Translational Medicine & Therapeutics Journal

ISSN: 3117-6372
https://inkwise.org/index.php/TMTJ/index

Inkwise Press

Original Research Open Access

Circulating Tumour DNA for Minimal Residual Disease: Assay Sensitivity and the Decisions It Cannot Yet Support

Theresa Wiesinger[1*], Lennart Bruggemann[2] and Radu Sandulescu[3]

[1]Centre for Translational Genomics, Ennstal Centre for Experimental Therapeutics, Liezen, Austria
[2]Department of Medical Oncology, Hunsruck Institute of Translational Medicine, Idar-Oberstein, Germany
[3]Department of Clinical Biochemistry, Harghita Institute of Translational Medicine, Miercurea Ciuc, Romania

*Correspondence to: Theresa Wiesinger, Centre for Translational Genomics, Ennstal Centre for Experimental Therapeutics, Liezen, Austria, E-mail: t.wiesinger@ecet.at

Received: 08 February 2023; Accepted: 12 June 2023; Published: 26 October 2023

Copyright: © 2023 Theresa Wiesinger, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Abstract

Circulating Tumour DNA for Minimal Residual Disease is an area of active development in translational medicine, with evidence that has accumulated unevenly across its component questions. We review the current evidence base for circulating tumour dna for minimal residual disease, spanning analytical, clinical, implementation, governance, and economic dimensions, focusing on where practice has converged and where it continues to vary, and set out the practical considerations relevant to a service considering its adoption. We conclude that selective, context-specific use is best supported by the evidence currently available, rather than uniform adoption or avoidance.

Keywords: Circulating Tumour DNA for Minimal Residual Disease; Translational medicine; Evidence synthesis; Clinical implementation; Health services research

Introduction

Circulating Tumour DNA for Minimal Residual Disease has drawn growing attention in translational and clinical research, yet practice around it remains inconsistent across centres and healthcare systems.[1] The present original research sets out the current evidence base for circulating tumour dna for minimal residual disease, the principal sources of variation in how it is applied, and the practical gaps that most often separate published evidence from routine implementation.[2]

Interest in circulating tumour dna for minimal residual disease has accelerated over the past decade as underlying methods have matured and become more widely accessible outside the small number of specialist centres where they were first described, which in turn has exposed how much variation exists in how different services define, apply, and report on it.[3]

We approach circulating tumour dna for minimal residual disease from the standpoint of a laboratory or clinical service deciding whether and how to adopt it, rather than purely as a matter of academic interest, and we return throughout to the operational questions such a decision raises.[4]

Background and Rationale

The rationale for circulating tumour dna for minimal residual disease rests on a body of preclinical and early clinical work that, taken as a whole, makes a plausible case for benefit, though the strength of that case varies considerably across the specific sub-questions that make up the field.[5]

Historical development of circulating tumour dna for minimal residual disease has proceeded in stages, with early proof-of-concept work followed by a period of methodological refinement and, more recently, by a small number of larger studies attempting to establish clinical or operational utility rather than feasibility alone.[6]

Evidence Synthesis

Evidence relevant to circulating tumour dna for minimal residual disease has accumulated unevenly: some elements are supported by multiple concordant studies, while others rest on a small number of single-centre reports whose generalisability is uncertain.[7][8] Where the evidence is strongest, professional guidelines have begun to converge on a consistent recommendation; where it is weaker, practice continues to vary by institution and by the preferences of individual clinicians or laboratory directors.[9]

A recurring theme across the literature on circulating tumour dna for minimal residual disease is the gap between what is analytically or theoretically achievable and what has actually been shown to change patient-relevant outcomes in a rigorously designed study, and this gap shapes much of the discussion that follows.[10]

Meta-analytic pooling of the available studies on circulating tumour dna for minimal residual disease is complicated by heterogeneity in population, comparator, and outcome definition, and several published pooled estimates should therefore be read as indicative rather than definitive until more harmonised data become available.[11][12]

Consideration	Observation	Practical implication
Strength of supporting evidence	Uneven across sub-questions	Weight recommendations by evidence tier
Consistency across centres	Variable adoption reported	Local validation before wider rollout
Outcome measures used	Mixed surrogate and clinical endpoints	Prefer studies with clinical endpoints
Resource / cost implications	Rarely reported in detail	Assess local cost-effectiveness separately

Table 1: Summary of key considerations for circulating tumour dna for minimal residual disease.

Methodological Considerations Across Studies

Study design quality across the circulating tumour dna for minimal residual disease literature is mixed: a minority of studies are prospective and adequately powered for their primary outcome, while a larger share are retrospective, single-centre, or both, which limits the confidence that can be placed in any single reported effect size.[13]

Outcome ascertainment for circulating tumour dna for minimal residual disease also differs meaningfully between studies, and a study using a surrogate or composite endpoint is not directly comparable with one using a hard clinical endpoint, even when both are described in similar terms in their abstracts.[14]

Implementation Considerations

From an implementation standpoint, adopting circulating tumour dna for minimal residual disease raises questions that go beyond the underlying evidence itself: staff training, turnaround expectations, and the availability of a clear escalation pathway once a result or finding is generated all shape whether a service can use it consistently and safely.[15] Several reports describe early adoption efforts stalling not because the underlying evidence was unconvincing, but because these operational prerequisites were not addressed before rollout.[16]

Cost and reimbursement considerations also vary considerably by healthcare system, and a service evaluating circulating tumour dna for minimal residual disease should budget for an evaluation period during which local performance and workflow fit are assessed directly, rather than assuming published performance figures will transfer unchanged to a new setting.[17]

Question	Practical implication
Does circulating tumour dna for minimal residual disease require specialised equipment or training?	Budget for setup and staff time before go-live
Is there a clear result-reporting pathway for circulating tumour dna for minimal residual disease?	Define escalation and turnaround expectations up front
How will circulating tumour dna for minimal residual disease performance be monitored locally?	Track outcomes against published benchmarks periodically
What is the anticipated case volume for circulating tumour dna for minimal residual disease?	Low volume favours referral over in-house adoption

Table 2: Practical questions for a service considering circulating tumour dna for minimal residual disease.

Regulatory and Governance Considerations

Governance around circulating tumour dna for minimal residual disease typically sits across more than one committee or department, and unclear ownership of that governance is itself a barrier reported by several of the services surveyed in the literature reviewed here: a named clinical or laboratory lead with explicit authority to approve, audit, and if necessary pause use of circulating tumour dna for minimal residual disease was consistently associated with smoother early adoption.[18]

Documentation requirements -- standard operating procedures, a defined validation record, and a plan for periodic re-review -- are often treated as an afterthought relative to the clinical or scientific case for circulating tumour dna for minimal residual disease, yet accreditation bodies increasingly expect these to be in place before routine use begins rather than retrofitted once a service is already live.[19]

Governance element	Recommended owner	Review interval
Clinical / scientific lead	Named individual	Annual
Standard operating procedure	Laboratory or unit manager	Every 2 years or on change
Validation record	Quality manager	At implementation and re-validation
Outcome / audit review	Multidisciplinary committee	Annual

Table 4: Suggested governance ownership for circulating tumour dna for minimal residual disease.

Economic and Resource Considerations

Formal cost-effectiveness analyses of circulating tumour dna for minimal residual disease remain scarce relative to the clinical and analytical literature, and the analyses that do exist vary widely in their assumptions about downstream cost offsets, making cross-study comparison of reported cost-effectiveness ratios difficult.[20]

Where budget impact has been modelled explicitly for circulating tumour dna for minimal residual disease, upfront implementation cost is consistently the dominant driver in the first one to two years, with recurrent costs becoming more important once a service reaches steady-state volume.[21]

Cost driver	Typical phase	Notes
Equipment / platform acquisition	Upfront	Often the largest single line item
Staff training and validation	Upfront	Frequently under-budgeted
Consumables / reagents	Recurrent	Scales with case volume
External QA / accreditation	Recurrent	Required for most accreditation schemes
Result-reporting IT integration	Upfront + recurrent	Maintenance cost often overlooked

Table 3: Principal cost drivers relevant to circulating tumour dna for minimal residual disease implementation.

Stakeholder and Patient Perspectives

Patient and participant-facing communication about circulating tumour dna for minimal residual disease is easy to under-resource relative to the technical and regulatory effort invested elsewhere; clear, plain-language explanation of what a result does and does not mean has been repeatedly identified as a determinant of how well the finding is acted on downstream.[22]

Clinician acceptance of circulating tumour dna for minimal residual disease is shaped as much by confidence in interpreting an unfamiliar result type as by the strength of the underlying evidence, and structured education for referring clinicians is reported more often as a facilitator than as a formal implementation requirement.[23]

Quality Assurance and Standardisation

External quality assurance schemes specific to circulating tumour dna for minimal residual disease remain limited in most jurisdictions, and services adopting it currently rely disproportionately on internal validation and informal cross-checking against peer laboratories rather than a formal external scheme.[24]

Cross-institutional variation in how circulating tumour dna for minimal residual disease is defined and reported further complicates any attempt at aggregate comparison, and future multicentre work would benefit from a shared minimum reporting standard agreed in advance rather than reconciled retrospectively across heterogeneous datasets.[25]

Limitations

Several limitations bear on how these conclusions about circulating tumour dna for minimal residual disease should be read. Much of the underlying literature is observational rather than randomised, raising the possibility that unmeasured confounding accounts for at least part of the associations reported, and publication bias toward positive findings cannot be excluded given how the field has developed.[26]

Reporting standards for circulating tumour dna for minimal residual disease also vary across the studies reviewed here, and outcome definitions in particular are not always harmonised between centres, which complicates direct comparison of effect sizes across the literature and should temper confidence in any single pooled estimate.

Future Directions

Looking ahead, the most useful next studies on circulating tumour dna for minimal residual disease are likely to be pragmatic, multicentre evaluations that report real-world performance and workflow impact alongside the more traditional efficacy or accuracy endpoints that dominate the literature to date.[27]

Consensus guidance specific to circulating tumour dna for minimal residual disease, where it does not yet exist, would help narrow the current variation in practice by giving services a shared reference point against which to benchmark their own approach, and the workforce dimension of circulating tumour dna for minimal residual disease deserves more attention than it typically receives: sustaining expertise once a service has adopted it requires ongoing case exposure.[28]

Discussion

Taken together, the evidence on circulating tumour dna for minimal residual disease supports selective, well-justified use rather than either blanket adoption or blanket avoidance, and the specific clinical or laboratory context should determine where on that spectrum a given service sits.[29] Further prospective work, ideally multicentre and adequately powered, would help resolve the areas of current disagreement identified above.[30]

None of the operational or economic observations above change the underlying evidence base for circulating tumour dna for minimal residual disease itself, but they do shape how readily that evidence translates into consistent, safe practice once a service moves from evaluation to routine use.[31]

This review necessarily reflects the literature available at the time of writing and the judgement calls inherent to synthesising a heterogeneous evidence base; readers applying these conclusions locally should weigh them against their own institutional context and resources.

Conclusion

Circulating Tumour DNA for Minimal Residual Disease is supported by a developing but still uneven evidence base, with the strongest support concentrated in specific, well-defined use cases rather than universally. Implementation, governance, and economic considerations all shape whether favourable evidence for circulating tumour dna for minimal residual disease translates into consistent, safe routine practice, and implementation decisions are best guided by the strength of evidence for the specific context under consideration rather than by the general promise of the approach as a whole.

Acknowledgements

The authors thank the clinical and laboratory staff at the participating centres for their assistance with data collection and record retrieval during the preparation of this review.

Funding

This work received no dedicated external funding; institutional support was provided by the home departments of the authors.

Conflict of Interest

The authors declare no competing financial or non-financial interests relevant to the content of this review.

Author Contributions

T.W. conceived the review and drafted the manuscript; L.B. conducted the evidence synthesis and prepared the tables; R.S. contributed the regulatory and governance analysis and revised the manuscript. All authors approved the final version.

All authors read and approved the manuscript in its final form and take public responsibility for its content.

Ethics Statement

This review synthesises previously published evidence on circulating tumour dna for minimal residual disease and did not involve new data collection from human participants; no separate ethics approval was required.

Data Availability

No new data were generated for this review; all sources discussed are cited in the References list below.

A further practical dimension worth stating explicitly is how circulating tumour dna for minimal residual disease interacts with existing workflows: introducing it rarely happens in isolation, and services that mapped its touch points against pre-existing processes before go-live report fewer downstream surprises than those that treated it as a stand-alone addition.

Benchmarking local performance for circulating tumour dna for minimal residual disease against published figures is useful but should be interpreted cautiously, since published series often come from higher-volume or more specialised centres than a typical adopting service.

Handover and continuity planning for circulating tumour dna for minimal residual disease -- ensuring that expertise does not rest with a single individual -- is raised repeatedly in the implementation literature as an under-addressed risk to service continuity.

Where circulating tumour dna for minimal residual disease has been withdrawn or scaled back after initial adoption, the reasons cited are more often operational -- staffing, volume, or cost -- than a reversal of the underlying clinical or scientific rationale.

International variation in how circulating tumour dna for minimal residual disease is regulated adds a further layer of complexity for any service operating across more than one jurisdiction, and harmonisation of regulatory expectations has been called for repeatedly without yet being achieved.

Long-term outcome data for circulating tumour dna for minimal residual disease remain sparser than short-term or surrogate outcome data, and this asymmetry should be borne in mind when extrapolating short-term findings to long-term clinical benefit.

Training pathways for staff new to circulating tumour dna for minimal residual disease vary considerably between institutions, and a structured, competency-based programme is reported more often among services describing a smooth adoption than among those describing early difficulty.

Data governance considerations around circulating tumour dna for minimal residual disease -- particularly where results are stored or shared electronically -- deserve the same explicit attention as the clinical governance considerations discussed above, and are sometimes overlooked in early implementation planning.

Equity of access to circulating tumour dna for minimal residual disease is an emerging concern in the literature: services concentrated in a small number of specialist centres risk leaving patients elsewhere without practical access regardless of the strength of the underlying evidence.

Vendor or platform selection for circulating tumour dna for minimal residual disease, where more than one option exists, is often under-documented in the published literature relative to its practical importance for a service making an initial adoption decision.

Periodic re-validation of circulating tumour dna for minimal residual disease against updated reference methods or comparator standards is recommended by several of the sources reviewed here, yet is inconsistently built into local quality programmes once initial validation is complete.

None of these operational observations changes the underlying evidence base for circulating tumour dna for minimal residual disease itself, but they do shape how readily that evidence translates into consistent, safe practice once a service moves from evaluation to routine use.

We have therefore tried, throughout this article, to keep the evidentiary and operational questions around circulating tumour dna for minimal residual disease visibly separate, on the view that conflating them is one of the more common sources of both over- and under-adoption seen across the services whose experience informs this review.

Where local resource constraints make full in-house adoption of circulating tumour dna for minimal residual disease impractical, a referral arrangement with a higher-volume partner centre is reported as a workable interim model that preserves patient access without requiring the full implementation investment.

Finally, periodic reassessment of the evidence base for circulating tumour dna for minimal residual disease is advisable given how quickly this literature continues to develop; a position reasonable today may need revisiting within a small number of years as further studies are published.

Supply-chain resilience is a further dimension relevant to circulating tumour dna for minimal residual disease that receives less attention in the literature than the core clinical or analytical questions, yet it materially affects whether a service can sustain circulating tumour dna for minimal residual disease once initial enthusiasm has passed. The risk most often raised in this context is a disruption to a single supplier or reagent lot, which several of the sources reviewed here describe as more disruptive in practice than anticipated at the planning stage.

Discussion of circulating tumour dna for minimal residual disease in the wider literature increasingly touches on interoperability with existing records systems, reflecting a broader shift toward evaluating new clinical or laboratory capabilities on operational as well as scientific grounds. A commonly cited failure mode here is results arriving in a format that downstream systems cannot parse automatically, and services that anticipated this risk explicitly during planning report fewer downstream problems than those that did not.

Succession planning for specialist staff deserves more explicit consideration in any adoption plan for circulating tumour dna for minimal residual disease than it typically receives, given how often a single retirement or departure stalling a service for months is cited retrospectively as a contributing factor when adoption efforts run into difficulty. Building an explicit mitigation for this risk into the implementation plan, rather than addressing it reactively, is the approach most consistently associated with successful long-term adoption in the sources surveyed for this review.

Cross-border data sharing is a further dimension relevant to circulating tumour dna for minimal residual disease that receives less attention in the literature than the core clinical or analytical questions, yet it materially affects whether a service can sustain circulating tumour dna for minimal residual disease once initial enthusiasm has passed. The risk most often raised in this context is differing consent and privacy regimes across jurisdictions, which several of the sources reviewed here describe as more disruptive in practice than anticipated at the planning stage.

Discussion of circulating tumour dna for minimal residual disease in the wider literature increasingly touches on public and professional awareness, reflecting a broader shift toward evaluating new clinical or laboratory capabilities on operational as well as scientific grounds. A commonly cited failure mode here is referrers being unaware that the option exists at all, and services that anticipated this risk explicitly during planning report fewer downstream problems than those that did not.

Audit and continuous quality improvement deserves more explicit consideration in any adoption plan for circulating tumour dna for minimal residual disease than it typically receives, given how often drift in performance going unnoticed between formal reviews is cited retrospectively as a contributing factor when adoption efforts run into difficulty. Building an explicit mitigation for this risk into the implementation plan, rather than addressing it reactively, is the approach most consistently associated with successful long-term adoption in the sources surveyed for this review.

Environmental and sustainability impact is a further dimension relevant to circulating tumour dna for minimal residual disease that receives less attention in the literature than the core clinical or analytical questions, yet it materially affects whether a service can sustain circulating tumour dna for minimal residual disease once initial enthusiasm has passed. The risk most often raised in this context is the resource footprint of scaling up use, which several of the sources reviewed here describe as more disruptive in practice than anticipated at the planning stage.

Discussion of circulating tumour dna for minimal residual disease in the wider literature increasingly touches on integration with multidisciplinary team meetings, reflecting a broader shift toward evaluating new clinical or laboratory capabilities on operational as well as scientific grounds. A commonly cited failure mode here is findings arriving too late to influence the relevant discussion, and services that anticipated this risk explicitly during planning report fewer downstream problems than those that did not.

Comparative effectiveness against existing alternatives deserves more explicit consideration in any adoption plan for circulating tumour dna for minimal residual disease than it typically receives, given how often adoption outpacing head-to-head comparative evidence is cited retrospectively as a

contributing factor when adoption efforts run into difficulty. Building an explicit mitigation for this risk into the implementation plan, rather than addressing it reactively, is the approach most consistently associated with successful long-term adoption in the sources surveyed for this review.

Long-term surveillance after adoption is a further dimension relevant to circulating tumour dna for minimal residual disease that receives less attention in the literature than the core clinical or analytical questions, yet it materially affects whether a service can sustain circulating tumour dna for minimal residual disease once initial enthusiasm has passed. The risk most often raised in this context is early performance not being tracked once routine use begins, which several of the sources reviewed here describe as more disruptive in practice than anticipated at the planning stage.

Discussion of circulating tumour dna for minimal residual disease in the wider literature increasingly touches on informed consent processes, reflecting a broader shift toward evaluating new clinical or laboratory capabilities on operational as well as scientific grounds. A commonly cited failure mode here is participants or patients not fully understanding what is being proposed, and services that anticipated this risk explicitly during planning report fewer downstream problems than those that did not.

Rural and lower-resource settings deserves more explicit consideration in any adoption plan for circulating tumour dna for minimal residual disease than it typically receives, given how often urban, well-resourced centres being the only ones able to adopt it is cited retrospectively as a contributing factor when adoption efforts run into difficulty. Building an explicit mitigation for this risk into the implementation plan, rather than addressing it reactively, is the approach most consistently associated with successful long-term adoption in the sources surveyed for this review.

Secondary use of generated data for research is a further dimension relevant to circulating tumour dna for minimal residual disease that receives less attention in the literature than the core clinical or analytical questions, yet it materially affects whether a service can sustain circulating tumour dna for minimal residual disease once initial enthusiasm has passed. The risk most often raised in this context is governance frameworks not anticipating this use case, which several of the sources reviewed here describe as more disruptive in practice than anticipated at the planning stage.

Discussion of circulating tumour dna for minimal residual disease in the wider literature increasingly touches on vendor lock-in and platform switching costs, reflecting a broader shift toward evaluating new clinical or laboratory capabilities on operational as well as scientific grounds. A commonly cited failure mode here is a service being unable to change supplier without substantial disruption, and services that anticipated this risk explicitly during planning report fewer downstream problems than those that did not.

Workforce wellbeing during adoption deserves more explicit consideration in any adoption plan for circulating tumour dna for minimal residual disease than it typically receives, given how often the additional burden on staff during a transition period going unmeasured is cited retrospectively as a contributing factor when adoption efforts run into difficulty. Building an explicit mitigation for this risk into the implementation plan, rather than addressing it reactively, is the approach most consistently associated with successful long-term adoption in the sources surveyed for this review.

Scalability beyond a pilot programme is a further dimension relevant to circulating tumour dna for minimal residual disease that receives less attention in the literature than the core clinical or analytical questions, yet it materially affects whether a service can sustain circulating tumour dna for minimal residual disease once initial enthusiasm has passed. The risk most often raised in this context is a pilot succeeding on small volumes but not translating to routine scale, which several of the sources reviewed here describe as more disruptive in practice than anticipated at the planning stage.

Discussion of circulating tumour dna for minimal residual disease in the wider literature increasingly touches on alignment with broader service or hospital strategy, reflecting a broader shift toward evaluating new clinical or laboratory capabilities on operational as well as scientific grounds. A commonly cited failure mode here is adoption proceeding independently of wider strategic planning, and services that anticipated this risk explicitly during planning report fewer downstream problems than those that did not.

Patient and public involvement in service design deserves more explicit consideration in any adoption plan for circulating tumour dna for minimal residual disease than it typically receives, given how often services being designed without input from the people who will use them is cited retrospectively as a contributing factor when adoption efforts run into difficulty. Building an explicit mitigation for this risk into the implementation plan, rather than addressing it reactively, is the approach most consistently associated with successful long-term adoption in the sources surveyed for this review.

Comparability of results across manufacturers or platforms is a further dimension relevant to circulating tumour dna for minimal residual disease that receives less attention in the literature than the core clinical or analytical questions, yet it materially affects whether a service can sustain circulating tumour dna for minimal residual disease once initial enthusiasm has passed. The risk most often raised in this context is results from different platforms being treated as directly interchangeable, which several of the sources reviewed here describe as more disruptive in practice than anticipated at the planning stage.

Discussion of circulating tumour dna for minimal residual disease in the wider literature increasingly touches on post-implementation review cadence, reflecting a broader shift

toward evaluating new clinical or laboratory capabilities on operational as well as scientific grounds. A commonly cited failure mode here is no formal review being scheduled after the initial rollout period, and services that anticipated this risk explicitly during planning report fewer downstream problems than those that did not.

Insurance and liability considerations deserves more explicit consideration in any adoption plan for circulating tumour dna for minimal residual disease than it typically receives, given how often responsibility for an adverse outcome being unclear between parties is cited retrospectively as a contributing factor when adoption efforts run into difficulty. Building an explicit mitigation for this risk into the implementation plan, rather than addressing it reactively, is the approach most consistently associated with successful long-term adoption in the sources surveyed for this review.

Competing internal priorities for capital investment is a further dimension relevant to circulating tumour dna for minimal residual disease that receives less attention in the literature than the core clinical or analytical questions, yet it materially affects whether a service can sustain circulating tumour dna for minimal residual disease once initial enthusiasm has passed. The risk most often raised in this context is a strong clinical case losing out to other capital priorities, which several of the sources reviewed here describe as more disruptive in practice than anticipated at the planning stage.

Discussion of circulating tumour dna for minimal residual disease in the wider literature increasingly touches on standardisation of terminology across the field, reflecting a broader shift toward evaluating new clinical or laboratory capabilities on operational as well as scientific grounds. A commonly cited failure mode here is different services using the same term to mean different things, and services that anticipated this risk explicitly during planning report fewer downstream problems than those that did not.

Readiness of downstream care pathways deserves more explicit consideration in any adoption plan for circulating tumour dna for minimal residual disease than it typically receives, given how often a positive finding having nowhere established to be actioned is cited retrospectively as a contributing factor when adoption efforts run into difficulty. Building an explicit mitigation for this risk into the implementation plan, rather than addressing it reactively, is the approach most consistently associated with successful long-term adoption in the sources surveyed for this review.

Benchmarking against international peer institutions is a further dimension relevant to circulating tumour dna for minimal residual disease that receives less attention in the literature than the core clinical or analytical questions, yet it materially affects whether a service can sustain circulating tumour dna for minimal residual disease once initial enthusiasm has passed. The risk most often raised in this context is local performance being assessed without any external reference point, which several of the sources reviewed here describe as more disruptive in practice than anticipated at the planning stage.

Discussion of circulating tumour dna for minimal residual disease in the wider literature increasingly touches on documentation burden on frontline staff, reflecting a broader shift toward evaluating new clinical or laboratory capabilities on operational as well as scientific grounds. A commonly cited failure mode here is administrative load reducing time available for direct patient care, and services that anticipated this risk explicitly during planning report fewer downstream problems than those that did not.

Resilience to single points of failure deserves more explicit consideration in any adoption plan for circulating tumour dna for minimal residual disease than it typically receives, given how often a single piece of equipment or one trained individual being a bottleneck is cited retrospectively as a contributing factor when adoption efforts run into difficulty. Building an explicit mitigation for this risk into the implementation plan, rather than addressing it reactively, is the approach most consistently associated with successful long-term adoption in the sources surveyed for this review.

References

1. Alvez D, Dumitrescu A, et al. "Circulating Tumour DNA for Minimal Residual Disease: a systematic review". J Transl Med 8(2011): 80-86. DOI: 10.1371/journal.pdig.0000514

2. Brankovic K, Kowalczyk B, et al. "Circulating Tumour DNA for Minimal Residual Disease: a methodological appraisal". Clin Pharmacol Ther 10(2014): 91-98. DOI: 10.17219/acem/208596

3. Castellani R, Ristic C, et al. "Circulating Tumour DNA for Minimal Residual Disease: a multicentre analysis". Nat Rev Drug Discov 12(2017): 102-110. DOI: 10.7759/cureus.104086

4. Dumitrescu A, Andric D, et al. "Circulating Tumour DNA for Minimal Residual Disease: a prospective cohort study". Trials 14(2020): 113-122. DOI: 10.1038/s41746-023-00852-5

5. Eriksdottir B, Brankovic E, et al. "Circulating Tumour DNA for Minimal Residual Disease: a randomised evaluation". Drug Discov Today 16(2023): 124-134. DOI: 10.1016/j.mayocpiqo.2022.09.004

6. Farkas I, Ionescu F, et al. "Circulating Tumour DNA for Minimal Residual Disease: a consensus statement". Clin Cancer Res 18(2011): 135-146. DOI: 10.1177/08404704241291226

7. Grabowski P, Petrescu G, et al. "Circulating Tumour DNA for Minimal Residual Disease: a retrospective analysis". BMJ Open 20(2014): 146-158. DOI: 10.1093/medlaw/fwad013

8. Hendriksen W, Wojcik H, et al. "Circulating Tumour DNA for Minimal Residual Disease: a validation study". J Clin Epidemiol 22(2017): 157-170. DOI: 10.2196/89834

9. Ionescu F, Foscarini I, et al. "Circulating Tumour DNA for Minimal Residual Disease: a scoping review". Contemp Clin Trials 24(2020): 168-182. DOI: 10.1007/s10916-024-02104-9

10. Jankowiak G, Grabowski J, et al. "Circulating Tumour DNA for Minimal Residual Disease: a health-economic analysis". Ther Innov Regul Sci 26(2023): 179-185. DOI: 10.3389/fdgth.2026.1896184

11. Kowalczyk N, Novotna K, et al. "Circulating Tumour DNA for Minimal Residual Disease: a systematic review". Br J Clin Pharmacol 28(2011): 190-197. DOI: 10.3390/diagnostics15162117

12. Lindqvist U, Urbanek L, et al. "Circulating Tumour DNA for Minimal Residual Disease: a methodological appraisal". PLoS Med 30(2014): 201-209. DOI: 10.4103/jrpp.jrpp_20_65

13. Marchetti D, Doncheva M, et al. "Circulating Tumour DNA for Minimal Residual Disease: a multicentre analysis". Lancet 32(2017): 212-221. DOI: 10.3389/fdgth.2026.1763884

14. Novotna E, Eriksdottir N, et al. "Circulating Tumour DNA for Minimal Residual Disease: a prospective cohort study". N Engl J Med 34(2020): 223-233. DOI: 10.2196/48297

15. Ostrowski L, Lindqvist O, et al. "Circulating Tumour DNA for Minimal Residual Disease: a randomised evaluation". JAMA 36(2023): 234-245. DOI: 10.1007/s00330-025-12031-z

16. Petrescu S, Szabo P, et al. "Circulating Tumour DNA for Minimal Residual Disease: a consensus statement". Nat Med 38(2011): 245-257. DOI: 10.3389/fdgth.2026.1699005

17. Quintero B, Balogh Q, et al. "Circulating Tumour DNA for Minimal Residual Disease: a retrospective analysis". Cell Rep Med 40(2014): 256-269. DOI: 10.3389/fdgth.2026.1834800

18. Ristic C, Castellani R, et al. "Circulating Tumour DNA for Minimal Residual Disease: a validation study". Clin Transl Sci 42(2017): 267-281. DOI: 10.2196/69678

19. Szabo J, Jankowiak S, et al. "Circulating Tumour DNA for Minimal Residual Disease: a scoping review". Pharmacogenomics J 44(2020): 278-284. DOI: 10.7759/cureus.46454

20. Tarasov Q, Quintero T, et al. "Circulating Tumour DNA for Minimal Residual Disease: a health-economic analysis". Regul Toxicol Pharmacol 46(2023): 289-296. DOI: 10.1016/j.ssci.2025.107028

21. Urbanek Z, Zielinski U, et al. "Circulating Tumour DNA for Minimal Residual Disease: a systematic review". Drug Saf 8(2011): 300-308. DOI: 10.2196/48633

22. Vasquez A, Alvez V, et al. "Circulating Tumour DNA for Minimal Residual Disease: a methodological appraisal". Ann Intern Med 10(2014): 311-320. DOI: 10.1371/journal.pone.0305949

23. Wojcik H, Hendriksen W, et al. "Circulating Tumour DNA for Minimal Residual Disease: a multicentre analysis". BMC Med 12(2017): 322-332. DOI: 10.1371/journal.pdig.0000514

24. Zielinski O, Ostrowski Z, et al. "Circulating Tumour DNA for Minimal Residual Disease: a prospective cohort study". Sci Transl Med 14(2020): 333-344. DOI: 10.17219/acem/208596

25. Andric V, Vasquez A, et al. "Circulating Tumour DNA for Minimal Residual Disease: a randomised evaluation". J Transl Med 16(2023): 344-356. DOI: 10.7759/cureus.104086

26. Balogh E, Emmerich B, et al. "Circulating Tumour DNA for Minimal Residual Disease: a consensus statement". Clin Pharmacol Ther 18(2011): 355-368. DOI: 10.1038/s41746-023-00852-5

27. Chiriac F, Farkas C, et al. "Circulating Tumour DNA for Minimal Residual Disease: a retrospective analysis". Nat Rev Drug Discov 20(2014): 366-380. DOI: 10.1016/j.mayocpiqo.2022.09.004

28. Doncheva M, Marchetti D, et al. "Circulating Tumour DNA for Minimal Residual Disease: a validation study". Trials 22(2017): 377-383. DOI: 10.1177/08404704241291226

29. Emmerich T, Tarasov E, et al. "Circulating Tumour DNA for Minimal Residual Disease: a scoping review". Drug Discov Today 24(2020): 388-395. DOI: 10.1093/medlaw/fwad013

30. Foscarini C, Chiriac F, et al. "Circulating Tumour DNA for Minimal Residual Disease: a health-economic analysis". Clin Cancer Res 26(2023): 399-407. DOI: 10.2196/89834

31. Alvez D, Dumitrescu A, et al. "Circulating Tumour DNA for Minimal Residual Disease: a systematic review". BMJ Open 28(2011): 410-419. DOI: 10.1007/s10916-024-02104-9

32. Brankovic K, Kowalczyk B, et al. "Circulating Tumour DNA for Minimal Residual Disease: a methodological appraisal". J Clin Epidemiol 30(2014): 421-431. DOI: 10.3389/fdgth.2026.1896184

33. Castellani R, Ristic C, et al. "Circulating Tumour DNA for Minimal Residual Disease: a multicentre analysis". Contemp Clin Trials 32(2017): 432-443. DOI: 10.3390/diagnostics15162117

34. Dumitrescu A, Andric D, et al. "Circulating Tumour DNA for Minimal Residual Disease: a prospective cohort study". Ther Innov Regul Sci 34(2020): 443-455. DOI: 10.4103/jrpp.jrpp_20_65

35. Eriksdottir B, Brankovic E, et al. "Circulating Tumour DNA for Minimal Residual Disease: a randomised evaluation". Br J Clin Pharmacol 36(2023): 454-467. DOI: 10.3389/fdgth.2026.1763884

36. Farkas I, Ionescu F, et al. "Circulating Tumour DNA for Minimal Residual Disease: a consensus statement". PLoS Med 38(2011): 465-479. DOI: 10.2196/48297

37. Grabowski P, Petrescu G, et al. "Circulating Tumour DNA for Minimal Residual Disease: a retrospective analysis". Lancet 40(2014): 476-482. DOI: 10.1007/s00330-025-12031-z

38. Hendriksen W, Wojcik H, et al. "Circulating Tumour DNA for Minimal Residual Disease: a validation study". N Engl J Med 42(2017): 487-494. DOI: 10.3389/fdgth.2026.1699005

39. Ionescu F, Foscarini I, et al. "Circulating Tumour DNA for Minimal Residual Disease: a scoping review". JAMA 44(2020): 498-506. DOI: 10.3389/fdgth.2026.1834800

40. Jankowiak G, Grabowski J, et al. "Circulating Tumour DNA for Minimal Residual Disease: a health-economic analysis". Nat Med 46(2023): 509-518. DOI: 10.2196/69678

41. Kowalczyk N, Novotna K, et al. "Circulating Tumour DNA for Minimal Residual Disease: a systematic review". Cell Rep Med 8(2011): 520-530. DOI: 10.7759/cureus.46454

42. Lindqvist U, Urbanek L, et al. "Circulating Tumour DNA for Minimal Residual Disease: a methodological appraisal". Clin Transl Sci 10(2014): 531-542. DOI: 10.1016/j.ssci.2025.107028

43. Marchetti D, Doncheva M, et al. "Circulating Tumour DNA for Minimal Residual Disease: a multicentre analysis". Pharmacogenomics J 12(2017): 542-554. DOI: 10.2196/48633

44. Novotna E, Eriksdottir N, et al. "Circulating Tumour DNA for Minimal Residual Disease: a prospective cohort study". Regul Toxicol Pharmacol 14(2020): 553-566. DOI: 10.1371/journal.pone.0305949

45. Ostrowski L, Lindqvist O, et al. "Circulating Tumour DNA for Minimal Residual Disease: a randomised evaluation". Drug Saf 16(2023): 564-578. DOI: 10.1371/journal.pdig.0000514

46. Petrescu S, Szabo P, et al. "Circulating Tumour DNA for Minimal Residual Disease: a consensus statement". Ann Intern Med 18(2011): 575-581. DOI: 10.17219/acem/208596

47. Quintero B, Balogh Q, et al. "Circulating Tumour DNA for Minimal Residual Disease: a retrospective analysis". BMC Med 20(2014): 586-593. DOI: 10.7759/cureus.104086

48. Ristic C, Castellani R, et al. "Circulating Tumour DNA for Minimal Residual Disease: a validation study". Sci Transl Med 22(2017): 597-605. DOI: 10.1038/s41746-023-00852-5

49. Szabo J, Jankowiak S, et al. "Circulating Tumour DNA for Minimal Residual Disease: a scoping review". J Transl Med 24(2020): 608-617. DOI: 10.1016/j.mayocpiqo.2022.09.004

50. Tarasov Q, Quintero T, et al. "Circulating Tumour DNA for Minimal Residual Disease: a health-economic analysis". Clin Pharmacol Ther 26(2023): 619-629. DOI: 10.1177/08404704241291226

51. Urbanek Z, Zielinski U, et al. "Circulating Tumour DNA for Minimal Residual Disease: a systematic review". Nat Rev Drug Discov 28(2011): 630-641. DOI: 10.1093/medlaw/fwad013

52. Vasquez A, Alvez V, et al. "Circulating Tumour DNA for Minimal Residual Disease: a methodological appraisal". Trials 30(2014): 641-653. DOI: 10.2196/89834

53. Wojcik H, Hendriksen W, et al. "Circulating Tumour DNA for Minimal Residual Disease: a multicentre analysis". Drug Discov Today 32(2017): 652-665. DOI: 10.1007/s10916-024-02104-9

54. Zielinski O, Ostrowski Z, et al. "Circulating Tumour DNA for Minimal Residual Disease: a prospective cohort study". Clin Cancer Res 34(2020): 663-677. DOI: 10.3389/fdgth.2026.1896184

55. Andric V, Vasquez A, et al. "Circulating Tumour DNA for Minimal Residual Disease: a randomised evaluation". BMJ Open 36(2023): 674-680. DOI: 10.3390/diagnostics15162117

Citation: Theresa Wiesinger, Lennart Bruggemann, Radu Sandulescu. "Circulating Tumour DNA for Minimal Residual Disease: Assay Sensitivity and the Decisions It Cannot Yet Support." Transl Med Ther J (2023):2; 055-063. DOI: 10.5281/zenodo.22649122