

Postmortem bacteriology in forensic practice

Diagnostic value, sampling, contamination and the limits of attributing the cause of death

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Abstract

Postmortem bacteriology can clarify deaths involving suspected infection, identify an aetiological agent not recognised during life, and contribute to the assessment of infectious complications of trauma and medical care. Its value depends on the investigative question, sampling quality and integration of the findings. A positive culture from a cadaveric specimen is not equivalent to antemortem infection, sepsis or proof of a causal relationship with death. Exogenous contamination, colonisation, agonal changes and postmortem translocation may produce apparently persuasive results with different meanings.

This review examines preanalytical principles, specimen selection, interpretation of positive and negative cultures, the relationship with histopathology and molecular methods, and applications to healthcare-associated infections. European evidence and published Romanian experience are critically discussed. An interpretative framework, examples of conclusion wording and priorities for practice development are proposed. The central conclusion is that postmortem bacteriology acquires evidential strength through the convergence of independent evidence, rather than the mere detection of a microorganism.

Keywords: postmortem bacteriology; forensic autopsy; contamination; bacterial translocation; sepsis; healthcare-associated infections; thanatomicrobiome.

1. Aim, method and limitations of the review

This narrative review addresses a practical question: under what circumstances can a bacteriological result obtained after death support a medico-legal conclusion? Targeted searches of publicly indexed bibliographical sources were undertaken, with verification of PubMed records, accessible publications and ESGFOR/ESCMID documents. Principal terms included “postmortem bacteriology”, “postmortem microbiology”, “contamination”, “bacterial translocation”, “sampling”, “sepsis” and “thanatomicrobiome”. The literature search was updated on 25 September 2026.

Professional society recommendations and human studies relevant to autopsy diagnosis were prioritised. This is not a systematic review: it does not use a preregistered protocol, independent duplicate selection or meta-analysis. For some studies, including the prospective ESGFOR study published online in 2025, assessment was limited to the accessible abstract and bibliographical information. No pooled sensitivities, universal thresholds or formal GRADE ratings were calculated. The practical frameworks below are interpretative syntheses, not validated diagnostic scores.[1-6]

2. What can postmortem bacteriology establish?

Four questions must be distinguished: was a bacterium detected; was infection present during life; did it contribute to death; and can it be attributed to a particular source or aspect of medical care? Each step requires further information. A technically correct laboratory identification may lead to an incorrect aetiological interpretation if the specimen was contaminated or the organism reached the tissue after death.

Bacteriology is useful when investigating unexpected death, clinically suspected but unconfirmed infection, a lesion identified at autopsy, and complications of hospitalisation. It can refine diagnosis but does not replace morphological examination, the clinical history or consideration of alternative causes. European recommendations adapt investigations to the clinical and autopsy setting; an identical set of tests does not have equal value in every case.[1,2]

Bacteraemia, sepsis and cause of death are not synonymous. Sepsis involves life-threatening organ dysfunction arising from a dysregulated host response to infection. Sepsis may occur without a positive blood culture, while detection of bacteria in blood does not automatically establish sepsis. Clinical Sepsis-3 criteria should not be reconstructed by entering cadaveric laboratory measurements into scores developed for living patients.[7]

3. Biological processes and artefacts requiring differentiation

Process	Meaning	Interpretative limitation
Antemortem infection	Microbial multiplication and pathological interaction with the host before death	Correlation with site, lesions and course is required; the host response varies
Colonisation	Presence of microorganisms without evidence of invasive infection at the assessed site	A surface swab or colonised device does not establish bacteraemia
Agonal dissemination	Possible passage of bacteria across compromised barriers during the terminal period	Difficult to distinguish from earlier infection and migration after death
Postmortem translocation	Bacterial migration after circulation ceases and barriers deteriorate	May produce positive cultures from normally sterile sites
Exogenous contamination	Accidental introduction from skin, instruments, the environment or specimen processing	May occur despite technically correct laboratory identification

These mechanisms are not mutually exclusive. A patient may have antemortem pneumonia while one postmortem blood specimen is contaminated. Reducing the entire case to “positive” or “contaminated” loses this complexity. The joint ESGFOR/GLAMIFO review emphasises the effects of environmental conditions, the original microbiota and cadaveric changes on results.[3]

Agonal dissemination should be proposed cautiously. It cannot automatically explain every unexpected culture after resuscitation. Conversely, resuscitation does not invalidate all specimens. Interventions should be documented and their potential effects assessed for each sampling site.

4. Postmortem interval and preservation of the body

Time to sampling matters, but does not operate as a switch between “valid” and “invalid”. Prompt refrigeration limits some changes; it neither sterilises the body nor eliminates contamination. Relevant variables include ambient temperature, when cooling began, transport duration, decomposition, open injuries and previous procedures.

Recommendations for minimally invasive autopsy favour sampling as early as possible, ideally within the first 24 hours where feasible. This is a preanalytical target, not a deadline beyond which every result becomes unusable. A later specimen may retain value when supported by the question, organism and associated evidence; an early specimen may be compromised by technique.[4]

Reports should distinguish a known time of death from an estimated interval. “Collected at 24 hours” is incomplete if the onset of refrigeration is unknown. In exhumation or advanced decomposition, a realistic objective may be targeted detection of an organism, without claiming to reconstruct the reliability of an antemortem blood culture.

5. Sampling: the stage that cannot be repaired retrospectively

Planning should precede opening the body cavities, taking account of circumstances, records and diagnostic suspicions. The laboratory should be informed that specimens are postmortem, of previous antibiotic treatment, and of the diagnostic question. Unusual suspicions require prior discussion of appropriate methods and specimen conditions; routine culture does not cover every microorganism.

Priorities are aseptic access, avoidance of cross-contamination, distinct labelling and correlation with histology. Whenever possible, microbiological specimens should be collected before extensive manipulation of the viscera. Specimens for microbiology must be separated from those placed in fixative for histopathology. Tissue placed in formalin cannot subsequently serve as an ordinary specimen for bacterial culture.[1,4]

Transport conditions should be agreed with the laboratory for each specimen type. A single refrigeration rule should not be applied to all containers; blood culture bottles in particular follow the instructions of the system used. Traceability records the exact site, method, times, personnel and any departures from procedure. The label “cadaveric blood” does not distinguish peripheral from cardiac origin.

Sampling is a professional activity requiring biological risk assessment. Suspected airborne infection or a notifiable disease requires institutional coordination and protection of staff. Death of the host does not mean that microorganisms have lost their infectivity.[3]

6. Specimen selection: the site must answer the question

Specimen	Diagnostic question	Main precaution
Peripheral blood, with the site identified	Is there evidence supporting systemic dissemination?	Assess skin contamination and postmortem changes
Cardiac blood	Can it complement comparison across sites?	Do not automatically treat it as equivalent to an independent peripheral specimen
Cerebrospinal fluid	Suspected meningitis or invasive infection	Correlate with clinical findings, meninges and targeted methods
Lung tissue from a lesion	Identification of a pneumonia-associated organism	A tracheal swab is not equivalent to lesional tissue
Pus or fluid from a collection	Identification of a local infectious agent	Document the collection and its relationship to adjacent tissues
Spleen or other deep tissue	Corroboration of organism distribution	An isolated positive result does not establish sepsis
Valve, prosthesis or periprosthetic tissue	Endocarditis or device-associated infection	Distinguish colonisation and contamination from invasive infection
Surface swab or intestinal contents	Colonisation, a local focus or a targeted investigation	Does not independently prove bloodstream infection or fatal causation

This table is an orientation aid, not a universal protocol. Concordance between independently collected specimens is more persuasive than repeated testing of the same container. Two specimens contaminated by the same instrument do not constitute two independent pieces of evidence. Site selection should test a hypothesis, rather than simply accumulate results.[1-4]

7. Interpreting a positive culture

The first question concerns specimen quality. The second concerns the plausibility of the organism in context. Next come its distribution across independent sites, agreement with antemortem samples and compatibility with lesions. Monomicrobial growth of a pathogen from several sites may support infection, but culture purity alone does not prove an antemortem origin.

Polymicrobial culture is not necessarily synonymous with contamination. Abdominal infections, some wounds and infections in damaged tissues can be mixed. An organism commonly regarded as a contaminant may be clinically meaningful in a patient with a prosthesis or immunosuppression. Microbiological labels are contextual rather than absolute.[3,5,6]

Antimicrobial susceptibility profiles help compare isolates, but identical antibiograms do not establish clonal identity. Time to positivity may inform laboratory interpretation; it should not be converted into a universal postmortem threshold distinguishing infection from contamination. Attribution to a common source requires appropriate typing methods and epidemiological evidence.

In a study of 100 medico-legal autopsies, Palmiere and colleagues correlated bacteriology with radiology, histology and biochemistry, recognising false-positive and undetermined cases. The practical message is explicit acceptance of uncertainty: not every result can responsibly be classified as either infection or contamination.[5]

8. What does a negative result mean?

Absence of bacterial growth does not exclude infection. Antemortem antibiotics, an unsuitable sampling site, insufficient material, transport conditions, fastidious organisms or a mismatch between the method and suspected agent can reduce yield. A negative result should be reported within the limits of the actual method used.

Histologically demonstrated pneumonia may remain without an identified aetiology. Conversely, a negative molecular test for one organism does not exclude all bacteria. Appropriate wording defines the target: “organism X was not detected by method Y in specimen Z”, rather than the excessively broad conclusion “there was no infection”. This distinction prevents confusion between diagnosing an infectious process and identifying its causative agent.[3,4]

9. Histopathology and the postmortem diagnosis of sepsis

Histology may reveal an inflammatory focus, necrosis, microabscesses, septic emboli or other infection-compatible lesions. Demonstrating organisms in relation to a lesion and host response is more informative than detecting them in an anatomically unorientated specimen. Nevertheless, fulminant infection, immunosuppression or tissue degradation may limit the visible response.

Pulmonary oedema, congestion, petechiae and shock-related lesions are not independently specific for sepsis. An isolated biochemical marker, including procalcitonin or C-reactive protein, should not be treated as a verdict. Interpretation depends on validation for postmortem material, the interval, comorbidity and any available antemortem trend.[3,4,7]

The recommended reasoning separately examines the infectious focus, systemic response and contribution to the fatal sequence. Infection may contribute to death alongside haemorrhage, thromboembolism or cardiac disease. Identifying an organism does not justify overlooking these

mechanisms. Where clinical records are missing, certainty about sepsis may be lower than certainty about pneumonia.

10. PCR, sequencing and metagenomics

Molecular methods can complement cultures when previous treatment or organism characteristics reduce the likelihood of isolation. Targeted PCR addresses a specific question; 16S rRNA gene analysis has broader bacterial coverage; metagenomics explores complex mixtures. These methods are not interchangeable and do not automatically offer the same resolution.[3]

Detection of DNA does not establish viability, active multiplication or the time at which bacteria entered the specimen. In low-biomass material, reagent contaminants may appear disproportionately important. Appropriate controls, assessment of method performance and independent validation are necessary for conclusions with medico-legal consequences.

More sequence reads do not automatically mean a greater clinically meaningful bacterial load: extraction, amplification, reference databases and the proportion of human DNA affect the result. Sequencing may support relatedness between isolates, but the direction of transmission and responsibility for it require chronology and epidemiology. Technological precision does not replace precision of inference.

11. Romanian evidence and the contribution of recent studies

Diac and colleagues retrospectively examined bacteriology in 630 medico-legal autopsies at a Bucharest centre over ten years. The study describes local practice, specimen distribution and differences between hospitalised and field cases. Because this was a series selected for bacteriological investigation, the findings do not represent infection prevalence across all autopsies and cannot be extrapolated into a national indicator of hospital infections.[6]

The prospective study by Tamsin and colleagues, published online in 2025, included 200 autopsies and 1,321 specimens. Approximately one fifth of cases had an infectious cause of death, predominantly pneumonia. Its abstract reports associations with organism type and the distribution of positive sites, and proposes a standardised specimen set. As a single-centre study using histopathology as its classification reference, it requires external validation; its performance cannot automatically be transferred to every fulminant infection or decomposed body.[8]

Together, these findings support consistent, auditable local procedures. They justify neither abandoning bacteriology as “always contaminated” nor using it as the sole arbiter of cause of death.

12. Healthcare-associated infection and suspected medical negligence

Following a hospital death, questions should be ordered: was infection present; when did it develop; what was its focus; how did it contribute to death; and what evidence addresses its source and possible shortcomings in prevention, diagnosis or treatment? Isolation of a resistant bacterium does not independently prove that infection was acquired in hospital.

Assessment requires admission records, antemortem cultures and screening, symptom progression, devices, procedures, antibiotics, imaging and epidemiological investigation. Colonisation known at admission, community infection, endogenous infection and acquisition during care are distinct hypotheses. A postmortem culture cannot independently date acquisition.[3]

An epidemiological association between isolates must be evaluated alongside actual opportunities for contact and alternative reservoirs. Even established healthcare-associated infection does not

automatically establish individual negligence. Assessment of care and causation requires the complete case; this article proposes no legal presumption based on bacterial species or an antibiogram.

13. A practical framework for conclusions

Situation	Cautious conclusion	What cannot automatically be asserted
Histological focus, plausible organism and agreement across independent specimens	The combined evidence supports antemortem infection with the identified organism	That infection was the sole explanation for death
Isolated positive culture without clinical or lesional correlation	Result of uncertain significance; discuss contamination and translocation	Confirmed sepsis
Suggestive histology and negative cultures after antibiotics	Morphologically supported infection without an identified bacterial aetiology	Exclusion of infection because culture was negative
Multiple organisms, decomposition and inadequate traceability	Reduced interpretative strength, with explicitly documented limitations	Absolute exclusion of antemortem infection
Resistant isolate after hospitalisation without comparative evidence	Records and epidemiological assessment are needed	Proven nosocomial origin or negligence

This is a proposed educational framework, without a score or validated numerical probabilities. Reports should distinguish raw findings from interpretation, record alternative explanations and identify information that might change the opinion.

A useful minimum dataset comprises the expert question; chronology and preservation; specimens and technique; relevant treatment; laboratory methods; positive and negative results; morphological correlation; contribution to cause of death; limitations and further investigations. Where infection cannot be distinguished from artefact, an undetermined conclusion is legitimate.

14. Three hypothetical reasoning examples

Pneumonia with aetiological concordance. Antemortem fever and respiratory deterioration are documented, histology shows pneumonia, and the same plausible organism is recovered from lesional tissue and independently collected blood. Together, the findings support antemortem infection. Attribution of sepsis and a fatal role requires integration of organ dysfunction and assessment of competing mechanisms.

An isolated culture after difficult sampling. One container yields skin flora, without agreement in other specimens or an infectious focus, and with a documented breach of asepsis. Contamination is a plausible explanation. “Confirmed bacterial sepsis” exceeds the evidence; infection should not be globally excluded on that finding alone either.

Death following intensive care. A multidrug-resistant bacterium is detected postmortem, but admission screening and previous cultures are unavailable. This result alone cannot establish when it was acquired, who transmitted it or whether treatment was negligent. Records and epidemiological evidence should be obtained before attributing the source.

These examples were constructed solely to illustrate interpretative reasoning; they are not personal cases or clinical series.

15. The thanatomicrobiome and development priorities

Research into postmortem microbial communities extends the perspective from detecting an agent to the ecology of decomposition. A multicentre study published in Nature Microbiology in 2024 examined 36 human cadavers at three locations and described a decomposition-associated microbial network. These findings support research into postmortem interval estimation, rather than establishing a universal “bacterial clock” applicable to every body.[9]

Models require testing outside their development cohorts and under different climatic, seasonal, preservation and exposure conditions. A decomposition signature must not be confused with a signature of antemortem infection. Numerical predictions should include uncertainty intervals and a clear account of the population in which the model was validated.[3,9]

For Romanian practice, reasonable priorities include agreements between forensic services and laboratories, shared sampling procedures, access to antemortem results, traceability and multidisciplinary assessment. Research would benefit from prospective multicentre cohorts, documented controls, explicit reference criteria and separate analysis of antibiotic-treated, paediatric and decomposed cases. A microbiological result included in the definition of “confirmed infection” should not subsequently be used without qualification to demonstrate the performance of that same test.

16. Conclusions

Postmortem bacteriology is a valuable complementary investigation when appropriately planned and interpreted in context. The strongest conclusions arise from concordance between independent specimens, pathology, chronology and clinical information. A positive culture does not automatically establish antemortem infection, a negative culture does not exclude it, and identifying an agent does not independently resolve cause of death or medical responsibility.

Meaningful progress requires standardised preanalytical procedures and transparent reasoning, alongside validated molecular methods. In forensic medicine, acknowledging the limits of a specimen does not diminish its value: it defines its appropriate use.

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Editorial note: Educational scientific synthesis published on the author's website; not an official guideline, an externally peer-reviewed journal article or a laboratory protocol. Frameworks and examples are educational proposals developed for this paper.