DELIVERABLE

DL.3.1.1. THE MAIN WELFARE ASPECTS OF THE DIFFERENT STUNNING METHODS IN RABBITS

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1. Introduction

According to FAO (Food and Agriculture Organization of the United Nations) the number of rabbits and hares slaughtered in 2021 were 572 million in the world and 97.7 million in the European Union (EU). However, there are no data differentiating the total number of rabbits from the total number of hares. In an attempt to report the total number of rabbits slaughtered for human consumption in the EU-27 and per Member State, the EUROSTAT database was consulted. However, there are no official data since 2008. That is because in the production and processing of meat rabbits there is a part that is commercially reared and slaughtered for human consumption in licensed slaughterhouses (66%), and another part where rabbits are reared on backyard farms and sold locally or consumed directly (34%) and therefore quite difficult to monitor (European Commission, 2018).

In order to know the total number of rabbits slaughtered in the EU-27, the number of slaughterhouses and slaughter capacity, the EURCAW-Poultry-SFA sent a survey to the competent authorities of the Member States requesting these data. Twenty of the 27 Member States provided data. Of these 20, fifteen confirmed to have at least one approved rabbit slaughterhouse while five Member States declared to have no rabbit slaughterhouses (i.e., Austria, Finland, Ireland, Netherlands and Romania). According to the data collected, approximately 62 million rabbits were slaughtered in the EU, of which Spain, France and Italy accounted for 88% of the total, while other Member States have a much smaller to almost negligible share (Table 1).

***Table 1**. Number and percentage of rabbits slaughtered in the European Union (EU-27) by Member State and number of total approved rabbit slaughterhouses in 2022. Data extracted from 20 out of 27 European Member States that replied an EURCAW-Poultry-SFA survey in 2023.*

Member State	Slaughtered rabbits, n	Slaughtered rabbits, %	Slaughterhouses, n
Spain	22,263,917	35.9	48
France	21,359,309	34.4	111
Italy	11,364,000	18.3	42
Belgium	2,471,022	4.0	2
Portugal	2,200,000	3.5	1
Poland	1,441,538	2.3	3
Czech Republic	700,000	1.1	1
Latvia	114,861	0.19	11
Malta	57,000	0.09	2
Cyprus	39,446	0.06	3
Lithuania	23,134	0.04	2
Slovenia	4,146	0.01	2
Bulgaria	1,712	0.003	2
Denmark	976	0.002	1
Sweden	500	0.001	3
Austria	0	0	0
Finland	0	0	0
Ireland	0	0	0
The Netherlands	0	0	0
Romania	0	0	0

As for the count of the number of slaughterhouses, out of a total of 233 declared list of slaughterhouses that the EURCAW could gather from the survey, almost half are in France (46%). In addition, although France slaughters a similar number of rabbits as Spain, comparatively, it has 2.3 times more slaughterhouses. On the other hand, Spain slaughters twice as many rabbits as Italy, yet Italy has a similar number of slaughterhouses (Table 1 and Figure 1). Therefore, it seems that France and Italy have a higher number of small-scale slaughterhouses compared to Spain. Although in Spain, France and Italy the vast majority of slaughterhouses have a small slaughter capacity, it is worth noting that these three countries also have the slaughterhouses with the highest slaughter capacity in Europe, some even slaughtering over two million rabbits per year. Other Member States such as Portugal, Belgium, Czech Republic and Poland, although being some of the most processers of rabbits, they have a lower number of slaughterhouses, but they are large-scale (Figure 1).

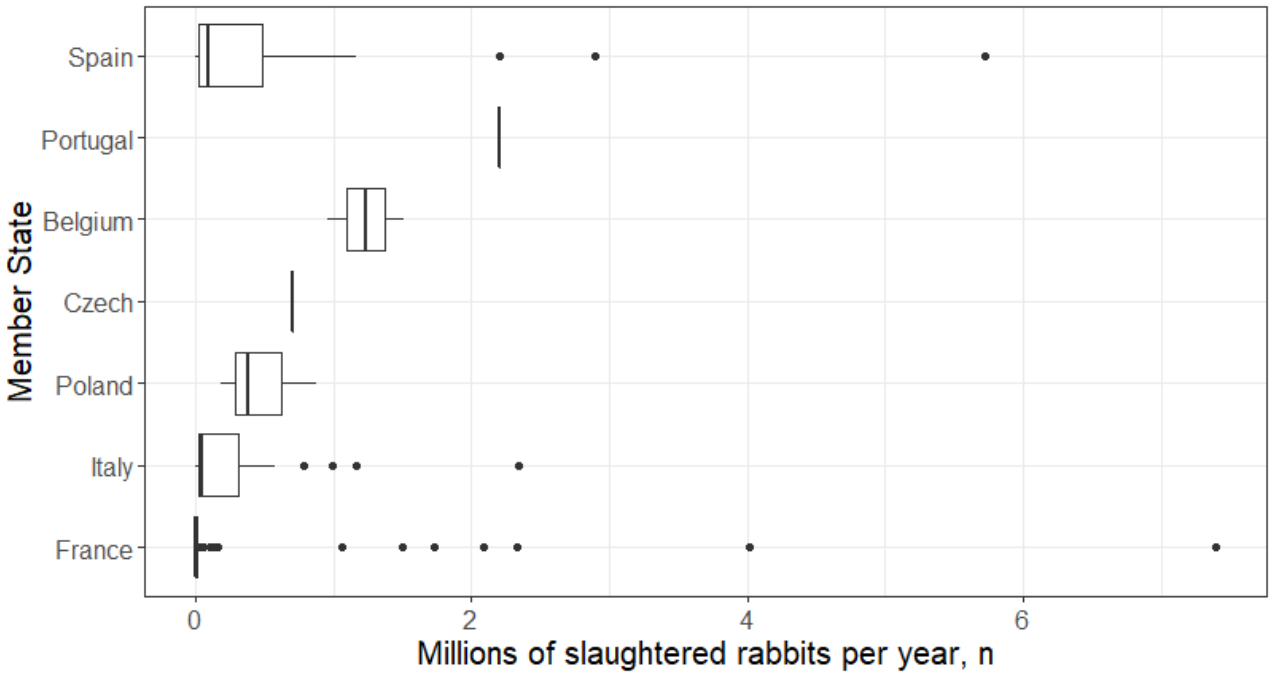


***Figure 1**. Number of slaughtered rabbits per slaughterhouse according to the top seven European Union Member States that slaughter most rabbits. Data extracted from 20 out of 27 European Member States that replied a EURCAW-Poultry-SFA survey in 2023.*

In the EU, the welfare of rabbits at slaughter is under Regulation (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of killing (European Union, 2009). This Regulation describes five methods that can be used for stunning rabbit at slaughter. These are: penetrative captive bolt, non-penetrative captive bolt, percussive blow to the head, head-only electrical stunning and head-to-body electrical stunning. It also states that an effective stunning method must induce unconsciousness without avoidable pain, distress or suffering. This is the case when the stunning method induces an immediate state of unconsciousness that is maintained until death by bleeding. In addition, it is stated that regular checks must be carried out to ensure proper stunning. In case the results of these checks indicate that an animal has not been properly stunned or that the animal regains consciousness after stunning, operators must immediately take appropriate corrective measures in accordance with standard operating procedures.

The present review is aimed at identifying the current stunning methods applied in commercial rabbit slaughterhouses in the EU, describe the method and the ABIs used to assess the state of consciousness and death in practice as well as, the associated risks for rabbits' welfare and how to prevent or minimise them. In addition, this review aims to identify existing gaps of knowledge that EURCAW-Poultry-SFA can address in the future.

2. Stunning methods

Approximately 93% of the 233 slaughterhouses use head-only electrical and 7% captive bolt stunning methods (Figure 2A). Among the slaughterhouses using captive bolt stunning, half of them use the penetrative captive bolt method and the other half use the non-penetrative captive bolt method. When it comes to the number of slaughtered rabbits, approximately the 99.99% of rabbits are stunned with head-only electrical stunning and 0.01% with captive bolt (Figure 2B). The slaughterhouses equipped with captive bolt as primary method to stun rabbits are always small-scale (<23,000 slaughtered rabbits /year) and are allocated in Lithuania, Slovenia, Latvia and Bulgaria.

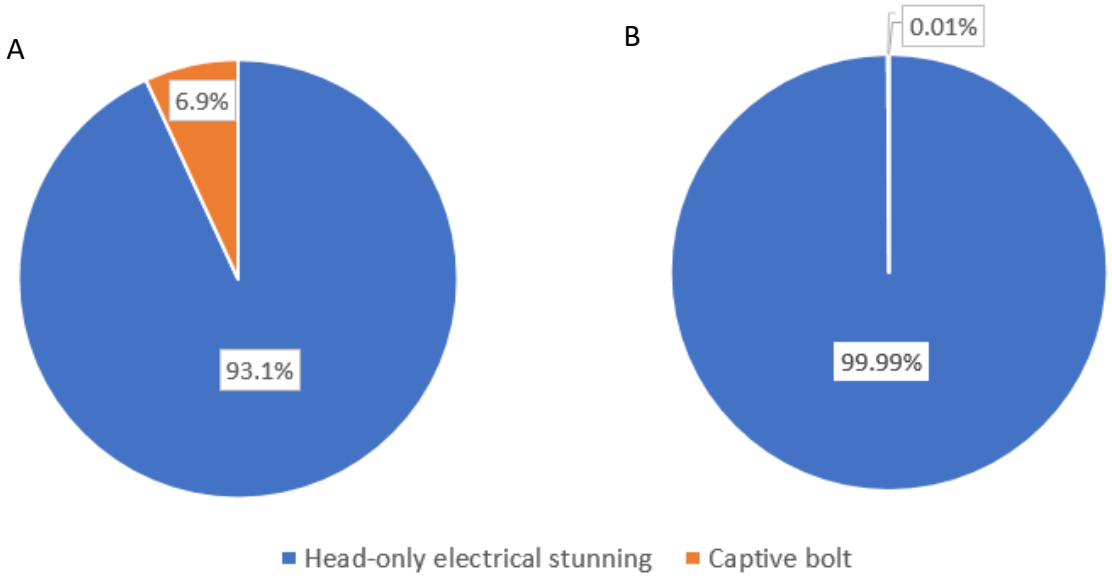


***Figure 2**. Percentage of the stunning methods used for rabbits in 2022 in the European Union in terms of A) number of slaughterhouses and B) number of slaughtered rabbits. Data extracted from 20 out of 27 European Member States that replied a EURCAW-Poultry-SFA survey in 2023.*

Since there is only evidence that head-only electrical and captive bolt are the current used stunning methods in the EU-27, the present review will focus on these two methods in the following sections.

2.1 Head-only electrical stunning

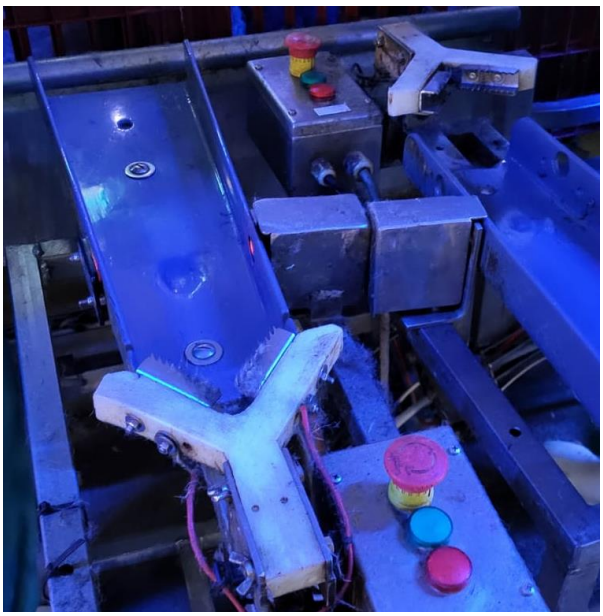
Head-only electrical stunning involves the application through the brain of an electrical current of sufficient magnitude to induce a generalised epileptiform seizure that renders rabbits temporarily unconscious (Anil et al., 1998; Terlouw et al., 2016a). The stunning device can differ in whether it is fixed or mobile (Figure 3). When fixed, the handling consists of grabbing an individual rabbit and guiding its head towards V-shaped stunning tongs. In contrast, in the case of mobile devices, the operator must direct the V-shaped stunning tongs towards the head of the rabbit. There is a variant of the fixed device that also has a channel-shaped support that facilitates the guidance of the animal's head towards the electrodes (Figure 3C).

Correct position of the rabbit's head implies firm contact against the electrodes so that there is contact between the outer corner of the eyes and the base of the ears, without touching the eyes so as not to cause eye burns and away from the nose to span the brain (European Commission, 2017).

A)

B)

C)



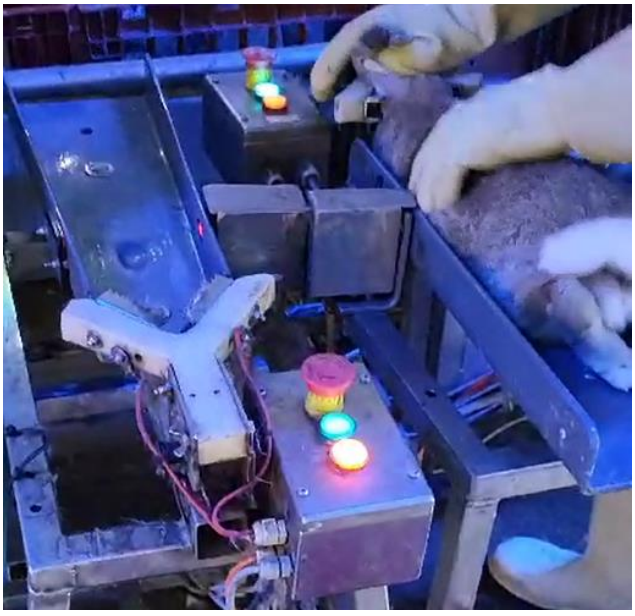


Figure 3. *Head-only stunning devices being A) fixed, B) mobile and C) fixed with channel-shaped support. Source: IRTA©.*

2.1.1 Key parameters

Regulation (EC) No 1099/2009 laid down minimum currents (A or mA) for head-only electrical stunning in bovine, ovine, caprine, pigs, chickens, and turkeys. Nevertheless, it is stated that minimum voltage, maximum frequency, minimum time of exposure and maximum stun-to-stick intervals are also some of the key parameters. However, there is no specific legal requirements on rabbits, only key parameters used by EU countries (European Commission, 2017). These key parameters are based on national guides and therefore, there is a variation in the values (Table 2). The minimum current is provided by a range between 140-400 mA per rabbit. However, the higher the current, the higher the probability of inducing an effective state of unconsciousness and therefore 400 mA should be applied instead of 140 mA. On the other hand,

although there is no a maximum frequency (Hz), EFSA (2020) reported the use of 50 Hz based on what is the most common frequency found to be applied under commercial conditions and because the lower the frequency, the greater the likelyhood of inducing an effective state of unconsciousness (Hindle et al. 2010). Although there are no especifications on the maximum stun-to-stick interval, it is known that the shorter, the better. This is because head-only electrical stunning is a reversible stunning method, therefore, the longer the stun-to-stick interval , the greater the risk of regaining consciousness before, during or after bleeding, thus representing a serious risk to the welfare of the animal.

Table 2. *Reported key parameters reported for head-only electrical stunning of rabbits. Source: European Commission (2017) and EFSA (2020).*

Minimum current, mA	Frequency, Hz	Voltage, V	Minimum time of exposure, s	Maximum stun-to-stick interval, s
140 – 400*	50	100-117*	0.5 – 3*	5 - 20*

* Thresholds found in different national guidelines and compiled in European Commission (2017).

Information from a total of 23 slaughterhouses located in seven Member States revealed that nine of them (39%) do not meet the parameters described in table 2. Among them, two of them used a lower current (<140 mA), three a higher frequency (> 50 Hz), three a lower voltage (< 100 V), two long stun-to-stick interval (> 20 s), one a combination of high frequency and low voltage and the last one both high frequency and long stun-to-stick interval. A general overview of the key electrical parameters (current, frequency and voltage) used in practice expressed as histograms of frequency are shown in Figure 4 while the minimum time of exposure and maximum stun-to-stick interval are shown in Figure 5. In terms of the electrical current type, 64% of the slaughterhouses use AC and 36% DC.

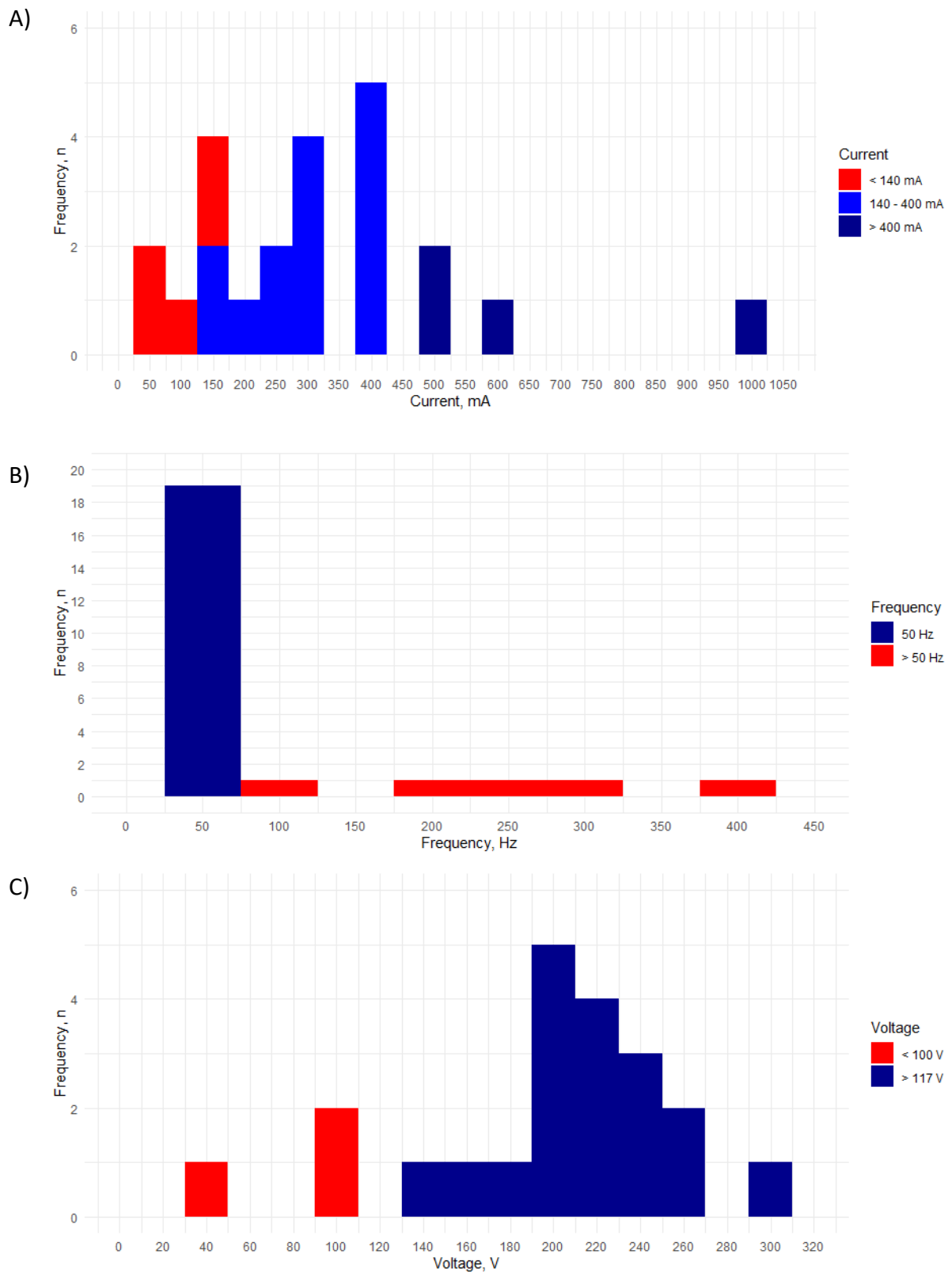


Figure 4. *Distribution (in number of slaughterhouses) of key electrical parameters for head-only electrical stunning in meat rabbits A) current, B) frequency and C) voltage used in a set of commercial rabbit slaughterhouses in the European Union. Data extracted from 23 different slaughterhouses in 2023. Red bars refer to values below 140 mA, above 50 Hz and below 100 V, blue bars are within the used values being the darkest optimal according to the European Commission (2017) and EFSA (2020).*

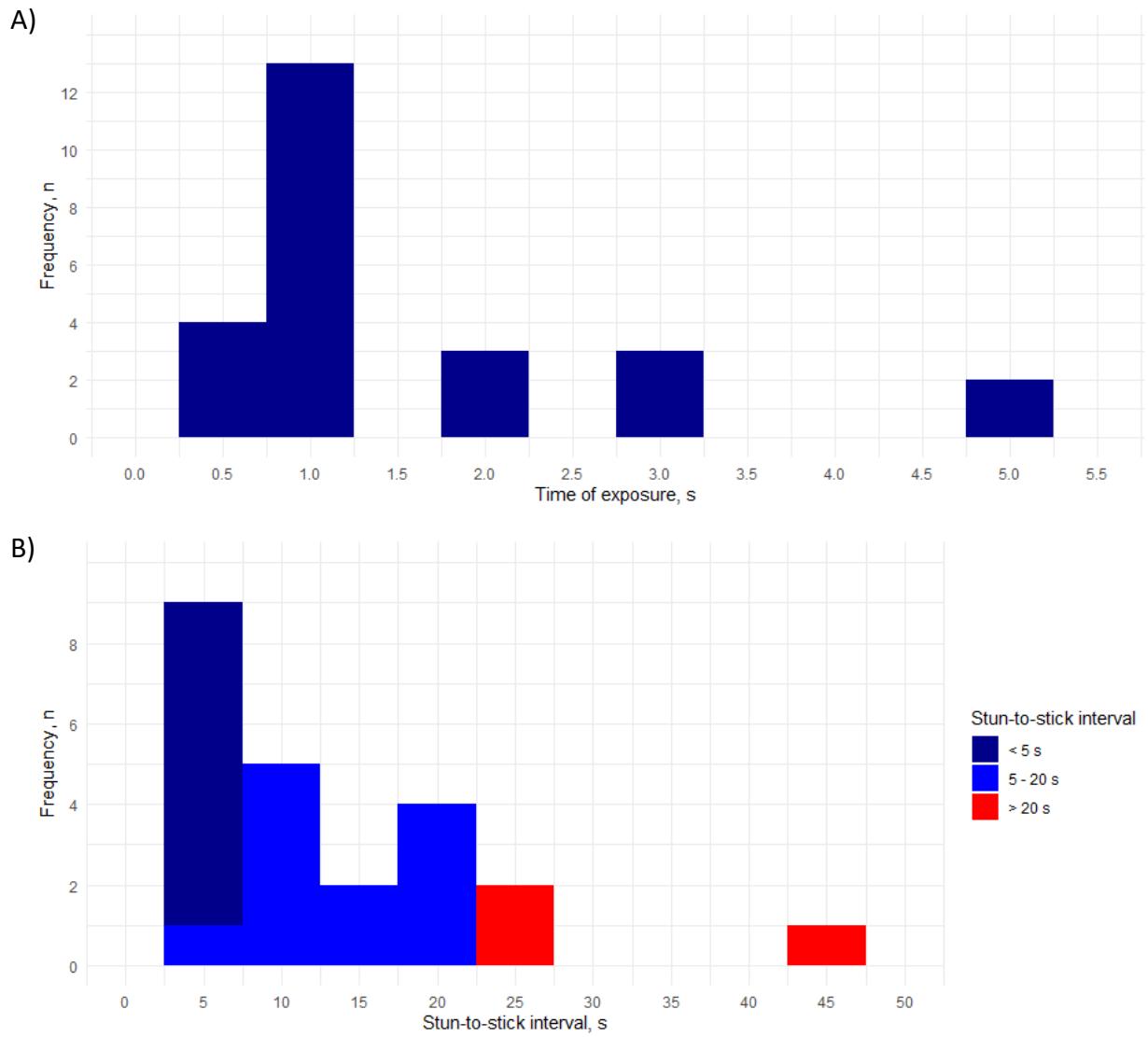


Figure 5. *Frequency distributions of two key parameters for head-only electrical stunning in meat rabbits A) time of exposure, B) stun-to-stick interval used in a set of commercial rabbit slaughterhouses in the European Union. Data extracted from 23 different slaughterhouses in 2023. Red bars refer to stun-to stick intervals values greater than 20 s, blue bars are within the used values being the darkest optimal according to the European Commission (2017) and EFSA (2020).*

2.1.2 Assessment of the state of consciousness and death

In 2020, the EFSA pointed out that the state of consciousness of rabbits stunned by head-only electrical device should be monitored in three key stages:

- Key stage 1: immediately following application,
- Key stage 2: at the time of neck cutting and,
- Key stage 3: during bleeding

In each key stage, animal-based indicators (ABIs) should be used. EFSA (2020) also reported a list of ABIs ranked according to the validity (i.e., sensitivity) and feasibility. Those had the highest validity and feasibility were shown as essentials indicators while the others were kept as optional, and all this information was summarised in a set of toolbox (Figure 6).

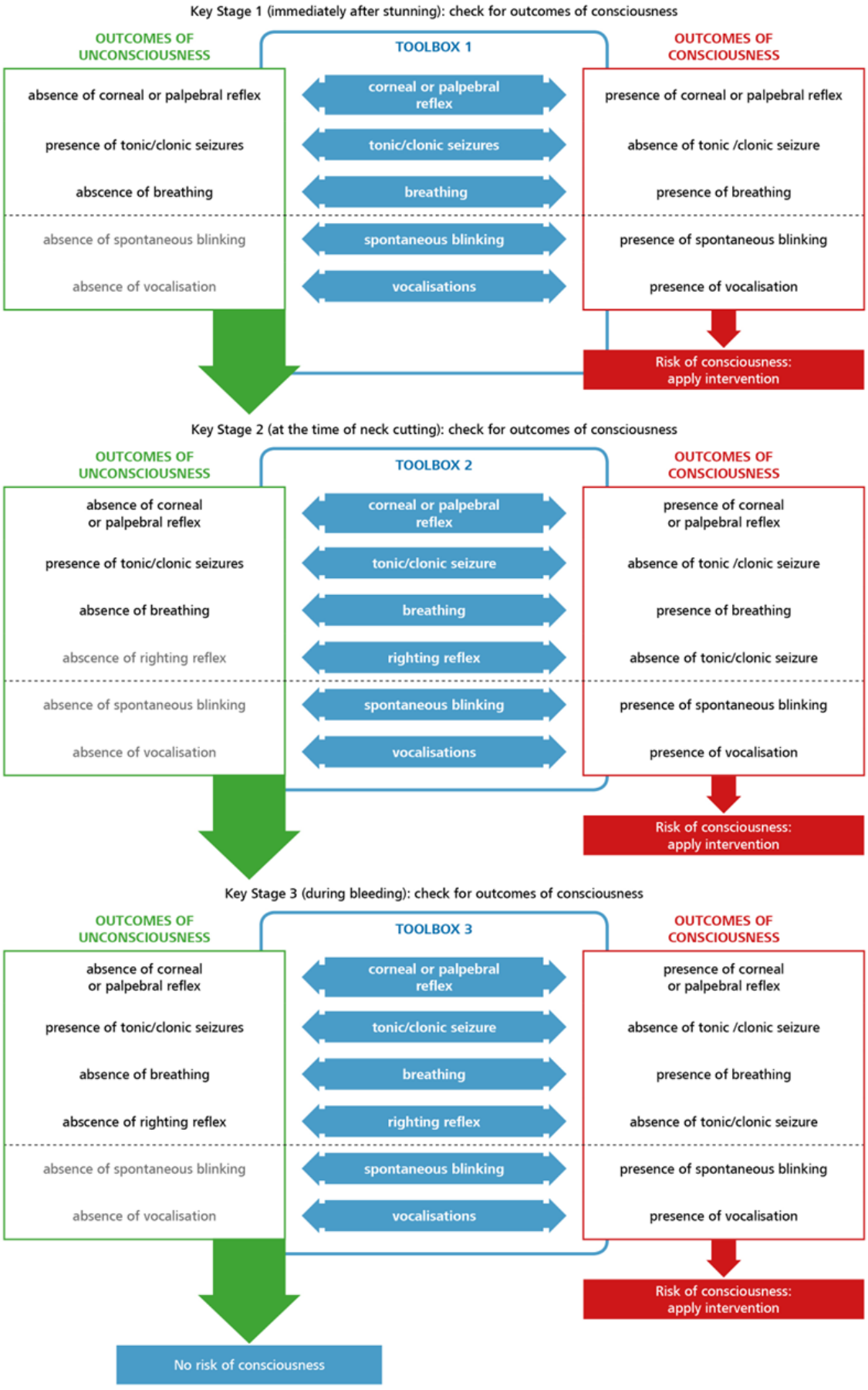


Figure 6. *Toolbox of animal-based indicators and flowchart for monitoring the state of consciousness in rabbits when applying head-only electrical stunning. Source: EFSA (2020).*

For each key stage, there is a toolbox. Each toolbox contains the selected ABIs highlighted in blue. On the left and in a green box, the outcomes of unconsciousness and on the right and in a red box, the outcome of consciousness for each ABI. In addition, there is a dashed line separating the essential ABIs (above the dashed line) from those that are considered optional or additional (below the dashed line). In particular, those ABIs which rely on the animal spontaneously manifesting certain behaviours (e.g. spontaneous blinking, vocalisations) should be used with caution since conscious animals might not perform them. Outcomes presented in grey are intended as a reminder of the limitations of the indicator. Nevertheless, the outcome of consciousness suggests that the animal is conscious or regaining consciousness. From those above the dashed line, a minimum of two ABIs relevant to each key stage should be used for the assessment of the state of consciousness according to EFSA (2020). Descriptions of the ABIs are reported in the Annex. Any rabbit exhibiting at least one outcome of consciousness indicates that the rabbit is conscious or regaining consciousness and therefore, the rabbit must be re-stunned with backup stunning equipment as soon as detected.

Before dressing, the death of the animals must be confirmed. The ABIs for assessing death are given in Figure 7. Only in case of outcomes of death, the animals can be dressed.

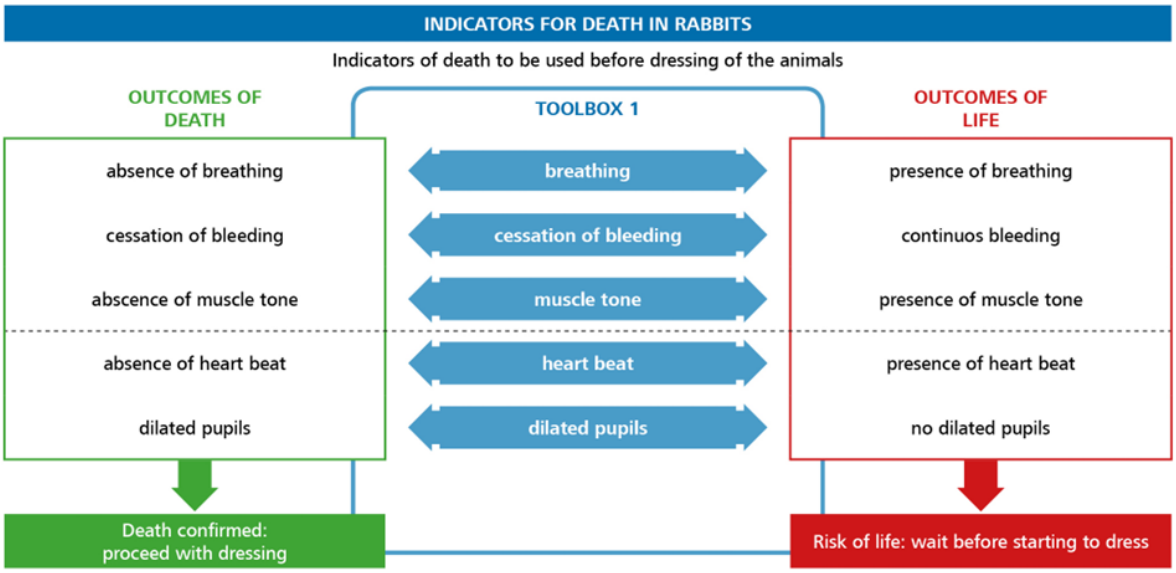


Figure 7. *Toolbox of animal-based indicators and flowchart for confirmation of death in rabbits. Source: EFSA (2020).*

Prevalence of ABIs that operators use for the assessment of consciousness and confirmation of death is shown in Table 2. The most used to assess the state of consciousness are corneal or palpebral reflex, breathing, vocalisation, tonic/clonic seizures and, lastly, spontaneous blinking (in order from most to least). Other ABIs not listed by EFSA (e.g. attempt to raise the head, ear position, response to painful stimulus, and running movements of the forelegs during bleeding and curling of the forelegs) have been also reported. The variability of ABIs used reflects heterogeneity in the applied criteria. The most commonly ABIs used for confirmation of death are muscle tone, respiration, bleeding, pupil dilation and heartbeat.

The ABIs reported by EFSA (2020) are the most valid and feasible. However, information on which indicators of consciousness are the most observed in rabbits when ineffectively stunned, the correlation among them and the repeatability between observers per key stage are not yet explored. Therefore, a refined list of the most relevant ABIs would be of interest to ensure consistency of monitoring of the state of

consciousness in commercial rabbit slaughterhouses and to better assess the efficiency of stunning as it was recently performed in broiler chickens (Contreras-Jodar et al., 2022) and turkeys (Contreras-Jodar et al., 2023)

Table 2. *Count of the animal-based indicators (ABIs) used for assessing the state consciousness and death in rabbits stunned by head-only electrical stunning. Data extracted from 29 rabbit slaughterhouses in 2023.*

Assessment	ABIs	Count, n (%)
State of consciousness	Corneal or palpebral reflex	22 (75.9%)
	Breathing	20 (69.0%)
	Vocalisation	18 (62.0%)
	Tonic/clonic seizures	18 (62.0%)
	Spontaneous blinking	14 (48.3%)
	Others	6 (20.7%)
Confirmation of death	Muscle tone	15 (51.7%)
	Breathing	13 (44.8%)
	Cessation of bleeding	8 (27.6%)
	Dilated pupils	7 (24.1%)
	Heartbeat	4 (13.8%)
	Others	1 (3.4%)

2.1.3 Potential risks of the stunning methods for animal welfare and good practices

The application of the head-only electrical stunning in rabbits may pose risks for their welfare. Identified risks and how to prevent or minimise them are shown below:

- **Handling:** handling of animals prior to stunning may cause stress and pain to the rabbits, especially if the handling is rough. Handling stress cannot be eliminated but can be mitigated following these recommendations. Rabbits should never be grabbed by the ears, legs or tail. It is painful and can cause serious damage (European Commission, 2017). They should be removed from the containers individually by holding and lifting by the neck (scruff) by one hand. Once outside the container, their body should be supported with the other hand (Figure 8) and the rabbit's head guided into V-shaped stunning tongs or electrodes by holding its ears.

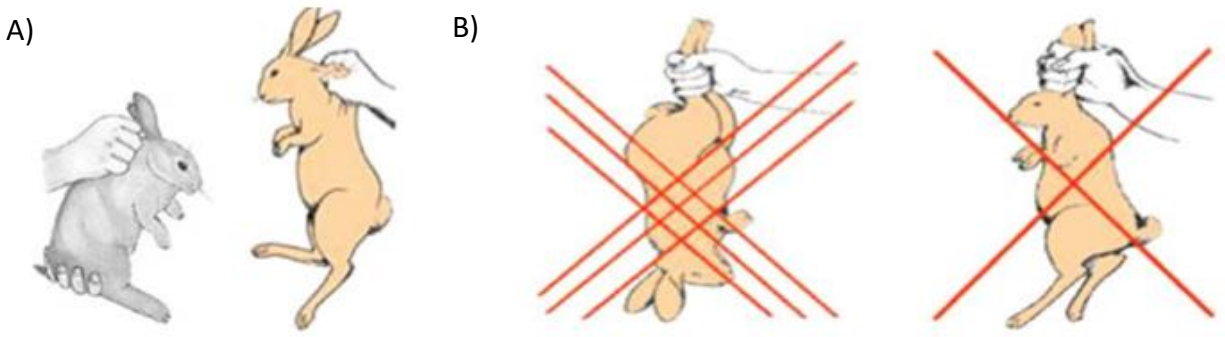


Figure 8. *Handling of rabbits when uncrated prior to be stunned according if it is A) a good or B) a poor practice. Source: Federation of French Poultry Industries.*

- **Incorrect placement of the electrodes:** it can pre-stun shocks or rabbit's eyes damage. Pre-stun shocks are caused due to incorrect handling that can lead to unintended contact of the electrodes in other parts of the animal's body causing painful electrical discharge. Rabbit's eye damage can occur when the electrodes contact the eyes. This can be extremely painful in case of delayed onset to unconsciousness or in case the rabbit regains consciousness before death. Preventive measures include having trained operators with sufficient rotation to ensure gentle handling of rabbits and minimise operator's fatigue. The likelihood of incorrect placement of the electrodes can be reduced when the slaughter design maximises the operator's comfort when handling alive animals.

- **Poor electrical contact:** this can happen when the electrodes are not cleaned regularly using a wire brush to remove the trapped hair or the carbonised debris within the stunning device. The electrical contact can be impaired and not only can cause burning of fur and pain (EFSA, 2020) but also increases the risk of failure to induce unconsciousness effectively. Therefore, the electrodes must be cleaned regularly during the slaughter process.

- **Too short exposure time:** the duration plays a critical role in inducing an effective state of unconsciousness or resulting in recovery of consciousness (EFSA, 2020). The stunning device needs to span the brain. Once the current cross the brain, no additional time is needed.

- **Inappropriate electrical parameters:** the electrical parameters applied in a head-only electrical stunner have a direct impact on the stunning efficiency. The higher the current and the lower the frequency, the higher is the efficiency of stunning. In addition, the use of DC current seemed to be less effective to induce unconsciousness in broiler chickens than the use AC current (Prinz et al., 2012) and similar effect is expected in rabbits. To prevent the use of inappropriate electrical parameters, the person in charge of the slaughterhouse should employ suitable parameters that match the frequency and waveforms of the current. The primary consideration should be the minimum current applied to rabbits' brain, which depends on rabbit's head resistance and the equipment's output voltage. Current equipment can adjust the voltage output to deliver a pre-established minimal current. However, to ensure the effectiveness of the electrical parameters in inducing unconsciousness, it is essential to monitor the animals' state of consciousness. Additionally, it is important to identify factors that could contribute to increase the electrical resistance, such as the fur. In this sense, the amount of current delivered to the rabbits may differ from that intended, so wetting the rabbits' heads is highly suggested to reduce electrical resistance and increase the likelihood of effective stunning (Anil et al., 1998; European Commission, 2017).

- **Inversion, shackling and neck cutting in conscious rabbits if the stunning is not effective:** Ineffective stunning can be very painful. Electric shock causes contraction and stiffening of body muscles, resulting in temporary immobility, muscle fatigue and severe pain. In addition, if the animal is shackled (hanged upside-down with legs inserted into metal shackles) and neck cut, this situation exacerbates the pain and fear. Preventive measures not also include the use of appropriate electrical parameters, but also correct electrical contact of the electrodes to rabbits' head in sufficient duration to ensure that the current is going through the brain, and the assessment of the state of consciousness of the rabbit prior to be shackled. In case of detection of indicators of consciousness, the rabbit should be immediately re-stunned.

- **Prolonged stun-to-stick interval:** as head-only electrical stunning is a reversible stunning method, its use causes a temporary state of unconsciousness. Therefore, the longer the stun-to stick interval (i.e., time between stunning and neck cutting), the longer the time it takes for the rabbit to be bled and, therefore, the longer it takes from stunning until the animal die. Thus, the longer the stun-to-stick interval, the greater the risk that effectively stunned rabbits will regain consciousness in the shackle line (before, during and after neck cutting) so may experience avoidable pain, fear and distress.

2.2 Captive bolt stunning

The captive bolt is equipped with a retractable bolt or rod that is powered by compressed air or a spring mechanism. There are two types of captive bolt: non-penetrative and penetrative (Skladanowska-Baryza et al., 2020). When using non-penetrative captive bolt, the bolt does not penetrate the skull but strike the head of the rabbit, delivering a severe blow that causes brain concussion. In case of penetrative captive bolt stunning, the bolt is propelled forward with force ensuring complete penetration and destruction of brain tissue (EFSA, 2020). After firing, the bolt retracts into the gun. Both non-penetrative and penetrative captive bolts may induce a reversible state of unconsciousness (simple stunning) and therefore, bleeding should follow to cause death. The duration of unconsciousness may be slightly longer in penetrative compared to non-penetrative captive bolt stunning (EFSA, 2006, 2020).

For appropriate application, the rabbit should be placed on a non-slippery surface with a backstop so the animal cannot back away. Then, the rabbit should be restrained in sternal recumbence with one hand by holding its neck and shoulder such that the ears are tucked away from the head, while the other hand is used to operate the gun (European Commission, 2017; Figure 9A). The gun should be firmly positioned against the rabbit's head on the midline and at the intersection of lines drawn from the outside edge of the eye to the base of the opposite ear (Figure 9B). The angle of firing should be perpendicular to the skull bones to prevent sliding or skidding (EFSA, 2020).

According to data collected, captive bolt stunning is performed in 14 of 232 rabbit slaughterhouses (7%). Half of them use penetrative captive bolt method, and the other half use non-penetrative captive bolt.

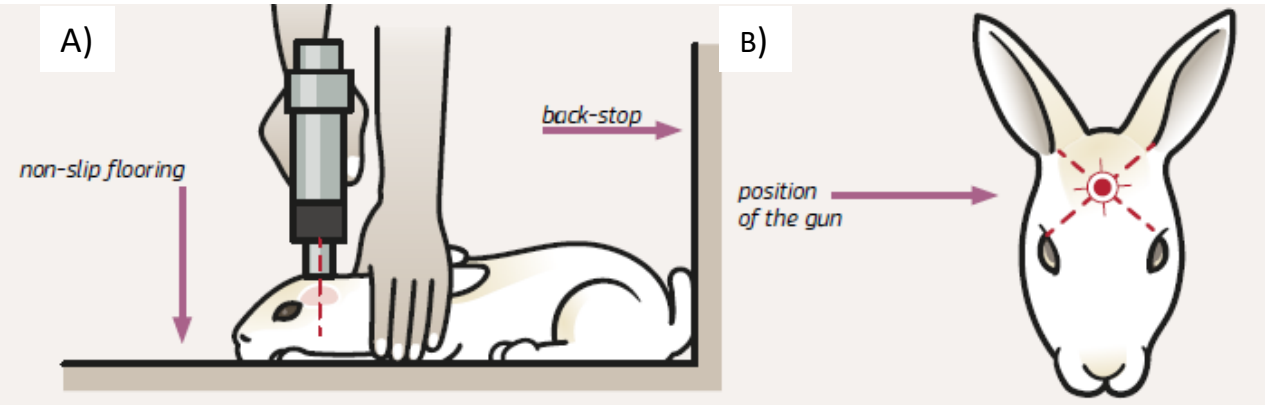


Figure 9. *A) Appropriate handling, the rabbit is placed on a non-slippery surface with a backstop so the animal cannot back away. B) Appropriate position of the gun to non-penetrative or penetrative captive bolt. Source: European Commission (2018).*

2.2.1 Key parameters

Regulation (EC) No 1099/2009 states that key parameters for penetrative captive bolt are position and direction of the shot, appropriate velocity, exit length and diameter of bolt according to animal size and maximum stun to stick/kill interval whereas for non-penetrative captive bolt, these are position and direction of the shot, appropriate velocity, diameter and shape of bolt according to animal size and species, strength of the cartridge used and maximum stun to stick/kill interval. However, it is not specified any of these parameters for any animal species. There are some suggestions for effective stunning on certain parameters based on the results of scientific studies or national guidelines, but for some parameters, there is still gaps of knowledge in rabbits. Table 3 summarises the reported values found in literature for rabbits according to the captive bolt device and the key parameters however, it is not specified for which animal category (e.g., growing-finishing, breeders). Time of the maximum intervals between stunning to sticking were reported in European Commission (2016) and taken from different national guidelines.

Table 3. *Reported key parameters for penetrative and non-penetrative captive bolt for stunning rabbits.*

Captive bolt	Key parameters	Values	Source
Penetrative	Appropriate velocity, m/s	-	-
	Exit length, mm	27	Schütt-Abrahan et al. (1992)
	Diameter of bolt, mm	6	Dennis et al. (1988)
			European Commission (2017)
	Max. stun to stick/kill interval, s	≤ 5; ≤ 10; ≤ 20*	European Commission (2017)
Non-penetrative	Appropriate velocity, m/s	-	-
	Diameter and shape of bolt	-	-
	Strength of the cartridge	-	-
	Max. stun to stick/kill interval, s	≤ 5; ≤ 10; ≤ 20*	European Commission (2017)

* Thresholds found in different national guidelines and compiled in European Commission (2017).

Air pressure in non-penetrative captive bolt is reported to be set at 70 psi (483 kPa) for growing-finishing rabbits and 90 psi (621 kPa) for breeders (Walsh et al., 2017). No values were found for penetrative captive bolt.

Although information from only two slaughterhouses that stun with penetrative captive bolt were gathered, both used devices whose characteristics are allegedly inferior to those reported (4 and 4.7 mm diameter, 20 and 25 mm exit length) according to scientific studies (Dennis et al., 1998; Schütt-Abrahan et al., 1992).

2.2.2 Assessment of the state of consciousness and death

In 2020, the EFSA pointed out that the state of consciousness of rabbits stunned by captive bolt device should be monitored in three key stages:

- Key stage 1: immediately following application,
- Key stage 2: at the time of neck cutting and,
- Key stage 3: during bleeding

EFSA (2020) also reported a list of ABIs ranked according to the validity (i.e., sensitivity) and feasibility per key stage. Those had the highest validity and feasibility were shown as essential indicators while the others were kept as optional, and all this information was summarised in a set of toolbox and flowchart (Figure 10).

For each key stage, there is a toolbox. Each toolbox contains the selected ABIs highlighted in blue. On the left and in a green box, the outcomes of unconsciousness and on the right and in a red box, the outcome of consciousness for each ABI. In addition, there is a dashed line separating the essential ABIs (above the dashed line) from those that are considered optional or additional (below the dashed line). Indicators below the dashed line are considered to have lower validity and they should not be relied exclusively. In particular, those indicator outcomes which rely on the animal spontaneously manifesting certain behaviours (e.g. spontaneous blinking, vocalisations) should be used with caution since conscious animals might not perform them. Outcomes presented in grey are intended as a reminder of the limitations of the indicator. Nevertheless, the outcome of consciousness suggests that the animal is conscious or regaining consciousness. From those above the dashed line, a minimum of two ABIs relevant to each key stage should be used for an effective assessment of the state of consciousness according to EFSA (2020). Descriptions of the ABIs are reported in Annex. Any rabbit exhibiting at least one outcome of consciousness indicates that the rabbit is conscious or regaining consciousness and therefore, the rabbit must be re-stunned with head-only electrical device as soon as detected.

Before dressing, the death of the animals must be confirmed. The ABIs for assessing death are the same as those shown in Figure 7. Only in case of outcomes of death, the animals can be dressed.

Since there are very few slaughterhouses using captive bolt as a method of stunning rabbits (16/232 slaughterhouses), the information that we could gather was minimal to be able to discuss which method of assessing consciousness and confirmation of death and which ABIs are being used in practice.

2.2.3 Potential risks of the stunning methods for animal welfare and good practices

Captive bolt stunning may pose risks for rabbits welfare. Identified risks and how to prevent or minimise them are listed and described below:

- **Incorrect handling and restraint**: Rabbits should never be grabbed by the ears, legs or tail. Poor handling and restraining can be painful and cause bone fractures, dislocations and bruising (European Commission, 2017). To minimise distress and pain, rabbits should be removed from the containers individually by holding and lifting by the neck (scruff) by one hand (see Figure 8). Once outside the container, their body should be supported with the other hand until restrained in sternal recumbence with one hand by holding its neck and shoulder such that the ears are tucked away from the head, while the other hand is used to operate the gun (EFSA, 2020).

- **Incorrect shooting position and angle:** when the captive bolt is positioned wrongly, not only unconsciousness of the rabbits might be not achieved but also may cause short-lasting concussion, and severe pain as it may sever the olfactory bulb, ocular orbit or nasal cavity instead of the cerebral cortex and brain stem (EFSA, 2020). Regular training and rotation of operators responsible for stunning rabbits are key factors at preventing or minimising the risk.

- **Inappropriate bolt parameters:** low airline pressure, low cartridge power, low bolt velocity, shallow penetration and faulty equipment (too narrow bolt diameter) cause fail to provoke an effective stun and render rabbits unconscious. It is also essential that the equipment is maintained and used according to the manufacturers' instructions (EFSA, 2020).

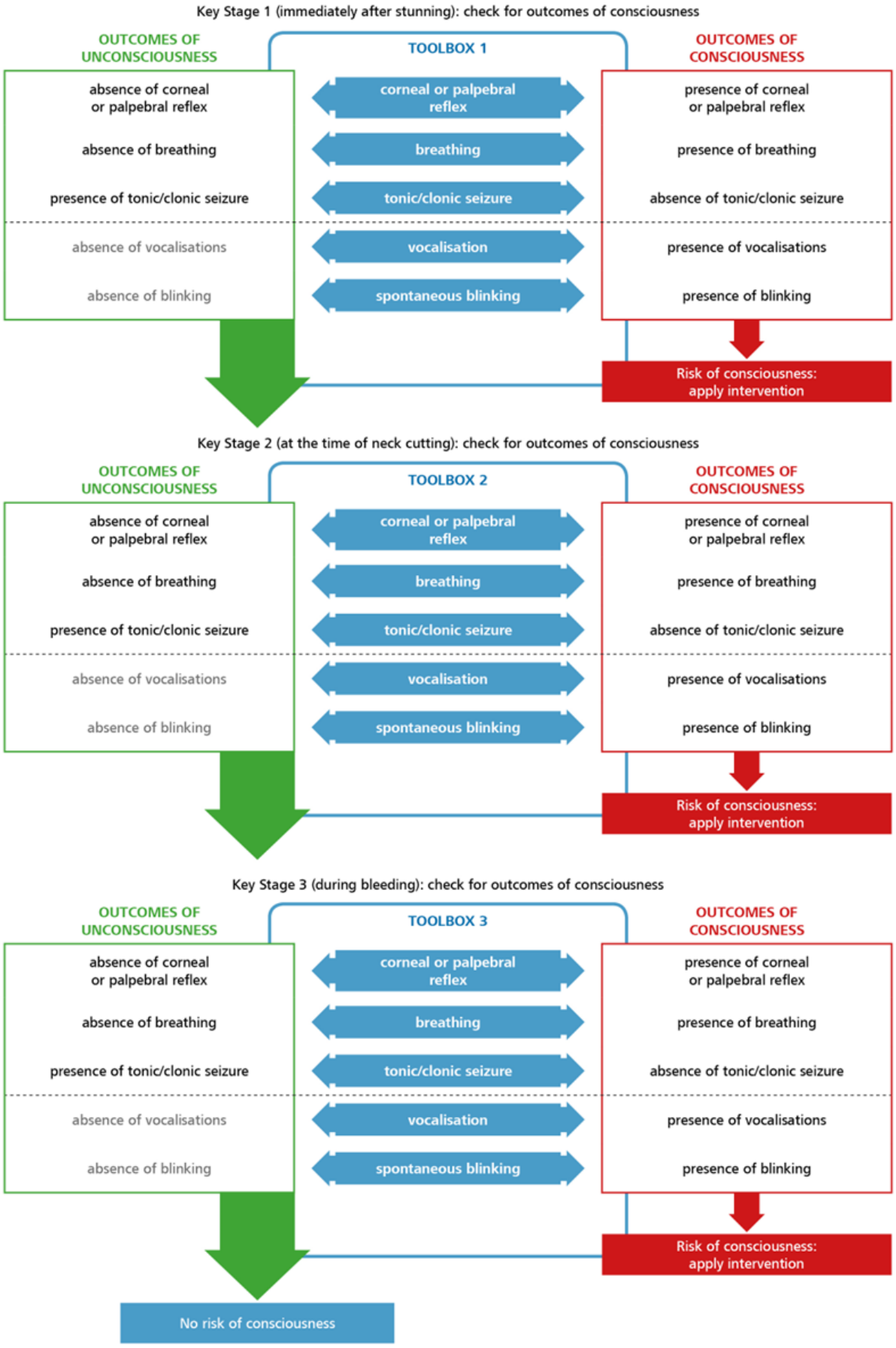


Figure 10. *Toolbox of animal-based indicators and flowchart for monitoring the state of consciousness in rabbits when applying captive bolt stunning. Source: EFSA (2020).*

- **Inversion, shackling and neck cutting in conscious rabbits if stunning is not effective.** Ineffective stunning can be very painful. In addition, if the animal is shackled (hanged upside-down with legs inserted into metal shackles) and neck cut, this situation exacerbates the pain and fear. Preventive measures not also include correct shooting position and angle and appropriate bolt parameters, but also the assessment of the state of consciousness of the rabbit prior to be shackled. In case of detection of indicators of consciousness, the rabbit should be immediately re-stunned with head-only electrical device as it would be difficult to know where to repeat the shot on the damaged skull (EFSA, 2020).

- **Prolonged stun-to-stick interval:** captive bolt stunning methods (penetrative and non-penetrative) cause a temporary state of unconsciousness. Therefore, the longer the stun-to stick interval, the longer the time it takes for the rabbit to be bled and, therefore, the longer it takes from stunning until the animal die. Thus, the longer the stun-to-stick interval, the greater the risk that properly stunned rabbits will regain consciousness in the shackle line (before, during and after neck cutting) so may experience avoidable pain, fear and distress.

3. Key points

- Approximately, 62 million of rabbits were slaughtered in the EU in 2022 of which Spain, France and Italy accounted for 88% of the total.
- The authorised stunning methods for rabbits in the EU are captive bolt (penetrative and non-penetrative), percussive blow to the head, head-only electrical stunning and head-to-body electrical stunning. However, only head-only electrical stunning and captive bolt are currently in use in EU.
- Approximately 93% of the slaughterhouses use head-only electrical and 7% captive bolt stunning methods but when it comes to the number of slaughtered rabbits, approximately the 99.99% of rabbits are stunned with head-only electrical stunning and 0.01% with captive bolt. The slaughterhouses equipped with captive bolt as primary method to stun rabbits are always small-scale (< 23,000 slaughtered rabbits /year).
- Regulation (EC) No 1099/2009 laid down minimum currents (A or mA) for head-only electrical stunning in some animal species. Nevertheless, it is stated that minimum voltage, maximum frequency, minimum time of exposure and maximum stun-to-stick intervals are also some of the key parameters. However, there is no specific legal requirements on rabbits, but figures based on national guides and very few scientific studies are available. Therefore, there is a variation in some proposed key parameters but even with the less restrictive, 25% of slaughterhouses apply key parameters below those available.
- Available key parameters on head-only electrical stunning do not distinguish between different animal categories (e.g., finishing rabbits, breeders). Although it is known that electrical key parameters should be adjusted to animal characteristics, the great majority of slaughterhouses do not change the electrical parameters.
- The most used ABIs of the state of consciousness are corneal or palpebral reflex, breathing, vocalisation, tonic/clonic seizures and, spontaneous blinking (from most to least). Some operators use ABIs not validated by EFSA.

- The variability observed in the ABIs chosen by the OVs reflects heterogeneity in the applied criteria.
- Information on which indicators of consciousness are the most observed in rabbits when are ineffectively stunned, the correlation among them and the repeatability between observers per key stage are not yet explored. Therefore, a refined list of the most relevant ABIs would be of interest to ensure consistency of controls in commercial rabbit slaughterhouses and to better assess the efficiency of stunning in commercial rabbit slaughterhouses.
- Potential risks for welfare when stunning with head-only electrical device include handling, incorrect placement of the electrode, poor electrical contact, too short exposure time, inappropriate electrical parameters, inversion, shackling and neck cutting in conscious rabbits (if the stunning is not effective) and prolonged stun-to-stick interval.
- Regulation (EC) No 1099/2009 states that key parameters for penetrative captive bolt are position and direction of the shot, appropriate velocity, exit length and diameter of bolt according to animal size and maximum stun to stick/kill interval whereas for non-penetrative captive bolt, these are position and direction of the shot, appropriate velocity, diameter and shape of bolt according to animal size and species, strength of the cartridge used and maximum stun to stick/kill interval. However, it is not specified any of these parameters for any animal species. Information on few parameters exist, but for most of them are still a gap of knowledge.
- The EFSA pointed out that the state of consciousness of rabbits stunned by captive bolt device (penetrative or non-penetrative) should be monitored in three key stages: immediately following application, at the time of neck cutting and, during bleeding. However, the EURCAW-Poultry-SFA could not gather enough information on where the checks are being carried out in practice. Similarly occurs with the ABIs chosen to assess the state of consciousness or the confirmation of death.
- Potential risks for welfare when stunning with captive bolt include incorrect handling and restraint, incorrect shooting position and angles, inappropriate bolt parameters, inversion, shackling and neck cutting in conscious rabbits (if the stunning is not effective) and prolonged stun-to-stick interval.

4. References

Anil, M. H., Raj, A. B. M., & McKinstry, J. L. (1998). Electrical stunning in commercial rabbits: Effective currents, spontaneous physical activity and reflex behaviour. *Meat Science*, *48*(1-2), 21-28.

Contreras-Jodar, A., Varvaró-Porter, A., Michel, V., & Velarde, A. (2022). Inter-Observer Repeatability of Indicators of Consciousness after Waterbath Stunning in Broiler Chickens. *Animals,* 12(14), 1800. https://doi.org/10.3390/ani12141800

Contreras-Jodar, A., Varvaró-Porter, A., Velarde, A., & Michel, V. (2023). Relevant Indicators of Consciousness after Waterbath Stunning in Turkeys and Stunning Efficiency in Commercial Conditions. *Animals*, 13(4), 668. https://doi.org/10.3390/ani13040668

Dennis, M. B., Dong, W. K., Weisbrod, K. A., & Elchlepp, C. A. (1988). Use of captive bolt as a method of euthanasia in larger laboratory animal species. *Lab. Anim. Sci.*, *38*(4), 459–462. http://europepmc.org/abstract/MED/3184857

EFSA. (2006). Opinion of the Scientific Panel on Animal Health and Welfare (AHAW) on a request from the Commission related with the welfare aspects of the main systems of stunning and killing applied to commercially farmed deer, goats, rabbits, ostriches, ducks, geese. *EFSA Journal*, *326*(3), 1-18. https://doi.org/https://doi.org/10.2903/j.efsa.2006.326

EFSA (2013). Scientific Opinion on monitoring procedures at slaughterhouses for poultry. *EFSA Journal*, *11*(12), 3521. https://doi.org/https://doi.org/10.2903/j.efsa.2013.3521

EFSA (2020). Stunning methods and slaughter of rabbits for human consumption. *EFSA Journal*, *18*(1), 106, 5927. https://doi.org/10.2903/j.efsa.2020.5927

European Council. (2009). COUNCIL REGULATION (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of killing. In (pp. 30-30). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R1099

European Commission. (2017). Preparation of best practices on the protection of animals at the time of killing: executive summary. Publications Office. http://publications.europa.eu/resource/cellar/ea4ef3e9-cda5-11e7-a5d5-01aa75ed71a1.0001.01/DOC_1

European Commission. (2018). Commercial rabbit farming in the European Union: overview report. Publications Office. https://data.europa.eu/doi/10.2772/62174

European Commission. (2019). How to stun / kill rabbits on-farm. Publications Office. https://food.ec.europa.eu/system/files/2019-01/aw_prac_slaughter_factsheet-2018_farm_rabbits_en.pdf

Hindle, V., Lambooij, E., Reimert, H. G. M., Workel, L. D., & Gerritzen, M. (2010). Animal welfare concerns during the use of the water bath for stunning broilers, hens, and ducks. *Poult. Sci.*, 89(3), 401–412. https://doi.org/10.3382/ps.2009-00297

Prinz, S., van Oijen, G., Ehinger, F., Bessei, W., & Coenen, A. (2012). Electrical waterbath stunning: Influence of different waveform and voltage settings on the induction of unconsciousness and death in male and female broiler chickens. *Poult. Sci.*, *91*(4), 998–1008. https://doi.org/https://doi.org/10.3382/ps.2009-00137

Schutt-Abraham, I., Knauer-Kraetzl, B., & Wormuth HJ. (1992). Beobachtungen bei der Bolzenschussbetaubung von Kaninchen. [Observations During Captive Bolt Stunning of Rabbits]. Berliner und Munchener Tierarztliche Wochenschrift, 105, 10–15. Cited by EFSA et al. (2020). Stunning methods and slaughter of rabbits for human consumption. *EFSA Journal*, *18*(1), 106, 5927. https://doi.org/10.2903/j.efsa.2020.5927

Terlouw, C., Bourguet, C., & Deiss, V. (2016a). Consciousness, unconsciousness and death in the context of slaughter. Part I. Neurobiological mechanisms underlying stunning and killing. *Meat Science*, *118*, 133-146. https://doi.org/10.1016/j.meatsci.2016.03.011

Terlouw, C., Bourguet, C. c., & Deiss, V. (2016b). Consciousness, unconsciousness and death in the context of slaughter. Part II. Evaluation methods. *Meat Science*, *118*, 147-156. https://doi.org/10.1016/j.meatsci.2016.03.010

ANNEX

To monitor stunning efficacy, the state of consciousness should be checked immediately after stunning, just prior to neck cutting and during bleeding. Death must be confirmed before carcass processing begins. The state of consciousness is assessed to identify if rabbits are successfully rendered unconscious or, if they are conscious (e.g. stunning was ineffective or they recovered consciousness) and therefore at risk of experiencing pain and fear. For each ABI of the state of consciousness (e.g. corneal reflex), outcomes either suggesting unconsciousness (e.g. absence of corneal reflex) or suggesting consciousness (e.g. presence of corneal reflex) are proposed. The definition of each indicator and the outcomes are described below (EFSA, 2013; EFSA, 2020; Terlouw et al., 2016b):

ABIs to monitor the state of consciousness

Corneal and palpebral reflex

Corneal and palpebral reflex is defined as the blinking response elicited by touching or tapping the cornea (corneal reflex) or touching or tapping the inner/outer eye canthus or eyelashes (palpebral reflex), which serves as indicators in assessing the state of consciousness of rabbits subjected to stunning. Conscious animals and those in the process of regaining consciousness exhibit a blink response when the cornea or eyelashes are stimulated. Unconscious animals show the absence of the corneal or palpebral reflex throughout all key stages.

Breathing

Breathing, characterized by regular cycles of inhalation and exhalation, can be identified by observing rhythmic movements of the flanks, mouth, and/or nostrils. To assess breathing, a small mirror can be held in front of the rabbit's nostrils or mouth to detect condensation resulting from the expulsion of moist air. A conscious rabbit or one in the process of regaining consciousness will exhibit attempts to breathe, initially in the form of regular gagging and eventually leading to the resumption of normal breathing. An unconscious rabbit will show the absence of breathing.

Tonic/clonic seizures

Tonic seizures, characterized by an arched back and rigidly flexed legs positioned under the body, occur and persist for several seconds. These seizures are followed by clonic seizures, lasting only a few seconds, which are characterized by leg kicking or paddling movements. It's important to note that the occurrence of tonic seizures may go unnoticed if there is a substantial delay between the end of captive stunning and the subsequent shackling. Conscious animals will not exhibit tonic/clonic seizures, whereas unconscious animals will show these seizure activities.

Spontaneous blinking

Unconscious rabbits will not show spontaneous blinking during any of the key stages. On the other hand, conscious rabbits may show spontaneous blinking, and therefore, this sign can be used to recognise ineffective stunning or recovery of consciousness after electrical stunning. However, not all the conscious animals may show spontaneous blinking.

Righting reflex

Head righting, characterized by attempts to raise the head and regain a normal posture, is observed in conscious animals, ineffectively stunned rabbits, and those in the process of recovering consciousness throughout the monitoring period in the two specified key stages. Conscious animals, as well as ineffectively

stunned rabbits and those recovering consciousness, may exhibit head righting during key stages 2 and 3. However, unconscious animals will not display the righting reflex. The absence of righting reflex does not ensure the state of unconscious. This reflex is applicable for evaluating rabbits subjected to head-only electrical stunning.

Vocalisation

Vocalisation, characterized by one or repeated, short and loud shrieking at high frequencies, is an indicator of consciousness. However, it should be noted that not all conscious animals will vocalise, and therefore, the absence of vocalisation does not always indicate unconsciousness. Unconscious animals will exhibit the absence of vocalisation.

ABIs for death

Bleeding

Slaughter leads to cessation of bleeding, with only minor dripping, from the neck cut wound, and therefore **end of bleeding** in both carotid arteries and jugular veins can be used as an indicator of death. Profuse bleeding from the neck cut wound following neck cutting reduces after a few seconds to minor dripping. A dead rabbit will show cessation or minor bleeding.

Muscle tone

Complete and irreversible loss of muscle tone led to relaxed body, which can be recognised from the limp carcass.

Heartbeat

Onset of death leads to permanent absence of cardiac activity (absence of heartbeat), which can be ascertained using a stethoscope. To hear the heartbeat, place the stethoscope between the intercostal spaces of the 2nd and 3rd ribs. In a conscious or recovering rabbit, the heartbeat will be audible. In a dead rabbit, the heartbeat will not be detectable.

Pupil size

Dilated pupils (mydriasis) are an indicator of onset of brain death, which requires close examination of the eyes. Open the eyes and use a light to see the pupils.