injuries is not always easy, especially for laypersons. For example, an impalement injury, i.e. piercing the body with stake-like objects, does not necessarily result in death. In such situations, every second counts<sup>8</sup>. For this reason, it is also important for laypersons to assess the situation. Not only to recognise when first aid is necessary or pointless, but also to avoid being deterred from providing first aid for injuries that appear dangerous (Figure 1).



**Figure 1.** Impaling injury. An impalement injury is an injury caused by the penetration of stake-like objects into the body. On the outside, impalement injuries resemble a stab wound. However, the injuring object can also enter the body through natural orifices. Although impalement injuries can look very severe, they are not a definitive death sentence. Rapid emergency medical measures are therefore necessary to ensure the survival of the casualty. Courtesy of Tannheimer et al.; Klinik für Allgemein-, Viszeral- und Thoraxchirurgie am Bundeswehrkrankenhaus Ulm. See [8].

## INJURIES THAT ARE INCOMPATIBLE WITH LIFE

Injuries that are incompatible with life are injuries that prevent the natural bodily functions required for life from functioning and being maintained.<sup>9</sup> This occurs, for example, when the head is separated from the torso, the entire torso is severed or visible fractures of the upper spine (geniculate fracture, etc.) (Figure 2).

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**Figure 2.** Initially inconspicuous external aspect during the examination of the body of a man who had been found in the inner courtyard of a residential complex requiring resuscitation. On dissection of the black of the body, the extensive muscular haemorrhage on the upper right rear thorax after impact on the back of the body (fall from a 5th-floor window in a suicide attempt) is clearly visible. Main autopsy findings: polytrauma with fracture of the 7<sup>th</sup> cervical vertebra, severe thoracic trauma (scapula fracture on both sides, sternal fracture, serial rib fractures, aortic rupture, haematopneumothorax right > left), rupture of liver and right kidney, hematopneumothorax, pelvic ring comminution. Courtesy of Dr. med. Class T. Buschmann et al.; Institut für Rechtsmedizin, Charité, Berlin, see [9].

However, not all of these injuries are as easily recognisable as a decapitation. For example, minor gunshot wounds (e.g. in the course of a suicide) can lead to death but be overlooked in the initial post-mortem examination<sup>10</sup>. Several reviews of post-mortems in Germany and other countries show that it is not easy to determine the cause of death with certainty, even in professional post-mortems. The existing literature shows that many death certificates are issued with minor, but sometimes also major errors<sup>11</sup>. The number of errors varies, depending on the reference and year of publication, from just under 50% of incorrectly issued certificates up to 97%. This is particularly problematic if legal investigations suffer as a result of these incorrectly issued certificates<sup>12,13</sup>. The reasons for the high number of errors are manifold. However, the most relevant sources of error are, on the one hand, the short time available to the coroners to issue the certificates and, on the other hand, the lack of a standardised regulation for issuing death certificates in Germany<sup>11,14,15</sup>. Keeping these points in mind, it is easy to imagine how difficult it is for laypersons to recognise a hopeless emergency situation. For this reason, injuries that are incompatible with life are only suitable for recognition in emergency situations to a limited extent. It has also been reported that people often behave irrationally in stressful situations. This also applies to emergency situations that require cardiac massage. For example, soldiers were reported to initiate resuscitation measures even though the fallen comrade's head was already missing. Examples such as this are relevant cases in the psychiatry of military medicine<sup>16</sup>. The three certain signs of death - lividity, rigor mortis and putrefaction - are easier to recognise. It therefore makes sense to familiarise laypeople with these, even if the subject is a rather stressful one. Be it for psychological reasons or simply out of disgust.

## LIVIDITY – LIVOR MORTIS

Cadaveric spots or death spots, also known medically as livor mortis, are discolourations of the body that occur post-mortem. They sometimes appear at the time of death, but usually about an hour after death has occurred<sup>17</sup>. Pathophysiologically, lividity is caused by hypostasis, the process that describes the deposition of body fluids in certain areas of the body depending on gravity. Blood accumulates dorsally in the body as a result of prolonged lying, less frequently in other positions. Haemolysis causes the haemoglobin to accumulate in the tissue, resulting in the familiar spots. While the death spots that appear in the first few hours after death can still be pushed away and are reversible, these spots are irreversible and permanent<sup>18</sup>. As death marks occur in the lowest parts of the body, they can also be used to infer the position during and after the dying process. When lying down, the blood collects in the back, in upright positions (for example when hanging) in the feet<sup>19</sup>. They are also relevant for determining the cause of death. Certain types of poisoning cause a discolouration of the spots. In carbon monoxide poisoning, the stains are reddish or red, whereas physiologically normal stains tend to be greyish purple<sup>20</sup>. Cadaver spots should not be confused with the very similar churchyard roses. Although these are very similar to cadaver spots, they still occur in life during agony<sup>21</sup> (Figure 3).



**Figure 3.** Death can generally only be determined by the emergency medical services on the basis of the three certain signs of death: lividity, rigor mortis and putrefaction. Courtesy of Dr. med. Class T. Buschmann et al.; Institut für Rechtsmedizin, Charité, Berlin. See [9].

## RIGOR MORTIS

Rigor mortis, is another sure sign of death. Put simply, rigor mortis is a gradual freezing of the body. The first rigor mortis occurs within 1 to 2 hours of death and affects the eyelids and chewing muscles. Complete rigor mortis occurs after 6 to 8 hours. This then lasts for two days. It then begins to resolve again<sup>22</sup>. Rigidity is caused by the lack of ATP, which is needed to relax the muscle tissue. Satz vielleicht weg streichen finde es ähnlich zu dem staz danach und so vermeiden wir den zorn der biochemie für so eine stark vereinfachte aussage ;). As the muscles can no longer be supplied with ATP after death, the proteins can no longer separate from each other. As a result, the muscles stiffen<sup>23</sup>. The release of rigor mortis that occurs over the next few days is again due to autolysis of the muscle cells<sup>24</sup>. Although rigor mortis is a good indicator of the time of death, certain aspects should be taken into account. For example, both the activities prior to death and the ambient temperature can cause the onset of rigor mortis to deviate significantly from the times stated above<sup>25</sup>. The Nysten rule is an important rule in forensic medicine. According to this rule, rigor mortis begins in the eyes and jaw and spreads via the neck to the upper and finally to the lower extremities. While lividity can be recognised with the eyes,

this is not possible with rigor mortis. Here the movement of the body and the so-called breaking of rigor mortis is necessary. Moving the upper extremities should be associated with a certain resistance and be difficult. After this passive movement, the reappearance of rigor mortis can be observed. It is questionable to what extent checking rigor mortis is suitable for laypersons in emergency situations. After all, potential corpses have to be touched. This can be disgusting, but should also be avoided for reasons of hygiene.

### CADAVERIC PUTREFACTION

Cadaveric putrefaction is another sure sign of death. A living person has barriers in the body that prevent bacteria from spreading. Among other things, this prevents the body from rotting. These barriers no longer function after death. As a result, bacteria can spread throughout the body and lead to so-called cadaveric putrefaction. In detail, this is anaerobic decomposition triggered by bacterial enzymes<sup>19,22</sup>. The first sign of putrefaction is a greenish colouring (due to the bacterial breakdown of haemoglobin) of the lower part of the abdomen. Other subsequent signs include peeling of the skin and a bloating/evaporation of the corpse due to putrefactive gases. An active infestation of maggots and fly eggs also clearly indicates putrefaction<sup>17,26</sup>. Fly eggs and maggots are often found at body orifices and open wounds<sup>27</sup>. In general, these signs can be categorised in different ways: Odour, green rot and gas flatulence. While putrefaction is a sure sign of death, it is less suitable for determining the time of death. The reason for this is the strong dependence on the environment. Temperature and milieu have a direct influence on the catabolic processes that take place in the body<sup>28,29</sup>. Casper's Law should help here. It states that one week in the air is equivalent to two weeks in water or eight weeks in a grave (Figure 4 and Figure 5).



**Figure 4.** Advanced cadaveric putrefaction with extensive maggot infestation. From Dettmeyer, Veit and Verhoff. Rechtsmedizin. 3<sup>rd</sup> Edition. ©Springer. See [17].



**Figure 5.** Cadaveric putrefaction with gas vaporization of the abdomen, so-called perforation of the venous network and burst, previously fluid-filled putrefactive blisters. From Dettmeyer, Veit and Verhoff. Rechtsmedizin. 3<sup>rd</sup> Edition. ©Springer. See [17].

### UNSAFE SIGNS OF DEATH

In addition to the certain signs of death, there are also a number of so-called uncertain signs of death. These are signs that occur at death, but can also occur as a symptom of various diseases<sup>30</sup>. They can indicate a condition requiring resuscitation. The following signs or symptoms are categorised as unsafe signs of death:

- \* Absence of circulatory function
- \* Unconsciousness
- \* Pale or dry skin
- \* Dilated pupils, corneal opacity
- \* Drop in body temperature/low body temperature
- \* Absence of reflexes (e.g. patellar tendon reflex)

As these signs can indicate a condition requiring resuscitation, laypersons should also pay particular attention to them. It is therefore advisable to at least include these signs in the various first aid courses and to communicate them to those undergoing first aid training. This should not only reduce the inhibition to provide first aid, but also improve the success rate by correctly and quickly recognising the situation. In contrast to the safe signs of death, the unsafe signs of death should also cause less disgust, revulsion and psychological stress when they are dealt with in class. This is a problem with safe signs of death as, despite their relevance, they are topics that medical laypersons can only be expected to deal with to a limited extent. A compromise could be to deal with the certain signs of death only in theory and in writing and to do without pictures. However, the visual component, which should not be underestimated and which plays an important role in medicine in particular, would be missing. On the other hand, upstream trigger warnings, which have recently become more popular online and in social media, should be completely avoided, as recent findings have shown that they either have no effect or are even counterproductive<sup>31</sup>.

### CONCLUSION

**In summary, educating laypersons about the definitive signs of death can effectively prepare them for what they may encounter in emergency situations. A fundamental understanding of these signs helps set realistic expectations and underscores the significance of initiating first aid measures.**

**In prehospital emergencies that require bystander intervention, unequivocal signs of death are infrequently observed. Thus, enhancing awareness of this reality may encourage individuals to provide first aid and counteract the damaging assumption that resuscitation efforts would be in vain. By addressing the misconception that "it is already too late," educational initiatives can foster higher rates of bystander intervention and enhance emergency response behaviors.**

**Authorship Contribution:** All authors share equal effort contribution towards (1) substantial contributions to conception and design, acquisition, analysis and interpretation of data; (2) drafting the article and revising it critically for important intellectual content; and (3) final approval of the manuscript version to be published.

**Potential Conflicts of Interest:** None

**Competing Interest:** None

**Acceptance Date:** 20 June 2025

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