

Editorial

Comprehensive and Continuously Updated Departmental Protocols: A Cornerstone of Safe and High-Reliability Perfusion PracticeSalman Pervaiz Butt^{1,2,*} ¹Department of Perfusion Services, Heart, Vascular & Thoracic Institute, Cleveland Clinic Abu Dhabi, 112412 Abu Dhabi, United Arab Emirates²College of Medicine, Alfaisal University, 11533 Riyadh, Saudi Arabia*Correspondence: buttsab9@hotmail.com (Salman Pervaiz Butt)

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The scope of contemporary perfusion practice has expanded considerably over the past two decades. Perfusionists are no longer involved solely in routine cardiopulmonary bypass procedures but now play critical roles in Extracorporeal Membrane Oxygenation (ECMO), mechanical circulatory support, Extracorporeal Cardiopulmonary Resuscitation (ECPR), heart and lung transplantation, minimally invasive cardiac surgery, hybrid cardiovascular procedures, and complex aortic surgery. As clinical responsibilities continue to broaden, the development, maintenance, and regular revision of comprehensive departmental protocols should be recognized as a fundamental component of safe, evidence-based perfusion practice.

While most perfusion departments maintain protocols for routine Cardiopulmonary Bypass (CPB) management, many lack comprehensive guidance covering uncommon clinical conditions, special patient populations, and low-frequency but high-risk emergencies. Examples include antiphospholipid syndrome, heparin-induced thrombocytopenia, pregnancy requiring cardiac surgery, morbid obesity, sickle cell disease, cold agglutinin disease, severe pulmonary hypertension, mechanical valve thrombosis, ECMO-to-CPB conversion, ECPR, ventricular assist devices, and transplantation [1,2,3,4].

The importance of such protocols becomes particularly apparent during rare and complex clinical situations. Consider a patient with antiphospholipid syndrome requiring urgent cardiac surgery, a patient with heparin-induced thrombocytopenia requiring alternative anticoagulation during CPB, or a pregnant patient requiring emergency valve surgery. Many perfusionists may encounter these scenarios only a few times during their careers. Similarly, events such as oxygenator failure, ECMO-to-CPB conversion, or emergency ECPR deployment often occur unexpectedly and under significant time pressure. In the absence of clearly defined protocols, management may become dependent on individual experience and recollection rather than standardized evidence-based practice. Comprehensive departmental guidance helps ensure a coordinated, reproducible, and safe response regardless of the experience level of the individual practitioner.

Departments should also maintain protocols for rare but potentially catastrophic emergencies including oxygenator failure, air embolism, venous air lock, pump malfunction, gas supply interruption, heparin resistance, protamine reactions, accidental decannulation, cardioplegia delivery failure, ECMO circuit emergencies, massive hemorrhage, emergency sternotomy, and emergency conversion from minimally invasive to open cardiac surgery. In these situations, comprehensive protocols and emergency checklists provide a structured framework for decision-making, reduce variability, and support effective team performance [5,6].

The benefits of robust departmental protocols extend beyond emergency preparedness. Standardization reduces unwarranted variability in anticoagulation management, transfusion practices, blood conservation, temperature management, oxygen delivery monitoring, myocardial protection, ECMO practice, and mechanical circulatory support. Evidence-based departmental guidelines help ensure patients receive consistent care regardless of the individual practitioner involved [1,2,3,4].

The value of standardized protocols and checklists has been demonstrated across multiple healthcare settings. The World Health Organization Surgical Safety Checklist was associated with significant reductions in postoperative complications and mortality following implementation [5]. Within cardiac surgery, implementation of standardized perioperative care pathways, blood conservation strategies, and evidence-based clinical guidelines has been associated with improved process reliability, reduced practice variation, and enhanced quality improvement efforts [4,7]. Standardized protocols and evidence-based guidelines have also been promoted as important mechanisms for improving team communication, enhancing emergency preparedness, and supporting consistent delivery of care across multidisciplinary teams [1,2,3,4]. Furthermore, studies evaluating checklist implementation and crisis resource management have demonstrated improvements in team performance, communication, and management of critical events [6,8]. Although direct perfusion-specific outcome studies remain limited, the broader surgical and patient safety literature provides compelling evidence that structured proto-



cols and checklists contribute to safer, more consistent, and higher-reliability clinical practice.

A suggested framework for organizing departmental perfusion protocols is presented in **Supplementary Table 1**.

Supplementary Table 2 provides examples of protocol categories that may be incorporated into a comprehensive perfusion department protocol library to support standardization, education, quality improvement, emergency preparedness, and management of special patient populations.

While comprehensive protocol libraries represent the ideal state, departments with limited resources may benefit from a phased implementation strategy. Protocol development should initially focus on high-risk and high-frequency processes that affect routine patient care, followed by high-risk but low-frequency emergencies where delayed or inconsistent management may have significant consequences. Additional protocols may then be developed according to institutional case mix, service complexity, available expertise, and local risk assessments. Similar protocol-based approaches have been widely adopted in patient safety and quality improvement initiatives [5,6,7,8]. This risk-based prioritization approach allows departments to progressively build a comprehensive protocol library while ensuring that the most clinically important scenarios are addressed first.

Comprehensive protocols also provide substantial educational value. Modern perfusion departments often comprise experienced clinicians, newly qualified graduates, trainees, international recruits, locum staff, and practitioners returning to practice after prolonged absences. A well-developed protocol library facilitates onboarding, competency development, continuing professional education, and preservation of institutional knowledge.

The increasing adoption of simulation-based education further reinforces the value of departmental protocols. Emergency simulations involving CPB emergencies, ECMO emergencies, ECPR deployment are most effective when supported by clearly defined institutional procedures. Protocols provide the foundation upon which simulation exercises and competency assessments can be built [9].

Importantly, protocols should never be regarded as static documents. Perfusion practice continues to evolve through advances in technology, monitoring, anticoagulation strategies, ECMO applications, transplantation, and emerging clinical evidence [4,10]. Consequently, departments should adopt a living protocol model whereby guidelines undergo regular review and revision. The proposed framework for this continuous quality improvement process is illustrated in Fig. 1.

Implementation of comprehensive protocol programs is not without challenges. Common barriers include competing clinical priorities, limited protected time for protocol development, staff resistance to change, resource con-

straints, and differing perspectives among multidisciplinary stakeholders. Successful implementation may be facilitated through strong leadership support, stakeholder engagement, simulation-based testing, and iterative revision processes that promote usability and long-term sustainability [1,2,3,4,9].

Departmental protocols should generally be viewed as local adaptations of established professional society guidelines rather than entirely de novo documents. Recommendations from organizations such as American Society of ExtraCorporeal Technology (AmSECT), The Society of Thoracic Surgeons (STS), and Extracorporeal Life Support Organization (ELSO) can provide the foundational framework, while local protocols incorporate institution-specific workflows, equipment, staffing models, regulatory requirements, and patient populations. When recommendations differ between professional societies or local circumstances require modification, multidisciplinary review committees should evaluate the available evidence and document the rationale for any deviations [1,2,3,4,10].

Departments should establish a formal Protocol Review Committee consisting of senior perfusionists, surgeons, anesthesiologists, intensivists, quality specialists, and educators. Such committees should oversee protocol governance, evaluate emerging evidence, review adverse events and near misses, assess compliance with professional society recommendations, and identify opportunities for improvement. Effective governance should include defined protocol ownership, version control, revision histories, document management processes, and periodic audits to ensure protocols remain current, accessible, and aligned with evolving clinical practice [1,2,3,4,10].

Comprehensive protocol governance should be regarded as a key component of departmental maturity and clinical excellence. Beyond supporting day-to-day operations, structured governance frameworks facilitate accreditation readiness, regulatory compliance, risk mitigation, and continuous quality improvement. By providing a mechanism to translate emerging evidence, institutional experience, and lessons learned from adverse events into standardized practice, protocol governance promotes accountability, consistency, and sustained improvements in patient care [1,2,3,4].

Audit activities may include monitoring protocol adherence rates, checklist completion, documentation completeness, protocol deviation reporting, and participation in competency assessments or simulation exercises. Significant deviations should undergo structured review to identify contributing factors and determine whether corrective actions, such as education, retraining, workflow modification, or protocol revision, are required [1,2,3,4,9].

Protocol design is equally important as protocol content. For time-critical emergencies, departments should consider supplementing comprehensive reference documents with concise checklists, visual algorithms, quick-



Fig. 1. The living protocol lifecycle in perfusion practice. Conceptual framework illustrating the continuous cycle of evidence surveillance, protocol development and revision, staff education, implementation, audit and compliance monitoring, and ongoing refinement. Formal review may occur annually or biennially, with interim updates triggered by new evidence, guideline revisions, adverse events, technological advances, or quality improvement initiatives.

reference cards, and mobile-accessible resources. Such formats may improve accessibility, reduce cognitive burden, and facilitate rapid decision-making during high-stress clinical situations while maintaining consistency with more detailed departmental guidance [5,6,9].

As protocol libraries expand, there is a risk that excessive document volume may reduce accessibility and increase cognitive burden during time-critical situations. Departments should therefore consider tiered protocol structures consisting of core protocols for routine and emergency

use, supplemented by extended reference documents for specialized scenarios. Indexed quick-reference tools, visual algorithms, searchable digital repositories, and decision-support resources may further enhance accessibility while minimizing information overload [5,6,9].

Looking ahead, departmental protocols may evolve beyond traditional document-based systems toward integrated digital platforms that provide clinicians with rapid access to evidence-based guidance at the point of care. Emerging technologies such as mobile protocol repository

ries, electronic health record integration, clinical decision-support tools, and artificial intelligence-assisted literature surveillance may facilitate more efficient protocol maintenance and dissemination. Such innovations have the potential to improve accessibility, enhance compliance, accelerate protocol updates, and further strengthen patient safety and quality outcomes. The specific structure, scope, and complexity of departmental protocol libraries will inevitably vary according to institutional size, available resources, case mix, staffing models, and clinical capabilities. Nevertheless, the underlying principles of standardization, continuous review, accessibility, and evidence-based practice remain broadly applicable across perfusion services and healthcare organizations.

Similar to the evolution of evidence-based perfusion guidelines at national and international levels, departmental protocols should undergo continuous refinement to reflect advances in clinical practice, technology, and patient safety science. Protocols should serve as mechanisms through which evidence is translated into consistent bedside practice.

As perfusion practice continues to evolve, investment in comprehensive protocol governance should be viewed not merely as an administrative responsibility but as a strategic patient safety initiative that supports consistency, quality, education, and clinical excellence.

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SPB conceived, wrote, and critically revised the editorial and approved the final version for publication. The author meets all four International Committee of Medical Journal Editors (ICMJE) authorship criteria and agrees to be accountable for all aspects of the work.

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Supplementary Material

Supplementary material associated with this article can be found, in the online version, at <https://doi.org/10.31083/HSF54523>.

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