The Temporal Localization Problem in Near-Death Research

An Element-Level Inverse-Problem Framework for Physiology, Information Acquisition, Experience, Memory, and Report

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Abstract

Near-death research combines unusually rich first-person reports with increasingly detailed clinical monitoring, yet the field often cannot determine when the informational, experiential, and mnemonic components of a later report arose. Existing instruments characterize near-death phenomenology but do not provide physiological timestamps. This review formulates temporal localization as an element-level inverse problem. For each report element, investigators should infer separate candidate windows for information acquisition, phenomenal occurrence, and memory formation on a shared clinical timeline, while recording report time and temporal phenomenology as distinct variables. These windows may coincide, differ, be discontinuous, remain unidentified, or include no discrete antecedent experiential interval.

Prospective cardiac-arrest cohorts, case-linked physiology, dying-brain electrophysiology, memory studies, narrative analyses, and controlled-target research are reviewed according to what each can and cannot localize. The literature supports recurrent reports of altered temporal phenomenology, unusually vivid autobiographical memory, and organized neural activity during some periods of resuscitation or dying. It does not yet establish a general mapping from later reports to a unique no-flow, cardiopulmonary-resuscitation, peri-return-of-spontaneous-circulation, emergence, or reconstruction interval. A positive time-stamped auditory-cue result would constrain information uptake and retrievable memory formation, but would not alone prove conscious hearing at presentation.

A provisional Temporal Localization Evidence Profile is proposed to grade timing evidence without rewarding dramatic content. Explanations are reorganized along orthogonal timing, construction, information-route, and population dimensions. The framework makes temporal claims more testable while preserving a central limit: localization is necessary for causal consciousness research, but is not itself an explanation of consciousness.

Keywords: near-death experience; consciousness; cardiac arrest; memory; temporal localization; source monitoring

1. Introduction

Near-death experiences (NDEs) are reports of vivid experiential or apparently experiential content associated with actual or perceived threats to life. Frequently described features include peace, altered time, accelerated thought, separation from the body, movement through darkness or toward light, encounters with persons or presences, autobiographical review, and a perceived boundary or return. The Greyson Near-Death

Experience Scale has provided a durable operational definition of the phenomenological construct, and the Near-Death Experience Content Scale (NDE-C) was developed as a broader content measure (Greyson, 1983; Martial et al., 2020). A recent Rasch comparison found that the two scales closely measure the same underlying construct, while also identifying category and item-level limitations and recommending continued reliance on the original scale for cumulative research (Pehlivanova et al., 2026). These instruments answer an important question: *How strongly does a report instantiate the recognized phenomenology of an NDE?* They do not answer a different question: *When did the reported informational, experiential, and mnemonic components arise?*

That second question is often compressed into a deceptively simple formulation: Did the experience occur "during cardiac arrest"? Cardiac arrest is not one homogeneous physiological instant. The relevant clinical episode can include pre-arrest deterioration, loss of responsiveness, an initial no-flow period, chest compressions producing variable cerebral perfusion, defibrillation, ventilation, medication administration, intermittent organized electrical activity, return of spontaneous circulation (ROSC), reperfusion, temperature management, sedation, coma, delirium, and gradual emergence. A report obtained after recovery may draw on processes occurring in one of these windows, in several windows, or during later memory construction. The phrase *during cardiac arrest* therefore names an episode; it does not supply a timestamp.

The distinction matters because major evidential classes constrain different parts of the problem. Prospective survivor cohorts establish that a minority of resuscitated patients later report NDEs or other memories (Greyson, 2003; Parnia et al., 2001, 2014, 2023; van Lommel et al., 2001). Case-linked electroencephalography (EEG), regional cerebral oxygen saturation, end-tidal carbon dioxide, and resuscitation logs can describe physiological conditions during portions of cardiopulmonary resuscitation (CPR), but do not reveal subjective content without a linked report (Parnia et al., 2023; Shellen et al., 2024). Dying-brain studies identify possible physiological mechanisms but, where patients do not survive, cannot connect those signals to later first-person reports (Borjigin et al., 2013; Xu et al., 2023). Memory studies show that NDE recollections can be vivid, detailed, self-referential, stable, and identity-central, but those properties are measured at retrieval rather than at initial acquisition or encoding (Cassol et al., 2020; Greyson, 2007; Moore & Greyson, 2017; Thonnard et al., 2013). Narrative and cross-cultural research describe how time is later represented, but a report of timelessness or simultaneity is not a physiological timestamp (Belanti et al., 2008; Kellehear, 1993; Martial et al., 2017).

A further difficulty is usually left implicit: the completed narrative may never have existed as one discrete antecedent episode. A later report might preserve a relatively bounded prior experience. It might combine sensory and affective fragments from several intervals. Information acquired implicitly could be integrated into a coherent narrative during emergence. Some elements may be added through source confusion, later disclosure, repeated retrieval, or culturally available interpretation. Under a strong reconstruction-first account, asking when "the complete NDE" occurred is ill-posed because no complete prior episode corresponds to the later account. Temporal localization must therefore proceed at the level of report elements, not automatically at the level of the final narrative as a whole.

This paper develops that claim into a methodological framework. Its central thesis is:

> **A later NDE report should be treated as an inverse problem in which the timing of information acquisition, phenomenal occurrence, memory formation, and later report must be estimated separately for each report element. Event association alone does not determine any of those latent windows.**

The thesis is deliberately neutral regarding whether NDEs are best explained by residual neural activity, reperfusion and emergence, distributed acquisition and reconstruction, heterogeneous mechanisms, or information acquisition not accounted for by measured neural and ordinary sensory routes. It requires each account to make temporally discriminating predictions rather than assigning the entire narrative to its preferred interval.

1.1. Contributions

The paper makes five linked contributions.

First, it formulates temporal localization as a joint inverse problem over a shared clinical timeline. The formal target is not a single timestamp for an entire narrative, but a posterior distribution over acquisition, experiential, and memory windows for each report element.

Second, it separates the *time of experience* from the *experience of time*. Reports of duration loss, expansion, acceleration, co-presence, panoramicity, or uncertain sequence are phenomenological variables. They may be theoretically important, but they do not identify the external interval in which the reported state occurred.

Third, it provides an operational hierarchy of temporal claims and a provisional Temporal Localization Evidence Profile (TLEP). The profile is intentionally nonsummed at this stage. Its purpose is to expose the evidential structure of a claim rather than convert complex evidence into an authoritative total score.

Fourth, it reorganizes proposed explanations along four orthogonal dimensions: candidate timing, construction architecture, information route, and population structure. This avoids presenting unlike propositions as mutually exclusive "models."

Fifth, it derives a focused research agenda and a high-level prospective architecture. The complete report-element coding manual, provisional TLEP instructions, interview module, multicenter study architecture, statistical framework, power analysis, reporting checklist, and preregistration statements are included in Appendices A–H so the full work remains self-contained.

1.2. Scope and limits

This is a critical methodological review, not a registered systematic review or meta-analysis. It integrates landmark prospective studies and recent psychometric, methodological, neurophysiological, memory, cross-cultural, and target-testing work identified through PubMed, publisher databases, and reference chaining through 15 July 2026. The review evaluates representative evidential classes and inferential practices; it does not estimate pooled prevalence or claim exhaustive coverage. Field-wide distributional claims are therefore framed as hypotheses for a subsequent preregistered review.

The paper does not argue that NDEs are unreal, trivial, reducible to hallucination, or devoid of clinical importance. It does not assume that experience is impossible during CPR. It does not assume that consciousness can occur independently of the brain. It does not treat organized EEG activity as proof of experience, vivid memory as proof of encoding during ischemia, or low statistical power as positive evidence. Its purpose is narrower: to specify the inferential steps required before a later report can constrain the timing and mechanism of conscious or memory-related processes.

2. Existing measures and the unresolved timing problem

A clear account of novelty requires distinguishing temporal localization from three neighboring measurement projects.

The Greyson NDE Scale and NDE-C measure NDE phenomenology. Pehlivanova et al. (2026) showed that the scales largely locate respondents on the same latent phenomenological continuum. That result strengthens cumulative measurement of *what kind of experience is reported*. It does not transform the scale into a timing instrument. An item concerning altered time can establish that altered time was reported; it cannot establish whether that phenomenology arose during no-flow, CPR, reperfusion, emergence, or later consolidation.

The multidisciplinary recalled-experiences-of-death consensus statement improved terminology, clinical framing, and recommendations for future research (Parnia et al., 2022). It also emphasized standardized physiological monitoring and prospective investigation, while subsequent methodological commentary highlighted the practical difficulty of connecting later reports to specific resuscitation intervals (Martial et al., 2024). The present paper addresses a narrower unresolved inference: how to move from a later, element-rich report to competing latent process windows without silently assuming that the report is a unitary record of one earlier interval.

The veridical NDE Scale (vNDE Scale) provides a structured method for evaluating the evidential strength of reports that claim correspondence with external events (Greyson et al., 2025). It is therefore relevant to information-route assessment and corroboration. The TLEP proposed here is complementary rather than competitive. It asks whether any report element—ordinary or extraordinary—can be localized to a defined interval, whether candidate windows have been compared, and whether acquisition, experience, memory, and later information exposure have been separated.

Table 1 summarizes the distinction.

Table 1
Existing instruments and the proposed timing framework

Instrument or framework	Primary construct	What it supports	What it does not establish
Greyson NDE Scale	NDE phenomenology and threshold classification	Standardized identification and cumulative comparison of NDE reports	Clinical interval of acquisition, experience, or encoding
NDE-C	Breadth and intensity of reported NDE content	Expanded phenomenological characterization	Physiological timing or source accuracy
RED consensus guidance	Terminology, clinical standards, and research priorities	More consistent study design and reporting	Element-level joint localization across candidate windows
vNDE Scale	Evidential strength of apparently veridical perception claims	Structured appraisal of corroboration and access questions	General timing profile for all report elements
Temporal Localization Evidence Profile	Quality of evidence constraining timing	Transparent domain profile for synchronization, anchors, sources, alternatives, and memory constraints	NDE classification, phenomenal intensity, or a validated total score

The proposed framework therefore occupies a methodological gap. It does not replace phenomenological instruments. It prevents phenomenological scores, memory vividness, or case impressiveness from being used as proxies for temporal localization. Its distinctive unit is the coded report element, its inferential target

is a joint distribution over latent process windows, and its output is a transparent evidence profile rather than a new phenomenological score.

3. Temporal localization as an element-level inverse problem

3.1. A common clinical timeline

Temporal inference must begin with a common externally recorded timeline, denoted here by H. For cardiac-arrest research, H should distinguish at least:

1. pre-arrest deterioration and loss of responsiveness;
2. no-flow or uncertain-flow intervals;
3. CPR with changing compression quality, ventilation, perfusion, and medications;
4. peri-ROSC transitions;
5. post-ROSC coma, sedation, temperature management, and stabilization;
6. emergence, delirium, and early recovery;
7. each interview and subsequent information exposure.

These intervals are not assumed to be internally uniform. They are practical candidate windows within which more precise time-series evidence may be available. A claim that an element occurred "during CPR" can be strengthened only by showing why the available evidence favors a particular part of CPR over other parts and over peri-ROSC or later alternatives.

3.2. Latent process windows for each report element

Let r_i denote a coded element of a later report and D_i the evidence relevant to that element. Rather than assigning one time to r_i, the framework distinguishes three latent windows:

- W_i^{acq}: when information relevant to the element entered a processing pathway;
- W_i^{exp}: when the element was phenomenally experienced, if there was a discrete or distributed phenomenal occurrence;
- W_i^{mem}: when a retrievable trace was encoded, consolidated, reorganized, or reconsolidated.

Report occasion $t_{i,k}^{rep}$ is observed rather than latent and is indexed by interview k. A separate variable, ϕ_i, records the temporal phenomenology attributed to the element: ordinary succession, duration loss, expansion, acceleration, co-presence, panoramicity, or uncertainty of order.

The conceptual target is therefore:

$$P\left(W_i^{acq}, W_i^{exp}, W_i^{mem} \mid D_i, H\right).$$

The windows need not be single intervals or mutually exclusive. They may be represented as probability distributions over H, sets of discontinuous intervals, or unidentified states. W_i^{exp} may be empty under an account in which the later element was constructed from information that was never phenomenally experienced in that form. W_i^{acq} and W_i^{mem} may also differ: information could be processed during cue presentation but become a stable retrievable trace only during later recovery.

This structure avoids two opposite errors. It does not infer conscious experience directly from later recall. It also does not assume that later reconstruction eliminates the possibility of a genuine earlier phenomenal episode. Both experience-first and reconstruction-first architectures remain expressible.

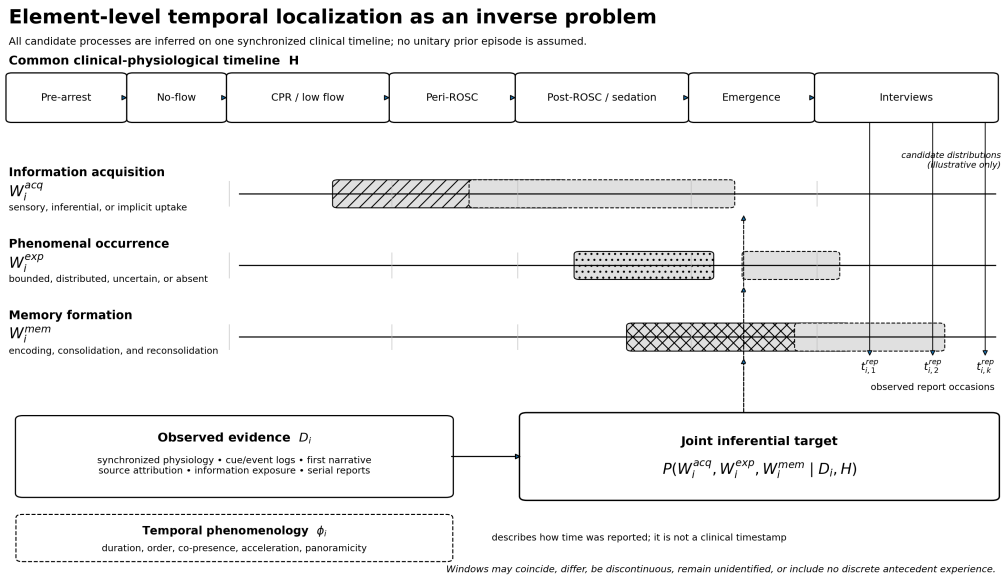

Figure 1. Element-level inverse-problem framework. Observed evidence constrains a joint distribution over acquisition, experiential, and memory windows for each coded report element on the common clinical timeline. The framework does not presuppose a unitary prior episode.

3.3. Report elements are coded units, not natural atoms

Moving from whole narratives to report elements improves temporal precision, but it introduces a new methodological responsibility: investigators must specify how elements are segmented. “Seeing a light,” “moving toward the light,” “feeling peace while approaching it,” and “later interpreting the light as a deceased relative” could be coded as one episode, several linked elements, or a hierarchy containing perceptual, affective, and interpretive components. Timing conclusions can change with the segmentation.

A defensible coding scheme should distinguish at least:

- sensory or perceptual content;
- bodily and affective states;
- thought and propositional content;
- autobiographical memories;
- temporal relations and temporal phenomenology;
- agency and causal attribution;
- metaphysical or spiritual interpretation;
- claims about externally verifiable events.

Coders should preserve hierarchical relations rather than forcing every element to be independent. A report may contain a superordinate scene with nested perceptual details and a later interpretation. Independent coders should segment and classify transcripts while blinded, where possible, to physiological data and theoretical condition. Agreement should be reported at both boundary and category levels. Sensitivity analyses should test whether temporal conclusions survive coarser and finer segmentations. Event-

segmentation research shows that perceivers impose boundaries on continuous activity, and source-monitoring research shows that recollected content and its attributed origin are separable judgments (Johnson et al., 1993; Zacks et al., 2007). Those lessons apply directly here.

3.4. The time of experience is not the experience of time

A report that "time stopped," "everything happened at once," or "my whole life was present" is evidence about ϕ_i, not direct evidence about W_i^{exp}. Brief episodes can feel extended. Sequential events can later be represented as a whole. Language can linearize content that was not experienced as linearly ordered. Conversely, a sequential narrative may reflect the order required by storytelling rather than the order of the original experience.

Temporal phenomenology deserves independent measurement because it may distinguish subtypes or mechanisms. Duration loss, expansion, accelerated cognition, co-presence, panoramic autobiographical access, and sequence uncertainty should not be collapsed into a single "timelessness" item. But no score on those dimensions can, by itself, identify a clinical interval.

3.5. A hierarchy of temporal claims

The strongest defensible claim should be matched to the evidence. Table 2 proposes a hierarchy.

Table 2
Hierarchy of temporal-localization claims

Level	Claim	Minimum evidence
Event association	A report followed a cardiac arrest or life-threatening episode	Documented event and later report
Episode association	The report is associated with the broad interval from deterioration through recovery	Clinical chronology and interview
Phase localization	Evidence favors CPR, peri-ROSC, post-ROSC coma, emergence, or later reconstruction over major alternatives	Synchronized phase data plus content or source evidence that discriminates phases
Window localization	A report element is linked to a defined time interval within a phase	Unique logged event, randomized cue, or other time-coded anchor
Content-locked localization	Verified content corresponds to information available only in that interval	Secure exposure, blinded scoring, access-route analysis, and candidate-window adjudication

The landmark studies examined here generally establish event or episode association more securely than phase- or window-level localization. Very few cases approach content-locked localization. This is not a criticism of the reports; it is a statement about what the available methods can infer.

3.6. Common inferential substitutions

Five substitutions recur across otherwise opposed interpretations:

1. **Event association becomes no-flow localization.** The report followed arrest, therefore it is assigned to the interval of absent circulation.
2. **Physiological possibility becomes case-specific experience.** Organized activity occurred in some monitored patients, therefore a particular survivor's later content is assigned to that activity.
3. **Memory vividness becomes encoding time.** A memory feels real and detailed, therefore it is assumed to have been encoded during the deepest physiological impairment.

4. **Temporal phenomenology becomes external timing.** Timelessness is treated as evidence that the experience occurred outside ordinary physiological succession.
5. **Accurate cue recall becomes conscious awareness at presentation.** A later report is treated as a direct measure of phenomenal hearing during the cue interval.

The framework does not prohibit any of the resulting conclusions. It requires the missing discriminating evidence to be supplied.

4. What the current evidence can and cannot localize

4.1. Prospective cardiac-arrest cohorts and the denominator chain

Prospective enrollment is a major advance because patients are identified through a clinical event rather than through retrospective self-selection. In the Dutch multicenter study, 62 of 344 successfully resuscitated patients reported an NDE (van Lommel et al., 2001). Other prospective studies reported smaller samples with broadly comparable minority prevalence (Greyson, 2003; Parnia et al., 2001). These studies support event association and permit comparisons between reporting and non-reporting survivors. They do not, without content-linked anchors, identify the interval in which individual elements arose.

AWARE I enrolled 2,060 cardiac-arrest events; 140 survivors completed a first interview and 101 completed a more detailed interview (Parnia et al., 2014). The study was innovative in attempting hidden visual targets, but the small number of survivors with relevant recollections and the absence of target exposure in the pertinent locations sharply limited temporal inference.

AWARE II illustrates why the complete denominator chain is part of the result. Of 567 in-hospital cardiac arrests, 53 patients survived, 28 completed interviews, and 11 of those 28 reported memories or perceptions suggestive of consciousness (Parnia et al., 2023). The often-cited 39.3% figure is therefore 11 of 28 interviewed survivors, not 39.3% of all arrests. No participant identified the visual target; one identified the auditory stimulus. EEG data were available only for a subset of arrests, and usable recordings were limited by the conditions of resuscitation.

The correct chain is:

$$N_{arrests} \rightarrow N_{survivors} \rightarrow N_{eligible} \rightarrow N_{interviewable} \rightarrow N_{interviewed} \rightarrow N_{valid\ exposure} \rightarrow N_{analyzable}.$$

Every transition is scientifically meaningful. Survivor and interview attrition can create selection effects. A null target result among five valid exposures is different from a null result among 1,000. A future study enrolling thousands of arrests but producing very few valid exposures would still be primarily a feasibility result.

4.2. Case-linked physiology constrains possibility, not content by itself

Reports and observations classified as CPR-induced consciousness show that overt responsiveness or apparent awareness can sometimes occur during ongoing chest compressions (West et al., 2022). This finding undermines any simple equation between cardiac arrest and uniform absence of organized cognition. It also increases the need for fine-grained timing because perfusion and responsiveness can change within the resuscitation episode.

AWARE II reported organized delta, theta, and alpha activity in some recorded intervals as late as 35–60 minutes into CPR (Parnia et al., 2023). Integrating EEG with regional cerebral oxygen saturation offers a

method for comparing electrophysiological organization with a perfusion proxy (Shellen et al., 2024). Such monitoring can identify candidate windows in which neural organization was more or less compatible with cognitive processing. It cannot, by itself, specify whether a survivor was conscious, what was experienced, or whether a later memory was formed during the same interval. Artifact, limited montage, intermittent recording, and survivor selection further constrain interpretation.

The same distinction applies to dying-brain electrophysiology. Borjigin et al. (2013) reported a brief surge of coherent gamma activity after cardiac arrest in rats. Xu et al. (2023) found increased gamma activity and connectivity in two of four comatose patients after withdrawal of ventilatory support. Because those patients died and could not report, the recordings cannot be linked to NDE content or establish that phenomenal experience occurred. Gamma activity is neither necessary nor sufficient as a generic marker of consciousness, and its interpretation depends on topography, coupling, artifact control, and the broader state of the system (Shaw, 2024).

The defensible inference is conditional: organized physiological activity may provide candidate mechanisms and candidate windows. Case-specific consciousness claims require linked behavioral, report, source, and timing evidence.

4.3. Memory phenomenology, implicit acquisition, and source monitoring

NDE memories often have an unusual retrieval phenotype. Compared with imagined or ordinary autobiographical memories, they may contain more sensory, emotional, self-referential, and episodic detail and may be experienced as exceptionally real or identity-central (Cassol et al., 2020; Moore & Greyson, 2017; Thonnard et al., 2013). Greyson (2007) found substantial consistency in accounts reported decades apart. These findings justify studying NDE recollections as important autobiographical memories. They do not identify the timing or mechanism of initial encoding.

Memory is not a passive record. The self-memory system organizes episodic material in relation to current goals and autobiographical knowledge, and repeated retrieval can stabilize some components while altering relations, confidence, and interpretation (Conway & Pleydell-Pearce, 2000; Schacter, 1999). Source monitoring is a judgment about whether remembered content arose from perception, imagination, inference, conversation, or another source (Johnson et al., 1993). A person can confidently remember content while misattributing its source or timing.

The anesthesia literature further cautions against equating later report with conscious awareness at acquisition. Systematic review evidence indicates that implicit memory effects can occur under some anesthetic conditions even when explicit recollection is absent, and process-dissociation methods attempt to separate controlled from automatic influences (Kim et al., 2023; Linassi et al., 2021). The analogy to cardiac arrest is limited; anesthesia and CPR are different physiological states. The methodological lesson is general: information processing, retrievable influence, explicit memory, and phenomenal awareness are not interchangeable.

A positive NDE memory finding must therefore be decomposed. Vividness, confidence, detail, autobiographical centrality, source attribution, and timing accuracy are distinct variables. Vividness may predict NDE classification and long-term impact while failing to predict externally verified timing.

4.4. Narrative temporality, culture, and specificity

Narrative studies show both recurring features and substantial variation in order. Martial et al. (2017) found that some elements showed probabilistic sequencing across accounts, but there was no fixed universal order. Reports of altered time occurred in a subset rather than all cases. These findings argue against treating "the NDE" as a unitary temporal script.

Cross-cultural work raises a second issue: the available categories are not culturally neutral. Non-Western reports can differ in imagery, interpretation, narrative convention, and the metaphors used for time, space, agency, and personhood (Belanti et al., 2008; Kellehear, 1993). A recent Chinese validation of the NDE-C supports cross-language use while also illustrating the need for item-level adaptation and measurement testing (Li et al., 2024). A participant who describes events as "present together" may not mean the same thing as a participant who endorses a translated item stating that "all events occurred at once."

Temporal phenomenology instruments should therefore begin with an open narrative in the participant's strongest language, followed by neutral clarification and only then structured ratings. Configural, metric, and scalar invariance should be tested before cross-cultural mean comparisons. Where invariance fails, the correct response is not to force a universal total score but to retain a shared core and culture-specific constructs.

Specificity also requires comparison with NDE-like reports outside life-threatening events. Similar phenomenology has been reported in syncope, anesthesia, meditation, drug states, dissociation, and non-life-threatening circumstances (Charland-Verville et al., 2014). If altered time and panoramicity occur across these conditions, they may index general features of altered consciousness, memory, or narrative construction rather than mechanisms specific to dying. This does not reduce their importance. It changes the causal question.

4.5. Apparently veridical perception and controlled information

Reports of accurate perception during apparent unresponsiveness are the most potentially discriminating evidence and the most vulnerable to timing, access, and information-flow errors. A corroborated detail can establish correspondence between a report and an event. It does not automatically establish when the information was acquired, that all ordinary routes were unavailable, or that the participant was phenomenally aware at acquisition.

The vNDE Scale improves transparency in evaluating such claims (Greyson et al., 2025). Prospective target paradigms improve further by randomizing content, logging exposure, blinding scorers, and defining chance. Yet target studies face a severe exposure problem. Visual targets positioned above eye level may rarely be in a participant's effective field, even if an out-of-body experience is later reported. Auditory cues create more valid exposures, but ordinary hearing and implicit processing remain live explanations.

A positive time-stamped auditory-cue result supports an inference ladder rather than one decisive conclusion (Figure 2). Verified presentation plus accurate later report supports cue-related information uptake and formation of a retrievable trace. The further claim that the participant consciously heard or understood the cue during presentation requires convergent evidence: a contemporaneous experiential description, source confidence, compatible physiology, exclusion of later disclosure, and discrimination from implicit acquisition.

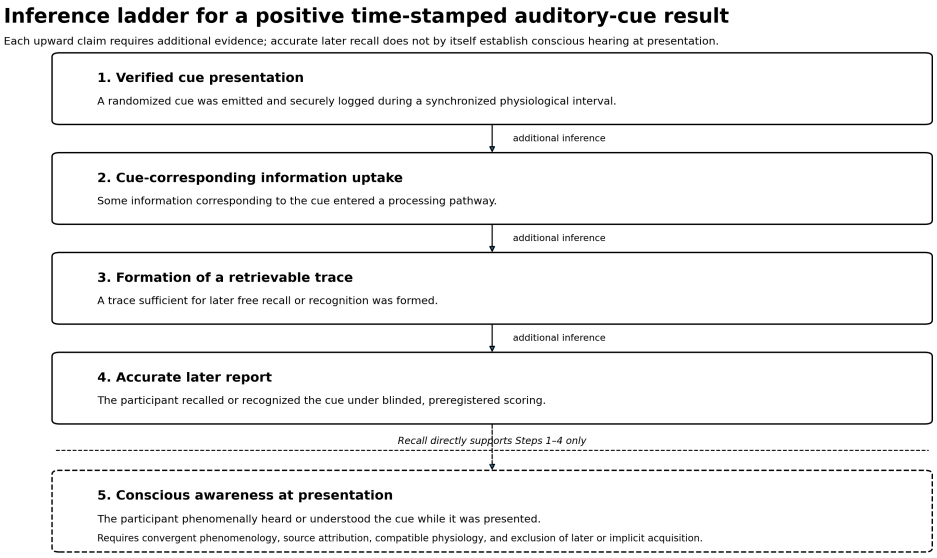

Figure 2. Inference ladder for a positive time-stamped auditory-cue result.

The same discipline applies to null findings. A null result is informative only relative to valid exposure and a model's predicted success rate. Low power is a limitation; it is not positive evidence for the claim that failed to produce a hit.

4.6. Evidence-class summary

Table 3
What major evidence classes can and cannot establish alone

Evidence class	Can establish	Cannot establish alone
Prospective survivor interview	Report frequency, phenomenology, associations, and aftereffects in a defined cohort	Exact interval of acquisition, experience, or encoding
Case-linked clinical timeline	Broad phase constraints and correspondence with resuscitation events	A narrow window unless content distinguishes one
EEG, cerebral oximetry, and CPR logs	Physiological organization and perfusion in measured intervals	Subjective content without a linked report
Dying-patient EEG without survival	Possible organized activity near death	Presence, timing, or content of experience
Memory-characteristics study	Vividness, confidence, centrality, detail, and later stability	Original source, conscious status at acquisition, or encoding time
Narrative and cross-cultural analysis	Reported structure, metaphors, order, and cultural variation	Literal experiential simultaneity or physiological chronology
Corroborated external detail	Correspondence between report and event	Exclusion of ordinary access or exact timing unless designed
Randomized target or cue	Interval-specific information acquisition under valid exposure	Conscious awareness at presentation or timing of the wider NDE

5. The Temporal Localization Evidence Profile

5.1. Purpose

The proposed Temporal Localization Evidence Profile (TLEP) is a provisional framework for describing how strongly a study or case constrains timing. It is not an NDE scale, a consciousness scale, a veridicality verdict, or a measure of spiritual significance. It should not be used to decide whether an experience was "real."

The TLEP contains seven domains, each rated provisionally from 0 to 2 for transparency. The ratings should be displayed as a profile. They should not be summed into a total until reliability, dimensionality, redundancy, weighting, and criterion validity have been studied. The earlier label "TLER-14" is therefore abandoned: a 0–14 total would imply psychometric maturity that does not yet exist.

5.2. Anti-halo rule

Raters must score only evidence that constrains temporal localization. Phenomenological intensity, emotional force, narrative beauty, perceived realism, moral transformation, metaphysical interpretation, and the apparent extraordinariness of a claim are not timing evidence. A mundane but precisely logged detail may have a stronger timing profile than a panoramic life review lacking an external anchor.

Where possible, timing raters should receive standardized case abstracts that mask nonessential evaluative language. Global "case impressiveness" should be rated separately in validation studies to test whether the TLEP resists halo effects.

5.3. Seven-domain profile

Table 4
Provisional Temporal Localization Evidence Profile

Domain	0: weak or absent	1: partial	2: strong
Time-base integrity	Approximate chronology; no reliable common clock	Major events time-stamped but devices, stimuli, or drift incompletely aligned	Physiology, resuscitation devices, stimuli, and logs share a validated time base with known error
Physiological-state resolution	Broad label such as "arrest" or "unconscious"	Major phases approximately resolved	High-resolution integrated physiology, interventions, drugs, ROSC, and behavioral state
Content-linked anchor	No external anchor	Generic or retrospectively timed event compatible with several windows	Randomized cue or unique independently logged event available only in a defined interval
First report and information flow	Delayed or undocumented first report; exposures unassessed	Early interview or partial exposure history	Open recorded narrative before leading questions or target disclosure, with content-specific exposure log
Corroboration and route analysis	No independent verification; ordinary access unexamined	Corroboration or route analysis incomplete	Independent blinded verification plus evaluation of sensory, inferential, leakage, and reconstruction routes
Candidate-window adjudication	One interval asserted; alternatives ignored	Alternatives named but not compared with case evidence	Claimed and clinically plausible alternative windows compared using physiology, cues, drugs, behavior, and interviews
Memory and source constraints	Encoding inferred directly from later report	Broad memory, amnesia, sedation, or interview constraints	Serial source monitoring, time-linked cue evidence, pharmacology, and report evolution materially constrain memory formation

The profile should be applied at the level of a claim or report element, not necessarily once for an entire case. A study may have excellent time-base integrity but weak source control, or strong corroboration but poor candidate-window adjudication. The profile makes those differences visible.

5.4. Validation agenda

TLEP development should proceed in stages:

1. create a detailed scoring manual with worked examples;
2. apply it to a preregistered sample of published studies and cases;
3. measure inter-rater reliability and domain redundancy;
4. test resistance to phenomenological halo effects;
5. use planted or independently known timing scenarios to assess criterion validity;
6. compare profiles with global case judgments, vNDE ratings, and design-quality measures;
7. test whether any additive or weighted total improves prediction of known timing.

If the domains do not form a coherent scale, that is not a failure. The profile may be more useful as a multidimensional evidence map than as a psychometric instrument.

6. Explanations should be represented on orthogonal dimensions

The literature often compares unlike "models" as if they were mutually exclusive. A claim about *when* an experience occurred is not at the same explanatory level as a claim about *how* a narrative was constructed or *how* information entered the system. A heterogeneous-population hypothesis can contain several timing and construction mechanisms. The solution is to represent explanations on orthogonal dimensions. Recent neuroscientific synthesis likewise favors a multimechanism research program over one undifferentiated cause (Martial et al., 2025).

6.1. Timing dimension

Candidate windows include pre-arrest deterioration, no-flow, CPR or intermittent low flow, peri-ROSC, post-ROSC coma or sedation, emergence, and later reconstruction. An element may have probability distributed over several windows.

6.2. Construction dimension

Three broad architectures are distinguishable:

- **unitary experience-first:** a relatively coherent episode occurs and is later encoded and reported;
- **distributed:** different elements arise in different intervals and are integrated over time;
- **reconstruction-first:** the later narrative acquires organization during consolidation or retrieval, and some elements have no discrete antecedent phenomenal counterpart.

These are endpoints, not exhaustive categories. Mixed architectures are expected.

6.3. Information-route dimension

A report element may derive from ordinary sensory access, implicit or unconscious acquisition, inference from available facts, later disclosure or contamination, imagination and source confusion, or acquisition not explained by the measured neural and ordinary sensory routes.

The last category is an operational residual, not an automatic endorsement of extracorporeal perception. It earns theoretical significance only after the measured routes are specified and prospectively constrained.

6.4. Population dimension

The field may contain one dominant process, several replicable latent classes, or continuous heterogeneity. The heterogeneous account is not permitted to explain every messy result after the fact. It should be tested with preregistered finite-mixture or latent-class models, constrained class numbers, minimum class sizes, held-out prediction, and cross-site replication (Collins & Lanza, 2010).

Table 5
Orthogonal explanatory dimensions

Dimension	Candidate values	Primary discriminating evidence
Timing	no-flow; CPR; peri-ROSC; post-ROSC; emergence; later	synchronized physiology, unique events, cues, pharmacology
Construction	unitary experience-first; distributed; reconstruction-first; mixed	earliest narrative, element dependencies, serial change, source attribution
Information route	ordinary sensory; implicit; inference; contamination; imagination; unexplained by measured routes	target security, access analysis, source monitoring, cue tests
Population structure	one process; latent classes; continuous heterogeneity	preregistered mixture models and out-of-sample replication

This structure permits precise joint hypotheses. For example, a report may involve ordinary auditory acquisition during CPR, no contemporaneous phenomenal awareness, later memory stabilization during emergence, and narrative integration during the first days after recovery. Another report may involve a coherent peri-ROSC experience with immediate memory formation. The framework compares these combinations rather than forcing them into one undifferentiated category.

6.5. Parameterizing acquisition not explained by measured routes

Claims of information acquisition without ordinary sensory access or relevant measured neural support require a high evidential threshold, but "high" should be defined prospectively rather than moved after the data are known.

A testable version must specify:

- the eligible population;
- a valid exposure definition;
- the target universe and chance model;
- what sensory and information routes are to be excluded;
- the minimum exposure-conditional success rate, p_U, predicted by the hypothesis;
- the replication criterion.

If zero successes occur in n valid independent exposures, the approximate 95% upper confidence bound is $3/n$ (Hanley & Lippman-Hand, 1983). Thus, zero successes in 300 valid exposures would place the upper bound near 1%; zero in 1,000 near 0.3%. Such findings cannot exclude a hypothesis that predicts one event per million exposures. They can exclude a preregistered version that predicts one per hundred.

A positive result should require more than nominal statistical significance. It should include prospective target security, independently audited exposure, blinded response scoring, explicit ordinary-route analysis,

correction for the defined target universe, and direct replication at an independent site. A claim that declines to specify any minimum event rate or discriminating prediction remains a metaphysical possibility rather than a tested empirical model.

7. Testable hypotheses and immediate research priorities

The framework is valuable only if it produces research that could alter its central claims. Table 6 presents eight hypotheses.

Table 6
Preregisterable hypotheses derived from the framework

Hypothesis	Test	Finding that would weaken it
H1. Temporal indeterminacy	Apply TLEP to a preregistered systematic sample of claims described as occurring during arrest	Most studies support phase-, window-, or content-locked localization
H2. Salience-timing dissociation	Model vividness, realism, emotion, and autobiographical centrality separately from externally verified timing	Phenomenological salience robustly predicts timing accuracy after design quality is controlled
H3. Acquisition-awareness dissociation	Compare cue recall alone with cue recall plus contemporaneous awareness description and compatible physiology	Recall alone predicts all relevant outcomes as well as convergent evidence
H4. Report evolution	Compare element boundaries, source attributions, and temporal order at 24–72 h, 1 month, 6 months, and 12 months	No stable core or systematic later organization can be distinguished
H5. Physiology-content coupling	Test whether case-linked EEG, perfusion, and intervention features predict time-linked content rather than survival alone	Physiological features fail to improve case-level timing prediction
H6. Cross-cultural structure	Test configural and partial metric invariance of temporal-phenomenology dimensions	No shared core can be identified across language groups
H7. Replicable heterogeneity	Compare one-class and constrained mixture models with held-out site replication	Classes are unstable, too small, site-specific, or nonpredictive
H8. Parameterized unexplained-route acquisition	Compare valid-exposure results with preregistered p_U and replication rules	The hypothesis survives only through post hoc reductions in predicted rate or relaxed exposure criteria

The most immediately feasible project is H1: a preregistered methodological review. Reviewers would identify published claims that locate experience during cardiac arrest, segment the claims into elements, apply the TLEP, and classify the strongest supported temporal level. This study would empirically test rather than merely assert that the literature is rich in event association but poor in narrow localization.

H2 should avoid unstable partial regression in the presence of highly correlated phenomenological variables. Vividness, emotional intensity, perceived realism, and autobiographical centrality can be modeled as separate indicators of a latent salience factor. Timing accuracy should be defined by independently logged events or cues, not by participant certainty. TLEP criterion validity would be supported if its domains predict known timing more strongly than salience or global case impressions.

H4 is especially important because apparent stability can coexist with reinterpretation. A core perceptual element may recur across interviews while source attribution, causal explanation, and temporal order change. Analyses should distinguish verbatim stability, semantic stability, boundary changes, and interpretive additions.

8. Implications for theories of consciousness

Temporal localization is not a theory of consciousness. It is a prerequisite for connecting reports to candidate mechanisms. Better timing would make several theory-relevant questions empirically tractable.

8.1. Global neuronal workspace and conscious access

Global-workspace approaches distinguish widespread access from local or unconscious processing (Dehaene & Changeux, 2011). If report elements were linked to intervals containing organized, globally coordinated activity during CPR, the finding would constrain how little perfusion and how much network organization can support access-like processing. If cue information influenced later behavior or memory without a contemporaneous awareness report, the result would reinforce the distinction between information processing and global access.

The framework does not assume that a particular scalp-EEG pattern is equivalent to workspace ignition. It requires a case-linked relationship among physiology, content, and timing.

8.2. Recurrent-processing accounts

Recurrent-processing theories emphasize feedback processing beyond an initial feedforward sweep (Lamme, 2006). High-resolution localization could test whether candidate experiential intervals contain signatures compatible with recurrent cortical organization, although ICU EEG is a coarse instrument for this purpose. A finding that content-locked reports arise only after the return of organized recurrent dynamics would favor one timing architecture over a no-flow account. A contrary result would require careful analysis of measurement sensitivity before theoretical revision.

8.3. Higher-order and metacognitive accounts

Higher-order theories distinguish first-order representation from awareness of being in that state (Lau & Rosenthal, 2011). The auditory-cue problem provides a concrete analogue. Cue-related information could be acquired and later retrieved without the participant having consciously heard it at presentation. Convergent source confidence, phenomenological description, and metacognitive access would therefore be theoretically informative rather than optional embellishments.

8.4. Memory-construction accounts

If major narrative organization appears during emergence or evolves systematically across interviews, the result would support accounts in which memory construction is integral to the reported episode rather than merely a source of error. Conversely, early stable element structure combined with content-locked timing would constrain strong reconstruction-first accounts. The framework therefore makes reconstruction empirically vulnerable rather than using it as an unrestricted explanation of any discrepancy.

8.5. Substrate-dependent and non-neural views

Theories that regard biological or physical substrate as essential to consciousness are not directly adjudicated by timing alone. Nor would an accurately timed unexplained target result establish a complete non-neural theory. It would, however, challenge the adequacy of the measured sensory and neural acquisition model and justify more discriminating experiments. Temporal localization narrows the causal target; it does not settle the ontology of consciousness.

Table 7 summarizes the theory-facing consequences.

Table 7
Examples of theory-relevant localization outcomes

Possible result	Primary theoretical consequence
Report elements align with organized activity during CPR	Constrains access and recurrent-processing models under low-flow conditions
Cue uptake occurs without contemporaneous awareness evidence	Separates first-order processing and memory from higher-order access
Major content localizes to peri-ROSC or emergence	Supports state-transition and reconstruction accounts
Phenomenal occurrence appears to precede durable memory formation	Separates experience from later reportability
Content-locked information persists after stringent route exclusion	Challenges the measured acquisition model; does not by itself prove a complete alternative ontology
Temporal phenomenology varies independently of clinical timing	Separates mechanisms of time experience from mechanisms of general awareness

9. Prospective research architecture

A full multicenter study architecture is presented in Appendix D. It remains a research proposal requiring co-development with resuscitation clinicians, EEG specialists, pharmacologists, memory researchers, psychometricians, statisticians, cross-cultural methodologists, and clinical ethicists. The principal design requirements are summarized here.

9.1. Complete denominator reporting

Every arrest that activates the study system should remain in the flow diagram, including cases later excluded from a primary timing analysis. Survival, neurological status, language, prior cognitive impairment, sedation, delirium, medical instability, consent or consultee process, interviewability, cue exposure, and signal quality should each be reported. Exclusion from an analysis must not erase a case from the denominator.

9.2. Common clock and operational integrity

Clinical monitors, compression devices, cue systems, EEG, cerebral oximetry, medication records, and event logs must use a documented common time base with known error and drift. Sites should pass simulated resuscitation runs before enrollment. Clock failure, target leakage, unlogged cue presentation, or leading disclosure should trigger preregistered case quarantine for the affected claim. Quarantined cases remain descriptively reported.

9.3. Case-linked physiology and pharmacology

The study should capture ECG, compression and ventilation data, end-tidal carbon dioxide, cerebral oximetry, EEG where feasible, shocks, medications, ROSC, temperature, and behavioral signs. Sedatives, analgesics, neuromuscular blockers, doses, routes, times, organ function, and temperature management must be modeled rather than treated as background noise. Clinical care should not be standardized for research convenience.

9.4. Cues and targets

Auditory cues should be randomized, time-stamped, securely logged, and accompanied by environmental audio or equivalent verification of presentation. Free recall should precede recognition. The response universe and semantic matching rules must be specified before data collection so that "chance" is calculable. Hidden visual targets can remain secondary, but valid exposure must be defined separately from mere device activation.

9.5. Early neutral interviews and information-flow records

The first interview should occur as soon as clinically and ethically appropriate, ordinarily within 24–72 hours, beginning with uninterrupted open narrative. Interviewers can be blinded to targets and specific hypotheses, but cannot remain blind to NDE-like content once disclosed. Blinding should therefore be described as partial, interviews recorded, adherence centrally rated, and interviewer identity modeled.

Every relevant information exposure should be logged by source, time, medium, content, documentation, and possible overlap with later report elements. "Spoke with family" is insufficient. The record should indicate what the participant was told and whether the exposure occurred before or after each interview.

9.6. Serial and cross-cultural assessment

Follow-up at one, six, and twelve months can distinguish early element structure from later consolidation and meaning-making. The primary timing analysis should privilege the earliest usable account. Longer follow-up is valuable for memory evolution and aftereffects but should not retrospectively upgrade weak early timing evidence.

Open narratives should be collected in the participant's strongest language. Translation, back-translation, cognitive interviewing, and differential-item-functioning analyses are necessary before treating temporal-phenomenology measures as comparable across cultures (Beaton et al., 2000; Wild et al., 2005).

9.7. Power envelopes and null updating

Sample-size simulation must propagate the entire denominator chain rather than begin with interviewed survivors. A study may be adequately powered to detect an exposure-conditional cue-recall rate above a specified threshold while remaining underpowered for rare subtypes, latent-class comparisons, or very low-rate unexplained acquisition hypotheses.

Null findings should be interpreted against valid exposure and preregistered predictions. Zero cue identifications in a well-audited, well-powered exposure sample is a result that updates the relevant hypotheses. It is not a failed study.

Table 8
Minimum architecture for a prospective temporal-localization study

Component	Requirement	Inferential purpose
Enrollment	Consecutive arrests and complete screening log	Defines population and attrition
Time integrity	Common clock, drift audit, mock-code certification	Makes interval claims technically possible
Physiology	Integrated resuscitation, perfusion, EEG, drugs, ROSC, and emergence data	Defines candidate windows
Auditory cues	Randomized, secure, time-stamped, exposure-audited	Constrains acquisition and memory formation

Component	Requirement	Inferential purpose
Interviews	Early open narrative, partial blinding, recordings, serial follow-up	Captures content before and across reconstruction
Information-flow record	Who conveyed what, when, and before which interview	Models contamination and source attribution
Cross-cultural process	Strongest-language narrative and measurement-invariance testing	Prevents culture-bound items from masquerading as universals
Quality assurance	Central audit, protocol-drift monitoring, quarantine rules	Prevents operational weakness from becoming strong inference
Analysis	Preregistered joint-window and model comparisons	Makes positive and null findings interpretable

10. Discussion

The central contribution of this paper is a change in the unit and target of inference. The unit is the report element rather than the finished narrative. The target is a joint distribution over acquisition, phenomenal, and memory windows rather than one presumed time of "the experience." Report time and temporal phenomenology are observed separately. This architecture is neutral about whether the later report preserves a unitary episode, integrates fragments, or partly constructs content during consolidation and retrieval.

The framework also clarifies why several kinds of impressive evidence remain temporally weak. A vivid memory is evidence about retrieval phenomenology. A gamma surge is evidence about electrophysiology. A report of timelessness is evidence about experienced or narrated temporality. A corroborated detail is evidence of correspondence. None of these variables automatically identifies the same latent process or interval.

This restraint does not make the framework skeptical in one direction only. Neural accounts cannot assign content to residual activity merely because such activity is physiologically possible. Non-neural accounts cannot assign content to no-flow merely because the report is lucid, panoramic, or difficult to explain. Reconstruction accounts cannot explain every mismatch without predicting how narratives should evolve. Heterogeneity cannot be invoked unless stable classes improve prediction. Each account must expose itself to timing evidence.

The TLEP is intentionally provisional. Its value at this stage is conceptual transparency, not numerical authority. The profile makes explicit whether a claim depends on synchronized clocks, a content-linked anchor, source control, candidate-window adjudication, and memory constraints. It can fail as a summed scale while succeeding as a reporting framework.

The paper's clinical implication is equally limited. NDE reports can be consoling, destabilizing, identity-transforming, or difficult to integrate. Clinicians need not adjudicate ontology to respond competently. They can document the report neutrally, ask about distress and meaning, avoid premature pathologizing, and distinguish the patient's interpretation from the evidential claims of a research study.

11. Limitations

First, this is a critical rather than systematic review. The temporal-indeterminacy thesis should be tested through preregistered screening, duplicate coding, and formal application of the TLEP to a defined literature sample.

Second, report-element segmentation may itself introduce investigator structure. Hierarchical coding, independent segmentation, and sensitivity analyses reduce but do not eliminate that risk.

Third, the latent windows are conceptual variables rather than directly observed states. Joint inference will require explicit generative models, priors, dependence structures, and uncertainty in clock alignment. The equation presented here is a formal target, not a completed statistical implementation.

Fourth, the TLEP has not been validated. Domain ratings may reflect reporting completeness rather than procedures actually performed, and the domains may be correlated or nonadditive. No total score should be treated as authoritative.

Fifth, ICU monitoring is incomplete. Scalp EEG has limited spatial sensitivity, cerebral oximetry is an indirect perfusion measure, and resuscitation creates artifact. Absence of a measured signal is not equivalent to absence of relevant neural activity.

Sixth, cross-cultural adaptation may reveal that some temporal constructs are not invariant. A universal scale may be neither possible nor desirable.

Finally, temporal localization is necessary but insufficient. Even a precisely timed phenomenal occurrence would leave open why that state was conscious, what physical properties were sufficient, and whether the report exhausts the experience. The framework improves the causal question; it does not solve consciousness.

12. Conclusion

Near-death research has advanced beyond anecdote. Prospective cohorts establish that structured reports occur in a minority of survivors. Physiological studies show that resuscitation and dying can contain more organized activity than a simple cessation model implies. Memory research documents vivid and identity-central recollections. Narrative research identifies recurring temporal themes and cultural variation. Controlled cues and targets create the beginnings of a rigorous test environment.

The remaining weakness is a recurrent collapse of several times into one. A report after recovery establishes a reportable memory at report time. Its elements may constrain earlier intervals, but they do not identify those intervals without independent anchors. Information can be acquired without a discrete reportable experience. Experience can occur before durable memory formation. Narrative unity can increase during consolidation. Temporal phenomenology can differ from external chronology.

The field should therefore ask, element by element: What information was available? When could it have been acquired? Was there evidence of phenomenal awareness? When did a retrievable trace form? What was learned later? Which candidate windows remain viable, and which are excluded?

The strongest immediate contribution is methodological rather than metaphysical:

> **Near-death research is rich in evidence about how time is later described, but comparatively poor in evidence about when the informational, experiential, and mnemonic components arose.**

Temporal localization is not the final answer. It is the condition for asking the causal question correctly.

Appendices and Operational Materials

These appendices provide the operational materials needed to apply the element-level inverse-problem framework developed in the main text. They specify a report-element coding method, a provisional and nonsummed Temporal Localization Evidence Profile, a temporal-phenomenology interview module, a prospective multicenter study architecture, a statistical analysis framework, a power and null-updating plan, a reporting checklist, and preregistration statements.

The materials are proposals for development and validation. They are not a validated instrument, a deployable clinical protocol, or a substitute for local clinical governance, regulatory review, device validation, or a complete statistical analysis plan.

Appendix A. Report-Element Segmentation and Coding Manual
Appendix B. Temporal Localization Evidence Profile
Appendix C. Provisional Temporal-Phenomenology Module
Appendix D. Prospective Multicenter Study Architecture
Appendix E. Statistical Analysis Framework
Appendix F. Power Envelope and Model-Dependent Null Updating
Appendix G. Reporting Checklist
Appendix H. Provisional Preregistration Statements

Appendix A. Report-Element Segmentation and Coding Manual

A.1. Why element-level coding is required

The phrase "the experience occurred during cardiac arrest" bundles at least three assumptions: that there was one completed experience, that it was stored as a coherent memory, and that the later report preserves the timing of the original episode. None follows merely from the existence of the report.

An element-level analysis permits different components to receive different temporal assignments. For example, a participant might report:

> "I heard a mechanical voice say *blue river*. I then felt myself above the bed, saw a nurse near my feet, felt peaceful, and later understood that I had been shown that death was not the end."

This account contains, at minimum:

- a claimed auditory detail;
- a claimed spatial perspective;
- a claimed visual detail;
- an affective state;
- a temporal relation among the reported components; and
- a later interpretation.

The auditory phrase might correspond to a time-stamped cue. The nurse's location might correspond to a clinical log. The elevated perspective may have no external anchor. The peaceful feeling may be difficult to localize. The metaphysical conclusion may have developed during subsequent reflection. Treating the entire narrative as one event would conceal these differences.

A.2. Definition of a report element

A **report element** is the smallest transcript unit that can receive a distinct classification for content type, source attribution, confidence, or candidate timing without materially changing its asserted meaning.

This definition is operational rather than metaphysical. Elements are coding units imposed for analysis; they are not assumed to be natural atoms of experience or memory. The distinction follows event-segmentation and source-monitoring research in treating perceived boundaries and attributed origins as analyzable judgments rather than transparent copies of a continuous event (Johnson et al., 1993; Zacks et al., 2007). A complex scene may be represented as a hierarchy containing a superordinate episode and nested elements.

Core element classes

1. **Perceptual or sensory content**
   Claimed visual, auditory, tactile, olfactory, gustatory, vestibular, proprioceptive, or interoceptive content.
2. **Bodily or affective state**
   Pain, peace, fear, warmth, pressure, bodily absence, bodily expansion, or other felt state.
3. **Thought or propositional content**
   A thought, judgment, realization, question, intention, or apparently communicated proposition.

4. **Autobiographical content**
   A personal memory, life episode, relationship, or panoramic autobiographical representation.
5. **Temporal relation or temporal phenomenology**
   Before/after relations, simultaneity, duration loss, expansion, acceleration, panoramicity, or uncertainty of sequence.
6. **Agency and causal attribution**
   Claims about who or what caused an event, initiated movement, communicated content, or returned the participant.
7. **External-event claim**
   A description asserted to correspond to a clinically or independently observable event.
8. **Interpretive or metaphysical attribution**
   A later conclusion such as "I was dead," "this was an afterlife," "the light was God," or "the experience was only a dream."
9. **Source statement**
   An explicit judgment about whether content was seen, heard, inferred, dreamed, remembered, learned later, or cannot be sourced.

A.3. Hierarchical representation

Elements should be coded in a hierarchy rather than flattened into an unordered list. A suggested structure is:

- **Scene or episode node**: a superordinate unit such as "being above the bed."
  - perceptual child: "I saw the physician at my left side";
  - spatial child: "I was near the ceiling";
  - affective child: "I felt calm";
  - temporal child: "this happened before the tunnel";
  - interpretive child: "I had left my body."

The hierarchy distinguishes the reported scene from the later explanation of the scene. It also permits a clinical anchor to support one child element without automatically supporting every other element in the scene.

A.4. Segmentation procedure

Stage 1: Preserve the source record

- Retain the complete audio or video recording and a verbatim transcript.
- Mark interviewer speech separately.
- Preserve pauses, uncertainty markers, corrections, and explicit source language.
- Do not replace the participant's wording with NDE terminology during transcription.

Stage 2: Identify candidate boundaries

Coders mark boundaries where any of the following changes:

- sensory modality;
- object or event referred to;
- spatial location or perspective;

- affective state;
- temporal relation;
- propositional content;
- source attribution;
- confidence;
- interpretive level.

A new sentence is not automatically a new element, and one sentence can contain several elements.

Stage 3: Assign hierarchy and content class

Each segment receives:

- a unique element identifier;
- parent scene or episode, where applicable;
- one primary content class and optional secondary classes;
- verbatim supporting text;
- participant confidence, if expressed;
- source attribution, if expressed;
- whether the element was spontaneous or elicited;
- whether it appeared in the first open narrative or only after prompting.

Stage 4: Separate observation from interpretation

Coders should split:

> "I saw the doctor shock me, so I knew I was dead."

into at least:

- claimed visual observation: doctor administered a shock;
- inferred self-state: participant was dead;
- causal relation: the observed shock produced that conclusion.

The inferred self-state should not inherit the temporal anchor or corroboration of the observable event automatically.

Stage 5: Link elements across interviews

Elements from later interviews should be linked to earlier elements as:

- verbatim recurrence;
- semantically stable recurrence;
- elaboration;
- boundary split or merger;
- changed source attribution;
- changed order;
- changed confidence;
- new element;
- interpretive addition.

This permits stability and reconstruction to be analyzed separately. A stable perceptual core can coexist with later interpretive expansion.

A.5. Coding reliability

At least two coders should independently segment a training subset and a formal reliability subset. Coders should be blinded, where feasible, to:

- physiological timing;
- cue or target content;
- whether an external detail was corroborated;
- the investigators' preferred explanatory account.

Reliability should be assessed at several levels:

- **boundary agreement**: similarity of element boundaries;
- **class agreement**: agreement on element category;
- **hierarchy agreement**: agreement on parent-child structure;
- **source agreement**: agreement on stated or inferred source class;
- **cross-interview linkage**: agreement on whether elements recur, elaborate, or change.

Because boundaries are not simple categorical labels, a tolerance-window or text-overlap metric may be more informative than exact boundary matching alone. Reports should include both raw agreement and a chance-corrected or model-based index appropriate to the data structure.

A.6. Segmentation sensitivity analysis

Temporal conclusions should be repeated under at least three representations:

1. **fine segmentation**, separating modality, attribution, and interpretation;
2. **primary segmentation**, determined by the preregistered manual;
3. **coarse segmentation**, combining tightly linked child elements into scenes.

A localization claim is more robust if it survives reasonable changes in segmentation. If support exists only under one highly specific segmentation, that dependence is part of the result.

A.7. Recommended coding fields

Table A1
Minimum Report-Element Record

Field	Description
Case and interview identifier	Participant and report occasion
Element identifier	Stable identifier across analyses
Parent element	Scene or episode containing the element
Transcript span	Verbatim text and timecode
Primary content class	Perceptual, affective, propositional, autobiographical, temporal, external-event, interpretive, or source statement
Secondary classes	Optional linked classifications
Spontaneous or elicited	Open narrative, neutral clarification, structured question, or recognition test

Field	Description
Participant source attribution	Seen, heard, felt, inferred, dreamed, remembered, learned later, mixed, or cannot tell
Confidence	Participant-rated confidence with “cannot tell” permitted
Proposed candidate windows	Pre-arrest, no-flow, CPR, peri-ROSC, post-ROSC, emergence, later reconstruction, or unidentified
External anchor	Cue, machine event, staff action, document, or none
Corroboration status	Independent, nonindependent, contradicted, unavailable, or not applicable
Information exposures	Linked entries from the information-flow record
Cross-interview status	Stable, elaborated, reordered, source-changed, new, or omitted

Appendix B. Temporal Localization Evidence Profile

B.1. Purpose

The TLEP is a provisional seven-domain profile for describing how strongly a study or case constrains temporal localization. Its domains respond to limitations identified in consensus guidance, prospective cardiac-arrest research, integrated physiological monitoring, and subsequent methodological commentary (Martial et al., 2024; Parnia et al., 2022, 2023; Shellen et al., 2024). It is not:

- an NDE scale;
- a consciousness scale;
- a credibility score for the participant;
- a measure of phenomenological depth;
- a probability that an event occurred as interpreted;
- a validated additive score.

The domains may be correlated and may not deserve equal weight. At this stage, investigators should report the seven-domain profile rather than a total. A summed 0–14 value may be retained only for exploratory validation analyses and should not be used to classify evidence as weak, moderate, or strong until dimensionality, weighting, reliability, and criterion validity are established.

B.2. Anti-halo rule

Raters must score only evidence that constrains timing. The following are **not** temporal evidence:

- narrative vividness;
- emotional intensity;
- perceived realism;
- spiritual significance;
- moral transformation;
- detail quantity by itself;
- the prestige of the research group;
- the rater's judgment that the report is extraordinary;
- the rater's judgment that the report is mundane.

A precisely logged ordinary detail can have a stronger temporal profile than a panoramic life review with no external anchor. Where feasible, TLEP raters should receive standardized case abstracts in which unnecessary dramatic and metaphysical language has been masked.

B.3. Domain definitions and anchors

Table B1
Provisional TLEP Domains and Operational Anchors

Domain	0	1	2
1. Time integrity	No common time base or timing cannot be audited	Partial synchronization or known but broad uncertainty	Validated common time base with documented offset, drift, and error tolerance

Domain	0	1	2
2. Physiological-state resolution	Clinical phase cannot be distinguished	Broad phases distinguished, but relevant windows remain unresolved or signals are incomplete	Resolution sufficient to compare the candidate windows material to the claim, with artifact and missingness documented
3. Content-linked temporal anchor	No anchor linked to the report element	Anchor exists but is broad, nonunique, retrospectively inferred, or weakly linked	Unique or highly discriminating logged event or randomized cue linked directly to the element
4. First report and information flow	First report occurred after uncontrolled information exposure or documentation is absent	Early report or partial exposure history, but important uncertainty remains	Open first report precedes disclosure and leading questions; content-specific, time-stamped information-flow record is available
5. Corroboration and access-route control	No independent corroboration or ordinary access not assessed	Some corroboration or access analysis, but independence or route exclusion is incomplete	Independent documentary or machine corroboration with explicit assessment of ordinary sensory, inferential, and later-information routes
6. Candidate-window adjudication	One interval is assumed; plausible alternatives are not considered	At least one alternative interval is identified but not compared using case evidence	Claimed and all clinically plausible alternative windows are compared against physiology, cues, medications, behavior, and information exposure
7. Acquisition and memory constraints	No evidence constrains uptake or trace formation; later vividness is treated as timing evidence	Some relevant memory, pharmacological, or serial-report evidence, but acquisition and trace formation remain conflated	Evidence distinguishes or jointly models information uptake, retrievable trace formation, consolidation, and later source attribution

B.4. Domain 1: Time integrity

Two points require more than a statement that devices were synchronized. The case record should document:

- the reference clock;
- synchronization method;
- maximum allowed offset;
- drift-check schedule;
- device or software changes;
- any detected discrepancy;
- the uncertainty interval attached to the final alignment.

A timing claim narrower than the clock uncertainty is invalid even if every other domain is strong.

B.5. Domain 2: Physiological-state resolution

The required resolution depends on the claim. A report localized only to “after ROSC but before the first purposeful response” may not require interpretable EEG. A claim assigned to a particular 30-second CPR interval may require:

- compression and rhythm logs;
- ventilation and end-tidal carbon dioxide;
- arterial pressure where available;
- regional cerebral oxygen saturation;
- EEG signal quality and artifact record;
- medications and shocks;
- ROSC and re-arrest;

- behavioral signs.

Nominal availability of a monitor does not earn credit when the relevant signal is absent or uninterpretable. Integrated regional cerebral oxygen saturation and EEG methods illustrate both the potential and the technical dependencies of this domain (Shellen et al., 2024).

B.6. Domain 3: Content-linked temporal anchor

The anchor must discriminate among candidate windows and must be linked to the element being timed. Examples include:

- a randomized cue emitted only during a logged interval;
- a unique defibrillator sequence described with sufficient specificity;
- a machine alarm or automated message whose exact time and content are recorded;
- a staff action independently documented and not repeated elsewhere;
- a digital target active only during a predefined interval.

A detail that occurred repeatedly throughout the episode is a weak anchor. A detail learned from staff after recovery is not an independent anchor for the earlier experience.

B.7. Domain 4: First report and information flow

The ideal first interview begins with an uninterrupted open narrative before:

- revealing targets;
- naming NDE features;
- asking recognition questions;
- disclosing detailed resuscitation events;
- allowing family or staff to rehearse the event with the participant where preventable.

The information-flow record should be content-specific. “Spoke with family” is insufficient. The record should indicate who conveyed what, when, by which medium, before or after which interview, and with what documentation.

B.8. Domain 5: Corroboration and access-route control

Corroboration and accessibility are distinct. A detail can be accurate yet ordinarily available. Conversely, an apparently inaccessible detail can remain uncorroborated.

Strong adjudication should consider:

- whether the event occurred;
- exactness of the match;
- whether the corroborator was independent;
- whether the event was visible or audible from an ordinary position;
- whether staff spoke about it;
- whether it could be inferred from routine practice;
- whether it was disclosed after recovery;
- whether response scoring was blinded;
- the defined chance or false-match rate.

B.9. Domain 6: Candidate-window adjudication

The standard candidate windows are:

1. pre-arrest deterioration and loss of responsiveness;
2. no-flow or uncertain-flow interval;
3. early CPR;
4. later CPR or intermittent reperfusion;
5. peri-ROSC transition;
6. post-ROSC coma, sedation, and stabilization;
7. emergence and delirium;
8. later consolidation, retrieval, and reconstruction.

Not every case requires every window. Two points require a documented comparison with all windows clinically plausible for that case. Merely listing alternatives earns no more than one point. The adjudication should identify which evidence favors or disfavors each window and should retain unresolved alternatives rather than forcing a single answer.

Table B2
Candidate-Window Adjudication Matrix

Candidate window	Supporting evidence	Contradictory evidence	Access or contamination routes	Residual uncertainty
Pre-arrest				
No-flow				
CPR / low flow				
Peri-ROSC				
Post-ROSC / sedation				
Emergence				
Later reconstruction				

B.10. Domain 7: Acquisition and memory constraints

The purpose of this domain is to prevent later memory quality from being treated as an encoding timestamp. Relevant evidence can include:

- a time-stamped cue;
- implicit-memory controls, informed by evidence that information can influence later performance without explicit recollection under some anesthetic conditions (Linassi et al., 2021);
- serial free recall before recognition testing;
- amnesia or emergence pattern;
- detailed pharmacological timeline;
- source-monitoring questions;
- cross-interview stability and change;
- evidence that an element was disclosed between interviews.

Two points do not require exact localization of every memory process. They require evidence capable of distinguishing at least some acquisition and memory alternatives.

B.11. Case-level and study-level use

The TLEP can be applied at two levels:

- **case level**, rating the evidence available for a particular report element;
- **study level**, rating the procedures and reporting that make strong localization possible.

These levels should not be conflated. A well-designed study can produce a temporally indeterminate case. A remarkable case report can be limited by poor study procedures. When only a publication is available, ratings may reflect reporting completeness rather than what investigators actually did; this limitation should be stated.

B.12. Worked contrast

Case A: mundane but well localized

A randomized two-word cue was automatically emitted during a 40-second CPR interval. The system and physiology shared a validated clock. The participant spontaneously reported both words in the first open interview before target disclosure. Environmental audio confirmed cue presentation, staff did not know the cue, and an independent scorer matched the response under a preregistered rule. Sedation and emergence were documented. This case would receive a strong profile even if the participant reported no tunnel, light, life review, or spiritual meaning.

Case B: profound but weakly localized

A participant reported a panoramic life review, timelessness, and a transformative encounter. The first interview occurred two weeks later after repeated conversations with family. The arrest chronology was broad, no cue or unique event was reported, and no physiological data distinguished CPR from emergence. This case may be phenomenologically important and clinically meaningful, but its temporal evidence profile would be weak.

The contrast is intentional. TLEP is designed to resist the tendency to let phenomenological impressiveness substitute for timing evidence.

B.13. Validation program

Before TLEP is used as an evaluative instrument, the following steps are required. Recent Rasch work on established NDE measures illustrates why category structure, dimensionality, and cumulative validity must be tested rather than inferred from face validity (Pehlivanova et al., 2026):

1. prepare a detailed rater manual and training cases;
2. register a sample of landmark and contemporary studies;
3. use independent raters blinded to theoretical conclusion;
4. estimate domain-level reliability;
5. compare TLEP profiles with global case-impressiveness ratings to test the anti-halo rule;
6. test domain redundancy and whether a latent factor is warranted;
7. test sensitivity to alternative weighting;

8. establish criterion validity using cases with known timing quality or planted anchors;
9. test whether the profile predicts externally logged timing better than NDE intensity, vividness, or participant certainty;
10. revise or abandon any domain that does not contribute reliably.

Failure of a total score would not invalidate the profile. The domains may be most useful as a structured reporting checklist.

Appendix C. Provisional Temporal-Phenomenology Module

C.1. Construct separation

The temporal-phenomenology module measures how time was experienced or later represented. It does not identify the external clinical interval of the experience. The construct map separates:

- loss of ordinary duration;
- apparent duration expansion or compression;
- acceleration or slowing of thought;
- co-presence or simultaneity;
- panoramic autobiographical access;
- certainty or uncertainty of sequence;
- perceived discontinuity between ordinary and event time;
- later narrative ordering.

These dimensions should not be collapsed into one item labeled "timelessness."

C.2. Interview sequence

1. **Open narrative**
   "Please tell me everything you remember, from the last thing you remember before the event until the first thing you remember afterward. Take your time. I will not interrupt unless you ask me to."
2. **Neutral clarification**
   Clarify referents, sequence, source, and confidence without naming expected NDE features.
3. **Element-level source questions**
   Ask whether each major detail was seen, heard, felt, inferred, dreamed, remembered, learned later, mixed, or cannot be determined.
4. **Temporal-phenomenology prompts**
   Use nonleading questions below.
5. **Established NDE measure**
   Administer the Greyson Scale or other chosen phenomenological measure only after the open account and timing-sensitive questions, unless the protocol provides a compelling reason otherwise.
6. **Recognition and target testing**
   Conduct free recall before forced-choice recognition and before disclosure of targets.

C.3. Provisional nonleading items

The following items are an unvalidated starting bank. Each should permit "cannot tell," followed by an open explanation.

1. During the event, did time seem to pass in its usual way?
2. Did the event seem shorter, longer, or about as long as you would expect?
3. Was there any period in which you had no sense of duration, or is that not an accurate description?
4. Could you tell which parts happened before or after other parts?
5. Did any parts seem present together, or did they seem to follow one another?

6. How certain are you about the order you have described?
7. Did your thinking seem slower, faster, or about the same as usual?
8. Did memories appear one at a time, in groups, as an overview, or in another way?
9. Is it more accurate to say that many events were present together, or that they came very quickly?
10. Did time feel different in different parts of the event?
11. Is the order in which you tell the event the order in which it seemed to occur?
12. Are any parts of the order based on what you later learned about the medical event?
13. Did any part feel outside ordinary time? What does "outside ordinary time" mean in your own words?
14. When you remember the event now, does it seem like one continuous episode, several episodes, or something else?

C.4. Candidate response formats

A structured version might use seven-point ratings, but anchors should be specific to each dimension. For example:

- duration: much shorter / somewhat shorter / slightly shorter / ordinary / slightly longer / somewhat longer / much longer;
- sequence clarity: no order discernible / … / completely clear order;
- thought speed: much slower / … / much faster;
- co-presence: entirely sequential / … / entirely co-present;
- confidence: not at all confident / … / completely confident.

The instrument should retain the open explanation because the same response label may have different meanings across individuals and cultures.

C.5. Cross-cultural development

Development should combine a shared candidate core with culture-specific inquiry, following established cross-cultural adaptation procedures rather than literal translation alone (Beaton et al., 2000; Wild et al., 2005):

- collect the open account in the participant's strongest language;
- conduct cognitive interviews in each language group;
- use forward translation, back-translation, and adjudication;
- examine whether concepts such as "all at once," "outside time," or "life review" have equivalent meanings;
- test configural and partial metric invariance before comparing scores;
- examine differential item functioning;
- retain culture-specific items when the shared core fails to capture recurrent local descriptions.

Failure of scalar invariance means group mean comparisons are not justified. Failure of configural invariance may indicate that the construct itself is organized differently and should not be forced into one universal score.

Appendix D. Prospective Multicenter Study Architecture

D.1. Study status

This section is an architecture for protocol development, not a ready-to-activate study. The design should be piloted in simulation and at a small number of sites before a definitive multicenter launch.

D.2. Primary aims

A prospective program could have three separable aims:

1. estimate the exposure-conditional rate of later recall for time-stamped auditory cues;
2. compare candidate acquisition, experiential, and memory windows for report elements using synchronized case evidence; and
3. characterize temporal phenomenology and report evolution without treating vividness or NDE intensity as timing evidence.

Each aim has a different denominator and should be reported separately.

D.3. Design

- prospective, multicenter observational cohort of consecutive adult in-hospital cardiac arrests;
- nested randomized auditory cue presentation during predefined resuscitation windows;
- optional activated visual targets with auditable exposure;
- synchronized clinical and physiological data;
- early neutral survivor interviews and serial follow-up;
- preregistered target scoring, window adjudication, power simulations, and data-quarantine rules.

An independent steering structure should include investigators with different expectations regarding NDE mechanisms. The overall cohort and reporting plan should follow applicable observational-reporting standards, including transparent enrollment, missingness, and analysis decisions (von Elm et al., 2007).

D.4. Enrollment, inclusion, and exclusion

Enrollment denominator

All adult in-hospital arrests that activate the study system remain in the screening and enrollment log, whether the patient survives or enters the primary analysis.

Suggested primary cohort criteria

- age 18 years or older;
- documented cardiac arrest requiring chest compressions or defibrillation;
- activation of the synchronized study system;
- arrest occurring in a participating clinical location.

Analysis-specific exclusions

A case may be excluded from a specific analysis for:

- cue or target device failure;

- failed clock synchronization;
- invalid or insecure exposure;
- absent or uninterpretable required physiology;
- protocol-compromising disclosure;
- inability to establish the relevant clinical timeline.

Such cases remain visible in the full denominator and may contribute to feasibility or descriptive analyses.

Interview eligibility

Interview eligibility is a later stage and should not redefine enrollment. Reasons for non-interview should be coded:

- death;
- persistent coma;
- medical instability;
- active delirium;
- continuing sedation;
- severe aphasia;
- severe pre-existing cognitive impairment;
- hearing, vision, or communication barrier not accommodated;
- unavailable language pathway;
- refusal;
- discharge before contact;
- loss to follow-up.

D.5. Consent and ethics

Where permitted, noninterventional monitoring and cue presentation may operate under emergency research provisions, waiver, or deferred consent because they do not alter clinical care. Participant consent is required before research interviews and continued use of identifiable narrative data. Capacity should be assessed at each interview. A medically unstable, delirious, or cognitively impaired survivor should not be pressed for a report.

Participants should be told that the study does not determine whether their experience was neurological, spiritual, or non-neural. Interviewers should avoid both pathologizing and endorsing a metaphysical interpretation.

D.6. Complete denominator chain

At minimum, report:

$$N_{arrests} \rightarrow N_{survivors} \rightarrow N_{eligible} \rightarrow N_{interviewable} \rightarrow N_{interviewed} \rightarrow N_{valid\ exposure} \rightarrow N_{analyzable}.$$

Additional branches should show usable EEG, cerebral oximetry, valid visual-target exposure, and completed follow-up. Missingness is likely to be informative; comparisons between included and excluded survivors should be reported where ethically and statistically appropriate.

D.7. Common clock and synchronization

Before enrollment, each site should pass simulated resuscitation tests covering:

- hospital time-server synchronization;
- cue and target timestamps;
- defibrillator and compression logs;
- ECG and physiological monitors;
- EEG and cerebral oximetry;
- medication-event entry;
- environmental audio;
- data transfer;
- interviewer notification.

The protocol should define maximum allowable clock error for each endpoint. Offsets and drift should be checked on a fixed schedule, after software or device changes, and after unexplained discrepancies.

D.8. Physiological and clinical recording

Core channels

- ECG rhythm and arrest recognition;
- compression timing and quality where devices permit;
- defibrillation and pacing;
- ventilation and end-tidal carbon dioxide;
- oxygen delivery;
- medication administration;
- ROSC, re-arrest, and loss of circulation;
- purposeful movement, eye opening, vocalization, or command following;
- sedation, analgesia, and neuromuscular blockade.

Enhanced channels

- arterial pressure;
- regional cerebral oxygen saturation;
- EEG;
- temperature;
- laboratory values relevant to drug clearance and cerebral physiology.

Raw data and artifact annotations should be retained. EEG frequency content should not be labeled conscious or unconscious without a preregistered state model and case-linked evidence. AWARE II and related integrated-monitoring work demonstrate both the feasibility of collection during CPR and the severe limits imposed by artifact, missingness, and small analyzable subsets (Parnia et al., 2023; Shellen et al., 2024).

D.9. Sedation, analgesia, paralysis, and emergence

Clinical care should not be standardized for the study. Instead, record:

- agent;
- dose;

- route;
- bolus and infusion times;
- cumulative exposure;
- renal and hepatic function;
- temperature management;
- neuromuscular blockade;
- shock and perfusion variables;
- site practice.

Pharmacological exposure should be modeled as time-varying. Emergence should be represented through repeated behavioral and physiological observations rather than one charted awakening time. Brief islands of responsiveness, delirium, dream reports, and post-ROSC amnesia should be documented.

D.10. Auditory cue system

Design requirements

- neutral, randomized cues with sufficient entropy;
- automatic generation and presentation;
- secure content hidden from bedside staff and interviewers;
- synchronized presentation logs;
- calibrated audibility in simulated clinical noise;
- environmental audio confirming presentation and detecting repetition by staff;
- predefined cue windows and sham windows;
- audit trail for device activation and failure.

Possible cue formats include uncommon word pairs, short word-tone sequences, or structured phrases. The target universe and semantic-equivalence rules must be defined before data collection.

Valid exposure

A cue counts as a valid exposure only if:

- it was emitted within a prespecified window;
- the content and time were securely logged;
- required devices were within timing tolerance;
- audio capture confirms delivery or the device has an independently validated delivery log;
- target secrecy was maintained;
- no disqualifying disclosure occurred before the first test.

Endpoints

Primary endpoint:

- preregistered free recall of cue content during the first eligible interview.

Secondary endpoints:

- partial free recall under predefined rules;
- source attribution;

- contextual binding of the cue to other report elements;
- forced-choice recognition;
- response to decoy cues;
- confidence and phenomenology.

Free recall should precede recognition testing. A correct recognition response is not equivalent to spontaneous recall.

Interpretation

A positive result can establish, with varying strength:

1. verified cue presentation;
2. cue-corresponding information uptake;
3. formation of a retrievable trace;
4. accurate later report.

The further claim of phenomenal hearing at presentation requires convergent evidence and remains a separate adjudication.

D.11. Visual or digital targets

Visual targets should be activated only during defined intervals and should log:

- exact content;
- activation and deactivation times;
- physical position and orientation;
- line of sight from ordinary and claimed perspectives;
- staff access;
- camera record where permissible;
- target security;
- actual exposure.

A target merely present in a room is not a valid exposure. Visual and auditory target results should be analyzed separately.

D.12. Interview architecture and partial blinding

Interviewer roles

- **Narrative interviewer**: trained in neutral interviewing; blind to cue and target content and to detailed physiology.
- **Target tester**: administers preregistered recall and recognition procedures; blind to correct content during scoring where feasible.
- **Element coders**: blind to physiology, target match, and theoretical condition.
- **Timing adjudicators**: receive coded elements and synchronized evidence after element coding is locked.

Interviewers cannot remain blind to whether a participant appears to describe an NDE once the narrative begins. Blinding should therefore be described as partial, not complete.

First interview sequence

1. capacity and delirium assessment;
2. consent;
3. uninterrupted open narrative;
4. neutral clarification;
5. source and confidence questions;
6. temporal-phenomenology module;
7. established NDE measure;
8. free cue and target recall;
9. recognition and decoy testing;
10. information-exposure interview.

All interviews should be recorded. A central unit should rate fidelity to neutral questioning. Interviewer identity and prior beliefs can be included as covariates or random effects.

D.13. Information-flow record

For every potentially relevant exposure, record:

Field	Example
Source	nurse, physician, family member, medical record, media
Time	hours after ROSC and relative to each interview
Medium	direct conversation, overheard speech, document, phone, online
Specific content	"You received three shocks"; "the cue system was active"
Documentation	audio, note, witness, participant recollection
Potential overlap	report elements that could derive from the exposure
Confidence	confirmed, probable, possible, unknown

This record should be represented as a time-stamped information-flow graph for analysis rather than reduced to a yes/no contamination variable.

D.14. Follow-up

Suggested follow-up intervals are:

- first eligible interview, ideally 24–72 hours after sufficient recovery;
- approximately one month;
- six months;
- twelve months.

The earliest usable account is primary for temporal localization. Later interviews assess stability, consolidation, source change, and meaning-making. A longer optional registry can study long-term aftereffects but should not retrospectively strengthen a weak early timing claim.

D.15. Cross-cultural implementation

- interview in the participant's strongest language;

- use trained interpreters familiar with neutral research interviewing;
- record the original language and translation pathway;
- conduct local cognitive interviewing for structured items;
- test measurement invariance before cross-language comparisons;
- preserve culture-specific descriptions instead of translating them prematurely into a Western NDE vocabulary.

D.16. Quality assurance and protocol drift

The coordinating center should monitor:

- enrollment and exclusion rates;
- survival and interviewability;
- cue and target exposure rates;
- timing error and clock drift;
- missing physiological channels;
- interview delay;
- interviewer fidelity;
- target security;
- information-flow completeness;
- site-level outcome differences;
- protocol deviations.

Sites exceeding predefined limits should undergo retraining, temporary suspension, or corrective action.

D.17. Data quarantine

A case or interval should be quarantined from a primary analysis when a preregistered critical condition fails, including:

- clock uncertainty exceeding the endpoint tolerance;
- insecure or unverified cue content;
- invalid exposure;
- target disclosure before testing;
- materially leading first interview;
- missing evidence essential to the stated localization claim.

Quarantine decisions should be made without knowledge of whether the case supports a preferred theory. Quarantined cases remain in the denominator and should be reported descriptively. A failure can invalidate one endpoint without invalidating every use of the case.

Table D1
Operational-Integrity Record

Area	Certification or ongoing check	Primary consequence of failure
Clock integrity	Common source, offset/drift audits, endpoint tolerance	Quarantine analyses requiring the failed clock
Cue system	Randomization, secrecy, audibility, presentation and environmental logs	Remove from valid-exposure denominator
Physiology	Signal quality, artifact annotation, uptime, raw retention	Downgrade resolution or exclude affected windows

Area	Certification or ongoing check	Primary consequence of failure
Interview fidelity	Neutral training, recording, central adherence scoring	Quarantine source or target claims affected by leading procedures
Information flow	Time-stamped, content-specific record	Downgrade source control and model contamination
Target adjudication	Independent blinded scoring	Do not classify unblinded matches as primary successes
Site drift	Central dashboard and predefined limits	Retraining, suspension, or site sensitivity analysis
Quarantine governance	Preregistered rules applied blind to result direction	Retain case in denominator and descriptive reporting

Appendix E. Statistical Analysis Framework

E.1. Joint latent-window target

For report element r_i, let D_i denote all relevant evidence and H the synchronized clinical timeline. The conceptual inferential target is:

$$P\left(W_i^{acq}, W_i^{exp}, W_i^{mem} \mid D_i, H\right).$$

The windows may coincide, overlap, differ, be discontinuous, remain unidentified, or include an empty experiential window. Report occasions $t_{i,k}^{rep}$ and temporal phenomenology ϕ_i are recorded separately.

A full implementation could use a hierarchical Bayesian model, a preregistered likelihood-based model, or a transparent evidence-adjudication procedure. The framework does not require one statistical school. It requires explicit representation of the candidate windows and uncertainty.

E.2. Evidence components

Potential likelihood components include:

- cue or target presentation and response;
- unique clinical events;
- physiological state and signal uncertainty;
- behavioral responsiveness;
- pharmacological exposure;
- free recall and recognition;
- source attribution;
- information-flow record;
- serial report stability and change;
- known clock error.

Dependencies among elements from one participant must be modeled. Treating every element as independent would overstate precision.

E.3. Cue analysis and chance

Free-recall chance cannot be declared without defining:

- the cue universe;
- acceptable exact and semantic matches;
- number of cues presented;
- decoy generation;
- multiple-testing correction;
- adjudication procedure.

A semantic match should be scored by independent raters blind to condition, preferably under a predefined ontology or embedding threshold validated on decoys. Forced-choice recognition should use balanced alternatives and report sensitivity and false-positive rates.

E.4. Model comparison across orthogonal dimensions

Candidate explanations should be parameterized across four dimensions:

- timing;
- construction architecture;
- information route;
- population structure.

A candidate account can therefore be represented as a joint configuration rather than one label. For example:

> CPR acquisition + later phenomenal integration + reconstruction-first narrative + ordinary auditory route + heterogeneous population.

Model comparison should examine held-out predictive performance, not merely retrospective compatibility.

E.5. Heterogeneity

If latent classes are tested, standard latent-class and mixture-model safeguards should be used (Collins & Lanza, 2010):

- define candidate features in advance;
- compare one-class with constrained finite-mixture or latent-class models;
- limit class number according to sample size;
- require minimum class size and separation;
- compare information criteria and held-out likelihood;
- test replication across sites or a held-out cohort;
- require classes to predict new observations, not merely fit existing complexity.

Heterogeneity is weakened if class solutions are unstable, site-specific, or fail to improve out-of-sample prediction.

E.6. Report evolution

Serial analyses should distinguish:

- element recurrence;
- semantic stability;
- boundary change;
- order change;
- source-attribution change;
- confidence change;
- interpretive additions;
- omissions.

A stable core is compatible with later reconstruction. Conversely, change does not prove that the entire report is constructed. The unit of analysis should remain the element and its hierarchy.

E.7. Interviewer and site effects

Use multilevel models or sensitivity analyses for:

- interviewer identity;
- interview delay;
- site;
- language pathway;
- sedation and emergence profile;
- participant prior NDE knowledge;
- data quality.

Interviewer effects should be estimated because complete blinding to NDE content is impossible after the narrative begins.

E.8. Missingness and selection

Missingness is unlikely to be random. Survival, neurological recovery, interviewability, valid cue exposure, and usable physiology can depend on arrest severity and treatment. Analyses should:

- describe every selection stage;
- compare observed characteristics across stages;
- use inverse-probability or selection models where justified;
- conduct best/worst-case sensitivity analyses;
- avoid generalizing interview results to all arrests without qualification.

Appendix F. Power Envelope and Model-Dependent Null Updating

F.1. Denominator-based simulation

Power simulations should begin with enrolled arrests and propagate:

- survival;
- eligibility;
- interviewability;
- consent;
- valid exposure;
- analyzable response;
- true identification rate;
- false-match rate;
- protocol failure.

The required number of arrests can be very large even when the target endpoint is simple.

F.2. Detection envelope

The final protocol should state clearly:

- the smallest exposure-conditional recall rate it is powered to detect;
- precision of the estimated rate;
- power to distinguish CPR from peri-ROSC or emergence models;
- whether latent-class analyses are feasible;
- which very rare hypotheses remain beyond the study's reach.

A study can be adequately powered for cue recall and underpowered for a broad ontological conclusion. Those are different claims.

F.3. Parameterized unexplained-route hypothesis

A specific hypothesis of information acquisition not explained by measured neural and ordinary sensory routes should preregister:

- eligible population;
- valid exposure;
- success criterion;
- ordinary-route exclusion standard;
- minimum expected exposure-conditional success rate p_U;
- independent replication requirement.

For zero successes among n valid independent exposures, the approximate 95% upper bound is $3/n$ (Hanley & Lippman-Hand, 1983). Therefore:

- 0/300 places the upper bound near 1%;
- 0/1,000 places it near 0.3%;
- 0/3,000 places it near 0.1%.

These results reject only versions predicting rates above the bound. A hypothesis that refuses any quantitative commitment cannot be disconfirmed by a null study and should be described as an untested possibility rather than an empirical model.

F.4. Positive evidence threshold

A positive result for unexplained-route acquisition should require:

- prospective preregistration;
- secure randomized target;
- independently verified valid exposure;
- blinded scoring;
- explicit chance and false-match model;
- content-specific information-flow audit;
- ordinary sensory and inferential route analysis;
- compatible timing;
- independent direct replication.

One nominal match without replication should trigger investigation, not a definitive conclusion.

Appendix G. Reporting Checklist

The checklist supplements, rather than replaces, general observational-reporting guidance such as STROBE (von Elm et al., 2007).

Table G1
Minimum Reporting Items for Target and Temporal-Localization Studies

Domain	Required report
Denominators	Total arrests, survivors, eligibility, interviewability, interviews, valid exposures, analyzable cases, and reasons for loss
Timing	Reference clock, synchronization method, error bounds, drift, and affected devices
Physiology	Channels available, usable duration, artifact, missingness, and candidate windows
Pharmacology	Agent, dose, route, time, cumulative exposure, paralysis, temperature, and relevant organ function
Cues or targets	Generation, security, presentation, actual valid exposure, target universe, and scoring rules
Interviews	Delay, open narrative procedure, partial blinding, recording, fidelity, and order of testing
Information flow	Who conveyed what, when, by which route, and before which interview
Element coding	Segmentation manual, hierarchy, coder blinding, and reliability
TLEP	Seven-domain profile, rater agreement, and unresolved domains; no authoritative total
Outcomes	Free recall, partial recall, recognition, decoys, false positives, source attribution, and phenomenology
Analysis	Candidate windows, joint or comparative model, missingness, site/interviewer effects, and sensitivity analyses
Null updating	Confidence or credible interval and minimum preregistered rate excluded
Deviations	All quarantined cases and reasons, retained in the enrollment flow

Appendix H. Provisional Preregistration Statements

The following statements can be adapted for future studies:

1. The primary unit of temporal analysis is a preregistered report element, not the finished narrative.
2. Element coding will be completed before coders receive physiological alignment or target-match status.
3. The first open narrative will precede recognition testing and target disclosure.
4. Cue recall will be interpreted as evidence about information uptake and retrievable memory, not automatically as conscious hearing at presentation.
5. Temporal phenomenology will be analyzed separately from external clinical timing.
6. TLEP domains will be reported individually; no categorical evidence label will be assigned from a total score.
7. All enrolled arrests will remain in the denominator flow.
8. Valid exposure criteria and data-quarantine rules will be fixed before outcome unblinding.
9. Any unexplained-route hypothesis will state a minimum exposure-conditional event rate before data inspection.
10. Positive target findings will require independent replication before strong causal or ontological conclusions are drawn.

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