

Scaling Up Patient Blood Management: Lessons from Global and Regional Implementation Efforts

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Abstract

This review summarises global patient blood management (PBM) implementation experiences, highlighting key drivers including governance, leadership, data systems, education, and resource alignment. Evidence across diverse settings shows that PBM can be effectively adapted; however, structural, behavioural, and organisational barriers continue to limit scale-up. Addressing these challenges requires coordinated, context-sensitive strategies that integrate PBM into clinical practice, health policy, and quality improvement systems, aligned with World Health Organization (WHO) guidance to achieve sustainable impact.

Key words: patient blood management, implementation, quality and safety

INTRODUCTION

Blood deficiencies, particularly anaemia, affects billions of people worldwide and represent a significant underrecognised contributor to morbidity, mortality, and health-system inefficiency.^{1,2} The burden disproportionately affects women, pregnant individuals, children, older adults, and socioeconomically disadvantaged populations, particularly in low- and middle-income countries, where anaemia and haemorrhage remain leading contributors to preventable death and disability.^{1,3,4}

The World Health Organization (WHO) has identified patient blood management (PBM) as a key strategy to address the global burden of anaemia, blood loss, and coagulopathy, and has issued policy briefs and implementation guidance to support its adoption across diverse healthcare systems.^{5,6} Integrating PBM into national health policy and routine clinical practice is therefore increasingly recognised as a high-value intervention aligned with universal health coverage, patient safety, and health-system sustainability goals.^{2,5,6}

Multiple systematic reviews and large-scale programmes have provided evidence that PBM implementation leads to reduced transfusion rates, complications, and hospital length of stay while enhancing cost-efficiency across diverse healthcare systems.^{7,8} For anaesthesiologists, surgeons, and obstetricians, it is of particular importance given the high prevalence of perioperative anaemia,

affecting 20% to 75% of patients, often compounded by surgical blood loss and hospital-acquired anaemia.^{9,10} Embedding PBM within perioperative pathways therefore represents a critical opportunity to improve patient outcomes and reduce avoidable transfusion.

This review summarises the global and regional experiences of PBM implementation, highlighting key strategies, success factors, and challenges across diverse healthcare settings. Through focus on real-world application examples and implementation pathways, it aims to support clinicians, institutions, and policymakers in translating PBM principles into sustainable clinical practice.

BRIDGING THE IMPLEMENTATION GAP: FOUNDATIONS FOR PBM SCALE-UP

Despite this sound evidence base and increasing policy support regarding PBM, its integration into routine clinical practice remains inconsistent across healthcare systems, highlighting a critical gap between knowledge and implementation. This disparity is attributed to a combination of structural, organisational, and behavioural barriers that limit the integration of PBM into routine clinical pathways. Fragmented governance, lack of standardised protocols, limited access to diagnostics and therapies, and insufficient data

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infrastructure continue to impede implementation, particularly in low- and middle-income settings.^{6,11,12}

In addition to structural constraints, entrenched transfusion-centred practices and limited awareness of PBM principles contribute to persistent variability in care. Misunderstandings on the tolerance of anaemia, overestimation of bleeding risk, and reliance on transfusion as a default intervention often delay the adoption of preventative and patient-centred strategies. These behavioural factors highlight that successful PBM implementation requires not only technical solutions but also sustained cultural and educational change.^{7,12}

Implementation science is a useful instrument to understand and combat these challenges. Conceptual models such as the Donabedian framework (structure–process–outcomes) enable systematic evaluation of PBM programmes by linking organisational capacity and clinical processes to patient- and system-level outcomes (Figure 1, Table 1).¹³ In parallel, change management perspectives such as Kotter’s model, emphasise the importance of leadership, the engagement of stakeholders, and structured strategies to overcome resistance and embed new practices within healthcare systems.¹⁴

These perspectives in concert emphasise that effective PBM scale-up depends on aligning health-system context, organisational readiness, and clinician behaviour through coordinated strategies that integrate policy, clinical pathways, and data systems.^{6,11,15}

KEY DRIVERS OF PBM IMPLEMENTATION

Addressing the implementation gap requires identification of the key system-level drivers that enable successful adoption, scale-up, and sustainability of PBM across diverse healthcare settings. As noted in implementation science and the PBM programme experience evidence, governance and policy alignment, clinical leadership, data structure, education, and resource availability have been identified as critical enablers of sustained adoption.^{6,11,12}

Governance and policy alignment provide the structural foundation for PBM implementation. National and institutional endorsement, supported by regulatory frameworks and alignment with quality and patient safety strategies, facilitates integration of PBM into standard care pathways and incentivises adherence to evidence-based practices.^{6,11} This is exemplified by large-scale PBM programmes, such as the Western Australia initiative, where system-level governance and policy

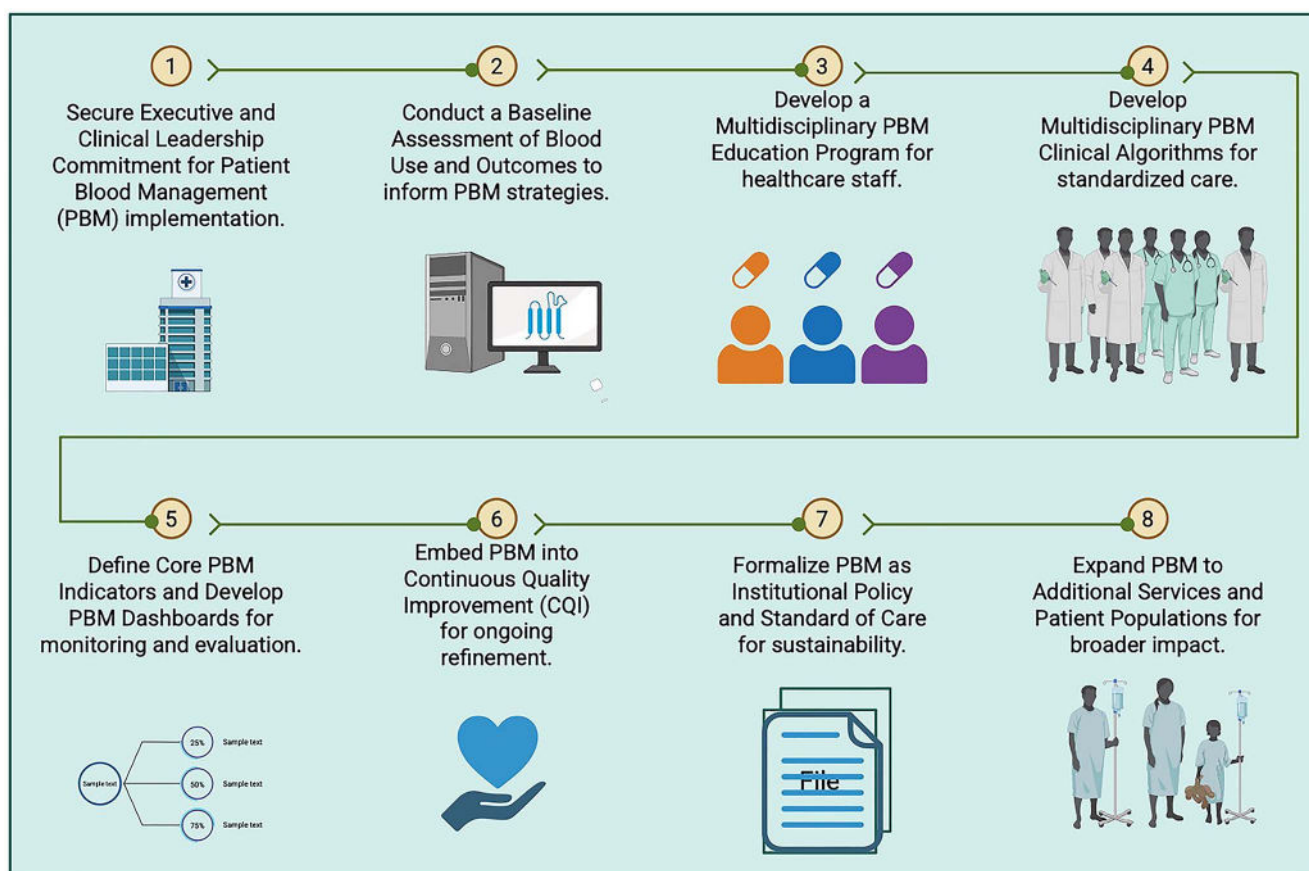


Figure 1 – A stepwise representation of PBM implementation linking structure, processes, and outcomes in accordance with the Donabedian framework. This figure provides an operational perspective on how PBM programmes are implemented across healthcare settings, complementing Table 1, which details the corresponding domains, elements, and indicators for evaluation. It should be interpreted alongside the system-level framework in Figure 2 and the hospital-level roadmap in Figure 3. Abbreviations: CQI, continuous quality improvement; PBM, patient blood management.

Table 1 – Scaling Patient Blood Management Using the Donabedian Framework

Donabedian Domain	Dimension	Key Elements for PBM Scale-Up
Structure	Governance and Policy	National PBM policies; institutional mandates; integration into accreditation systems; alignment with quality, patient safety, sustainability, and universal health coverage agendas
	Organizational Capacity	Dedicated PBM commissions and task forces; protected leadership roles; availability of essential medicines, devices, and point-of-care diagnostics
	Education Infrastructure	Integration of PBM into undergraduate, postgraduate, and continuing professional education; formal training programs across disciplines
	Data Infrastructure	Transfusion registries; PBM data platforms; dashboards enabling benchmarking and accountability
Process	Clinical Pathways and Algorithms	Standardized PBM pathways with contextual flexibility; goal-directed anaemia and haemostasis management; integration of point-of-care testing
	Multidisciplinary Engagement	Active participation of physicians, nursing, laboratory services, perfusionists, pharmacists, administrators, and community health workers
	Audit and Feedback Cycles	Routine monitoring of PBM indicators; transparent reporting; continuous quality-improvement loops
	Change Management	Framing PBM as patient safety and quality care; structured pilot-to-scale implementation; local adaptation within global standards
Outcomes	Clinical Outcomes	Reduced anaemia prevalence, bleeding complications, infections, ischaemia, morbidity, mortality, and length of hospital stay
	Utilization Outcomes	Reduced transfusion rates and blood product use; improved appropriateness of transfusion practices
	Economic Outcomes	Cost savings; improved resource allocation; measurable returns on investment supporting health-system sustainability
	Equity and Sustainability	Improved outcomes in vulnerable populations; strengthened blood supply resilience; reduced donor exposure
Cross-cutting Risks	Barriers and Challenges	Fragmented health systems; limited diagnostics or data capacity; entrenched transfusion culture; staff turnover; loss of momentum without institutionalization

Abbreviation: PBM, patient blood management.

integration were associated with sustained reductions in transfusion and improved clinical outcomes.¹⁶

Clinical leadership and multidisciplinary engagement are essential to drive behavioural change and ensure ownership across specialties. Effective PBM programmes are typically led by multidisciplinary teams—including anaesthesiologists, surgeons, haematologists, nurses, and administrators—who coordinate implementation efforts and promote adherence to clinical pathways.^{11,12}

Data systems, audit, and feedback mechanisms enable continuous monitoring of performance and outcomes, supporting both implementation and sustainability. The availability of reliable data on transfusion practices, anaemia prevalence, and clinical outcomes allows benchmarking, identification of gaps, and reinforcement of desired behaviours through audit and feedback cycles.^{6,15} Large-scale programmes such as ONTraC have demonstrated that structured data collection and feedback are key to achieving sustained improvements in transfusion practice and patient outcomes.^{8,17}

Education and training play a central role in overcoming knowledge gaps and shifting transfusion-centred paradigms. Ongoing, multidisciplinary educational strategies (integrated into professional

development and institutional programmes) are necessary to sustain behavioural change and ensure adherence to PBM principles.^{7,12} Contemporary consensus recommendations further emphasise that structured education and clinical decision support are essential components of effective PBM implementation.¹⁸

Finally, **resource alignment and access to essential interventions** are critical for translating PBM principles into practice. Availability of diagnostics, pharmacological therapies (such as iron and haemostatic agents), and point-of-care technologies must be adapted to local context, with prioritisation of high-impact, scalable interventions, particularly in resource-limited settings.^{6,11}

Together, these drivers highlight that successful PBM implementation is not dependent on isolated interventions but on coordinated, system-level strategies that align governance, clinical practice, data systems, and workforce capacity to support sustainable change.^{6,11,15}

WHO GUIDANCE FOR PBM IMPLEMENTATION: A SYSTEM-LEVEL ROADMAP

The World Health Organization (WHO) provides a structured, system-level approach for PBM implementation based on a comprehensive implementation model designed for complex

health system interventions.^{5,6} Grounded in public health principles (prevention, protection, and promotion of blood health) and supported by evidence, ethics, and economic considerations, this model integrates stakeholders across public health, healthcare organisations, and individual patient care levels.

The implementation pathway is organised into three sequential phases. Phase A focuses on preparing the national or jurisdictional health system, requiring high-level policy commitment, establishment of governance structures, and alignment of education, financing, and access to essential resources. Phase B addresses implementation at the healthcare organisation level, led by local multidisciplinary teams responsible for developing data systems, education programmes, communication strategies, and clinical pathways. Phase C involves national or jurisdictional scale-up, including evaluation of pilot programmes, designation of reference centres, and progressive expansion of data systems to support benchmarking and outcome monitoring (Figure 2).

This phased approach provides a practical roadmap for translating PBM principles into coordinated, system-wide action, supporting

scalable and sustainable implementation across diverse healthcare settings.⁶

GLOBAL AND REGIONAL PBM IMPLEMENTATION MODELS

The initial large-scale, coordinated implementations of PBM from high-income settings validated system-wide feasibility and effectiveness. The Western Australia Patient Blood Management Program remains a seminal model, combining policy support, multidisciplinary implementation, and continuous monitoring to reduce blood utilisation, improve outcomes, and lower costs.¹⁶ Programmes across provinces such as ONTraC in Canada have similarly shown that PBM can be implemented successfully at scale, with sustained reductions in transfusion rates and improvements in efficiency over more than two decades.⁸

In Europe, PBM implementation has evolved from single-centre initiatives to broader national and multicentre models. In Germany, the Frankfurt experience proved that a multicomponent PBM implementation strategy could improve clinicians' knowledge, risk perception, and transfusion practice, while a later national survey

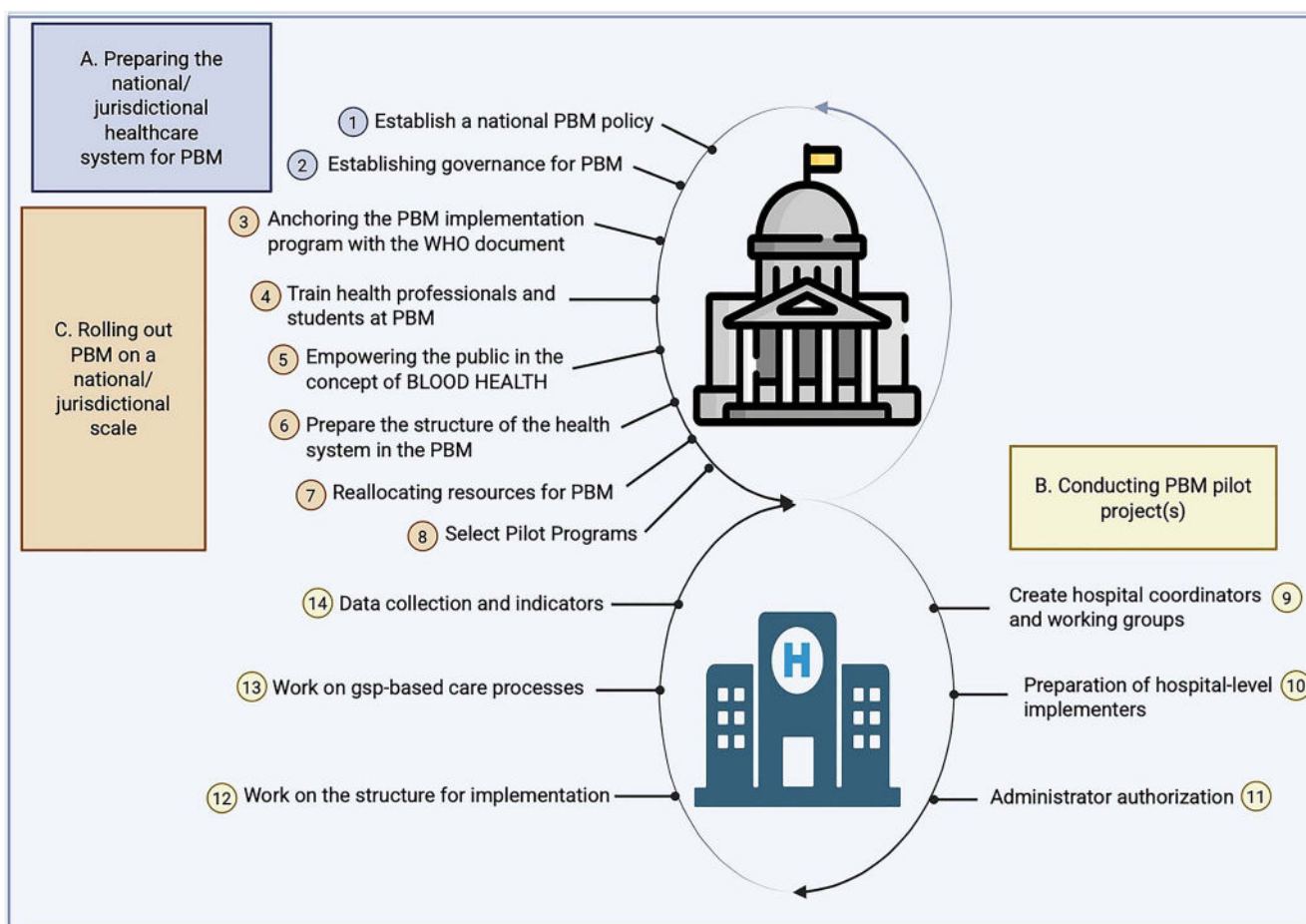


Figure 2 – A three-phase, system-level roadmap for PBM implementation based on WHO guidance. Phase A focuses on national or jurisdictional preparation, including policy development, governance, health system strengthening, and resource alignment. Phase B addresses implementation at the healthcare organisation level through multidisciplinary leadership, capacity building, clinical pathway development, and data systems. Phase C represents scale-up, encompassing evaluation of pilot programmes, expansion across health systems, and strengthening of monitoring and benchmarking frameworks to support sustainability. This system-level pathway complements the evaluative Donabedian framework in Figure 1 and the operational hospital-level roadmap in Figure 3. Abbreviations: PBM, patient blood management; WHO, World Health Organization.

showed that PBM uptake remained incomplete and continued to be limited by workload, staffing, administrative support, and lack of economic incentives.^{17,18} In France, the multicentre PERIOPE study reported that standardised implementation of PBM resulted in improved preoperative anaemia treatment and a decrease of hospital length of stay, whilst significant gaps remained in the management of anaemic patients.¹⁹ In Romania, both a national survey and a pilot cardiac-surgery programme demonstrated progress in PBM uptake after national recommendations were introduced, while also revealing persistent deficits in formal PBM teams, standardised processes, and access to diagnostic and therapeutic resources.^{20,21}

In middle-income settings, PBM implementation has often been driven by institutional leadership and progressively expanded through regional collaboration. Latin America provides important examples of this bottom-up model. In Brazil, the PBM programme in Ceará is a particularly important milestone: through a multidisciplinary strategy combining medical education, perioperative anaemia clinics, haemostasis support, cell salvage, and government backing, the programme reduced transfusion rates and generated substantial cost savings, providing a scalable model for other low- and middle-income settings.²² Multicountry implementation reports also identify Mexico and Colombia as settings in which PBM uptake has been driven by leading clinicians within large national institutions, illustrating how champion-led models can initiate wider system recognition.¹¹

In low- and lower-middle-income settings, published PBM-specific implementation experience remains comparatively limited, but available evidence suggests that progress is feasible when programmes are adapted to local realities. Rwanda provides a useful example: a train-the-trainer initiative in transfusion medicine established locally driven leadership in knowledge translation and sustainability, while a prospective feasibility study showed that context-adapted education could improve participants' knowledge and confidence in transfusion-related practice.^{23,24}

Recent international collaborations, particularly those led by the WFSA, provide growing evidence that PBM can be implemented in resource-limited settings. In Ethiopia, a structured national initiative combining facility assessment, context-adapted education, and stakeholder engagement, demonstrated feasibility despite major system constraints, with early improvements in clinician knowledge and transfusion practices. These efforts have also catalysed broader system-level progress, including engagement with ministries of health, development of draft national guidelines, and identification of pilot institutions. Complementary WFSA activities such as international faculty support and large-scale digital education programmes have further strengthened capacity building.

Across regions, these experiences show that successful PBM implementation depends less on replicating a single model than on combining core PBM principles with context-specific governance, education, data systems, and multidisciplinary leadership. Together, they reinforce that PBM is adaptable across diverse healthcare environments and can progress from hospital-based initiatives to coordinated regional or national programmes when supported by sustained institutional and policy commitment.

PBM MATURITY MODELS AND IMPLEMENTATION FRAMEWORKS

Insights from these diverse experiences have informed the development of structured implementation frameworks and maturity models that guide the progressive scale-up of PBM programmes. Successful scale-up requires a structured, staged approach to integrating PBM into routine clinical practice. Maturity models, as developed and applied in PBM by several national and international groups, provide a roadmap to assess capabilities, prioritise interventions, and support continuous improvement, while implementation frameworks facilitate the translation of evidence into sustainable system-level change (Figure 3).^{13,15,25}

Together, these frameworks are complementary: the Donabedian model provides an evaluative structure, the WHO implementation pathway defines system-level action, and PBM maturity models describe the progressive integration of PBM into routine clinical practice over time.

A Staged PBM Maturity Model

PBM implementation can be conceptualised as a progressive pathway comprising four stages that reflect increasing levels of integration and system alignment:

1. *Awareness and engagement:* Initial efforts focus on recognising the clinical and economic burden of anaemia, bleeding, and inappropriate transfusion. Key activities include stakeholder engagement, identification of local champions, and baseline audits of transfusion practices and anaemia prevalence.
2. *Early implementation:* Institutions introduce targeted, high-impact PBM interventions, including perioperative anaemia detection and treatment, restrictive transfusion strategies, and basic haemostasis optimisation. Early data collection systems are established to monitor adherence and outcomes. Evidence from hospital-based PBM programmes demonstrates that even limited interventions at this stage can significantly reduce transfusion rates and improve outcomes.²⁶
3. *Integration and standardisation:* PBM becomes embedded into routine clinical workflows through standardised clinical pathways, multidisciplinary coordination, and integration with hospital quality and safety systems. Audit-and-feedback mechanisms and digital tools support adherence, while education programmes reinforce behavioural change.
4. *System-level optimisation and scale-up:* Advanced stages involve expansion beyond individual institutions to regional or national programmes. PBM is incorporated into policy frameworks, accreditation standards, and financing mechanisms, supported by robust data systems and benchmarking. Large-scale programmes such as those implemented in Western Australia and Canada demonstrate the feasibility and impact of system-wide PBM adoption.^{8,16}

This staged model reflects real-world implementation trajectories observed across diverse healthcare systems, from high-income countries

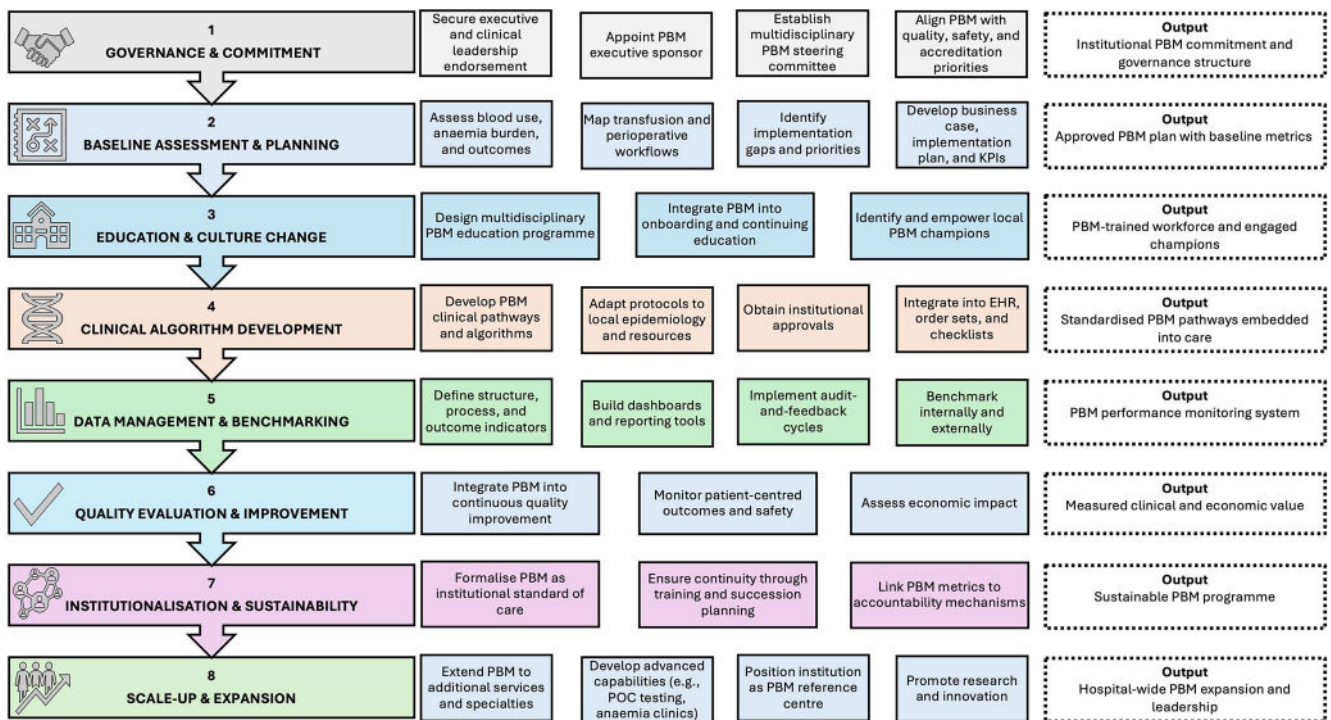


Figure 3 – A phased, hospital-level roadmap outlining key steps for implementing PBM within healthcare organisations, from initial governance and planning to integration, sustainability, and expansion. The model provides a practical, operational framework to guide multidisciplinary teams in translating PBM principles into routine clinical practice. It complements the system-level approach described in Figure 2 and the conceptual Donabedian framework in Figure 1. Together, these figures provide an integrated view of PBM implementation from evaluation to system design and institutional execution. Abbreviations: EHR, electronic health record; KPI, key performance indicator; PBM, patient blood management; POC, point of care.

with mature PBM programmes to resource-adapted models in low- and middle-income settings.

Key Components of PBM Implementation Frameworks

Across maturity stages, several core components consistently underpin successful PBM implementation:

- *Governance and leadership*: Establishment of multidisciplinary PBM committees, effective communication strategies and alignment with institutional and national policies
- *Clinical pathway and standardised documentation*: Development and implementation of evidence-based, standardised protocols for anaemia management, haemostasis optimisation, and transfusion decision-making
- *Data and metrics*: Continuous monitoring of key indicators, including transfusion rates, anaemia prevalence, and clinical outcomes
- *Education and training*: Ongoing multidisciplinary education to support behavioural change and adherence to PBM principles
- *Resource alignment*: Progressive access to diagnostics, pharmacological therapies, and point-of-care technologies adapted to local context

These components align with implementation science frameworks and global PBM guidance and should be implemented in an

integrated, context-sensitive manner, recognising that their relative priority may vary according to the stage of PBM maturity and local resource availability.^{6,12,15,27}

Measurement and Continuous Improvement

Robust measurement systems are essential to track progress along the PBM maturity pathway. Key performance indicators typically include rates of preoperative anaemia detection and treatment, transfusion utilisation, complication rates, and length of hospital stay. Continuous audit and feedback enable iterative refinement of PBM programmes and support accountability at institutional and system levels.^{13,28,29}

Importantly, measurement frameworks should be adapted to local context, particularly in low- and middle-income countries, where simplified indicators and pragmatic data collection approaches may be required.

Toward Scalable and Sustainable PBM Systems

Maturity models and implementation frameworks provide a structured pathway to move from fragmented PBM initiatives to fully integrated, sustainable systems of care. By enabling stepwise progression, alignment of stakeholders, and continuous evaluation, these approaches support the long-term goal of embedding PBM into routine clinical practice and national health strategies.

Ultimately, the integration of PBM maturity models with global health priorities including universal health coverage, patient safety, and resource stewardship, positions PBM as a scalable and transformative strategy for improving blood health and perioperative outcomes worldwide.

CHALLENGES IN IMPLEMENTING PBM

Adaptation Rather than Replication

Successful implementation of PBM depends on local adaptation to epidemiological, cultural, and economic contexts rather than direct replication of models developed in high-resource settings. Healthcare systems differ substantially in terms of infrastructure, workforce capacity, financing mechanisms, and access to diagnostics and therapeutics. Accordingly, PBM approaches must be tailored to local realities, often requiring reorganisation of existing systems and integration of transfusion medicine into broader healthcare frameworks. In low- and middle-income settings, these contextual constraints frequently necessitate prioritisation of high-impact, scalable interventions rather than full replication of mature PBM systems.^{6,11}

Structural and Resource Barriers

Scaling up PBM is frequently constrained not by a lack of clinical evidence but by structural and organisational barriers. At the outer-setting level, misaligned reimbursement models, transfusion-centred incentives, variable regulatory environments, and inequitable access to essential PBM resources limit system-wide adoption. Within the inner setting, fragmented perioperative pathways, limited laboratory and referral capacity, and insufficient data systems for case identification, audit, and feedback restrict effective implementation. At the level of the implementation process, the absence of formal governance structures, unclear multidisciplinary roles, and a lack of robust performance metrics undermine coordinated execution and long-term sustainability.¹²

These barriers are consistent with WHO implementation guidance, which emphasises the need for institutionalised governance, standardised clinical pathways, fit-for-purpose diagnostics, and robust data infrastructure.⁶

Behavioural and Cultural Resistance

Beyond structural constraints, behavioural and cultural factors represent major barriers to PBM implementation. Long-standing transfusion-centred paradigms, reinforced through clinical training, habit, and perceived safety, continue to position allogeneic blood transfusion as the default response to anaemia and bleeding, despite robust evidence supporting restrictive and patient-centred strategies.

Persistent misconceptions regarding anaemia tolerance, overestimation of bleeding risk, and overconfidence in the benefits of transfusion further limit adoption of preventive and adjunctive PBM interventions. These behaviours are often compounded by hierarchical decision-making, limited multidisciplinary ownership, and inadequate feedback on transfusion-related harms and PBM-associated benefits.¹² Overcoming these barriers requires targeted behaviour-change strategies that promote shared decision-making, strengthen multidisciplinary accountability, and realign clinical practice with evidence through continuous feedback, audit, and peer engagement.³⁰

Sustainability Challenges

Beyond initial implementation, ensuring the long-term sustainability of PBM programmes represents an additional and often underappreciated challenge. High workforce turnover, competing clinical priorities, and reliance on individual champions rather than institutional structures frequently lead to erosion of PBM practices. In the absence of formal integration into governance frameworks, clinical pathways, performance indicators, and continuous education programmes, PBM initiatives risk losing visibility and momentum. Limited audit-and-feedback mechanisms further weaken reinforcement of desired behaviours and hinder demonstration of long-term value.

These challenges underscore that sustainability depends on institutionalisation—embedding PBM into routine systems of care, quality improvement processes, and accountability structures—rather than relying on episodic or project-based efforts.^{26,29} Addressing both implementation and sustainability challenges is essential to fully realise PBM as a system-level strategy for improving patient outcomes and healthcare efficiency.

SUMMARY

Despite strong supporting evidence and clear WHO guidance, PBM implementation remains inconsistent across healthcare systems due to persistent structural, behavioural, and organisational barriers. However, global and regional experiences consistently demonstrate that PBM can be effectively adapted to diverse clinical and resource settings when supported by coordinated, context-sensitive strategies. Achieving sustainable scale-up requires embedding PBM into routine clinical practice, health policy, and quality improvement frameworks, supported by governance, data systems, education, and continuous performance evaluation.

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