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REVIEW ARTICLE

Contemporary Management and Long-Term Outcomes of Tetralogy of Fallot: A Narrative Literature Review

Arketa Guli[1*], Sokol Xhepa[2,3], Altin Veshti[2,3]

[1] Department of Clinical Subjects, Faculty of Natural Sciences, University "Luigj Gurakuqi" of Shkodra, Albania.
[2] University of Medicine, Faculty of Medicine, Tirana, Albania
[3] Department of Heart & Vascular Surgery, University Hospital Center "Mother Teresa", Tirana, Albania

Corresponding author: Arketa Guli M.D, Ph.Dc.
Department of Clinical Subjects, Faculty of Natural Sciences,
University "Luigj Gurakuqi" of Shkodra, Albania.
Email: arketa.guli@unishk.edu.al
ORCID: https://orcid.org/0000-0001-8881-7434

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ABSTRACT

Background: Tetralogy of Fallot (TOF) remains the most common cyanotic congenital heart disease and a cornerstone of congenital cardiology. While advances in surgical repair have dramatically improved survival, the condition increasingly presents as a lifelong clinical challenge characterized by evolving complications and ongoing care needs.
This review aims to synthesize current evidence on contemporary management strategies and long-term outcomes in patients with TOF, with particular focus on surgical approaches, late complications, and lifelong follow-up.
Design and Data Sources: A narrative literature review was conducted using a structured search of PubMed, Scopus, Web of Science, and Google Scholar for studies published between 2016 and 2026. Eligible studies included clinical cohorts, registry analyses, systematic reviews, meta-analyses, and international guidelines addressing TOF management and outcomes A thematic narrative synthesis approach was applied to integrate findings across heterogeneous studies. In total, 36 studies met the inclusion criteria and were included in the final synthesis.
Results: Despite excellent survival after repair, long-term morbidity remains significant, driven by right ventricular dysfunction, pulmonary regurgitation, and arrhythmias. Management is individualized, with cardiac magnetic resonance central to follow-up. Neurodevelopment and quality of life are increasingly recognized, while disparities in access to care continue to influence outcomes.
Conclusion: TOF should be regarded as a chronic condition requiring coordinated, multidisciplinary, and lifelong management. Optimizing long-term outcomes will depend on improved risk stratification, timely intervention, and equitable access to specialized care.
Keywords: Arrhythmias; Congenital heart disease; Lifelong care; Long-term outcomes; pulmonary regurgitation; Tetralogy of Fallot.

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INTRODUCTION

Tetralogy of Fallot (TOF), the most prevalent cyanotic congenital cardiac disease, is characterized by ventricular septal defect, overriding aorta, right ventricular outflow tract obstruction, and right ventricular hypertrophy (1,2). TOF is a major focus in pediatric and adult congenital cardiology due to its anatomical intricacy.

TOF management has altered dramatically in recent decades. Surgical procedures, perioperative care, and cardiac imaging have improved survival, with most patients now living to adulthood (3,4). As a result, the clinical focus has switched from survival after repair to long-term clinical outcomes, functional capacity, and quality of life (3-5).

The fact that surgical repair does not cure is becoming increasingly apparent. Repair is just the start of a chronic illness path that requires ongoing monitoring and personalized treatment. International guidelines recommend risk-based follow-up and early intervention to prevent late consequences (1,2).

Managing late postoperative sequelae is a daily therapeutic issue. Pulmonary regurgitation, increasing right ventricular dilatation, ventricular dysfunction, and arrhythmias sometimes require further treatment (6-8). Arrhythmias are a prominent cause of morbidity and abrupt cardiac death in people with corrected TOF (9).

Beyond cardiovascular outcomes, TOF's impact on patients' lives is becoming clearer. Increasing data suggests that congenital cardiac disease, especially TOF, may cause neurodevelopmental and psychological problems into adolescence and adulthood (10-12). These are now crucial to complete treatment.

These data suggest that TOF management involves surgical decision-making, sophisticated imaging, rhythm surveillance, and patient-centered outcomes rather than lifelong care ideas. However, variations in access to specialized care, particularly in low- and middle-income countries, continue to affect outcomes and highlight the need for a global health perspective (13)**.** This study presents a comprehensive synthesis of surgical techniques, long-term clinical outcomes, and systemic determinants, establishing Tetralogy of Fallot as a complicated illness need coordinated and contextually tailored therapy.

Aim and Objectives

The aim of this review is to synthesize current evidence on the contemporary management and long-term outcomes of patients with Tetralogy of Fallot, with particular emphasis on advances in therapeutic strategies, lifelong surveillance, and the persistent challenges related to complications and quality of life. To address this aim, the review provides an integrated evaluation of the anatomical, physiological, and diagnostic features relevant to clinical management; critically examines current surgical and catheter-based treatment approaches across diverse patient populations; evaluates both short- and long-term outcomes following repair, including ventricular function, pulmonary regurgitation, arrhythmias, and the need for reintervention; and explores broader patient-centered outcomes, including quality of life, neurodevelopment, and the complexities inherent in lifelong care.

Theoretical framework

The interpretation of contemporary management and long-term outcomes in Tetralogy of Fallot (TOF) is best understood by framing the condition as a chronic, evolving disease rather than a one-time surgical event. The Life-Course Model emphasizes that early anatomical features and surgical decisions influence outcomes across the lifespan (14), supported by evidence showing that, despite excellent survival, patients remain at risk for pulmonary regurgitation, right ventricular dysfunction, arrhythmias, and heart failure (3-5,15).

The Biopsychosocial Model extends this perspective by highlighting neurodevelopment, psychological well-being, and quality of life (16), with studies indicating potential cognitive and psychosocial challenges in affected individuals (10-12). The Risk Stratification Model supports individualized management by accounting for variability in clinical presentation and long-term risk (17), where factors such as right ventricular dilation, severity of pulmonary regurgitation, and arrhythmia burden guide follow-up and reintervention (6,7,9). Finally, a Chronic Care and Systems-Based Perspective underscore the need for continuous, multidisciplinary care and structured follow-up (18,19), while international guidelines and global evidence highlight the importance of access to specialized services and healthcare system organization in determining long-term outcomes (1,2,13).

MATERIALS AND METHODS

This study was conducted as a narrative literature review aimed at synthesizing current evidence on the contemporary management and long-term outcomes of Tetralogy of Fallot. Although narrative in design, a structured and transparent approach was adopted to enhance reproducibility and methodological rigor.

Data Sources and Search Strategy

A comprehensive literature search was performed across four major electronic databases: PubMed, Scopus, Web of Science, and Google Scholar.

The search strategy combined Medical Subject Headings (MeSH) and free-text terms. The core search string used in PubMed was: ("Tetralogy of Fallot" OR "TOF") AND ("surgical repair" OR "management") AND ("long-term outcomes" OR "pulmonary regurgitation" OR "arrhythmias" OR "right ventricular dysfunction"

OR "pulmonary valve replacement" OR "adult congenital heart disease"). This strategy was adapted for use in other databases using equivalent indexing terms and Boolean operators (AND, OR).

The search was limited to studies published between January 2016 and January 2026, and only articles published in English were considered. A manual search of reference lists of key articles and relevant reviews was conducted to identify additional eligible studies.

Eligibility Criteria

Studies were selected based on predefined inclusion criteria. Eligible studies included clinical studies (such as cohort, multicenter, and registry-based studies), systematic reviews and meta-analyses, international guidelines and scientific statements, as well as narrative reviews addressing key aspects of Tetralogy of Fallot management and outcomes.

Included studies focused on surgical or interventional management, short- and long-term outcomes, postoperative complications such as arrhythmias, pulmonary regurgitation and heart failure, as well as imaging, follow-up strategies, neurodevelopment, and quality of life.

Studies were excluded if they did not specifically address Tetralogy of Fallot, lacked clinical relevance to management or outcomes, were published outside the predefined time frame, or consisted of case reports or studies with insufficient methodological detail.

Study Selection

The process of choosing studies was organized in a way that met PRISMA 2020 guidelines. We found a total of 430 records by searching databases and other sources. After getting rid of 90 duplicates, there were 340 records left to screen. We looked at the titles and abstracts and threw out 190 records that didn't satisfy the criteria we had set up.

We looked for 150 full-text articles to get back, but we couldn't find 10 of them. As a result, 140 full-text papers were evaluated for eligibility. We didn't include 104 of these studies because they had methodological problems, didn't have meaningful outcomes, or didn't have enough clinical data. In the end, 36 papers met the criteria for inclusion and were incorporated in the final synthesis. The study selection process is illustrated in Figure 1.

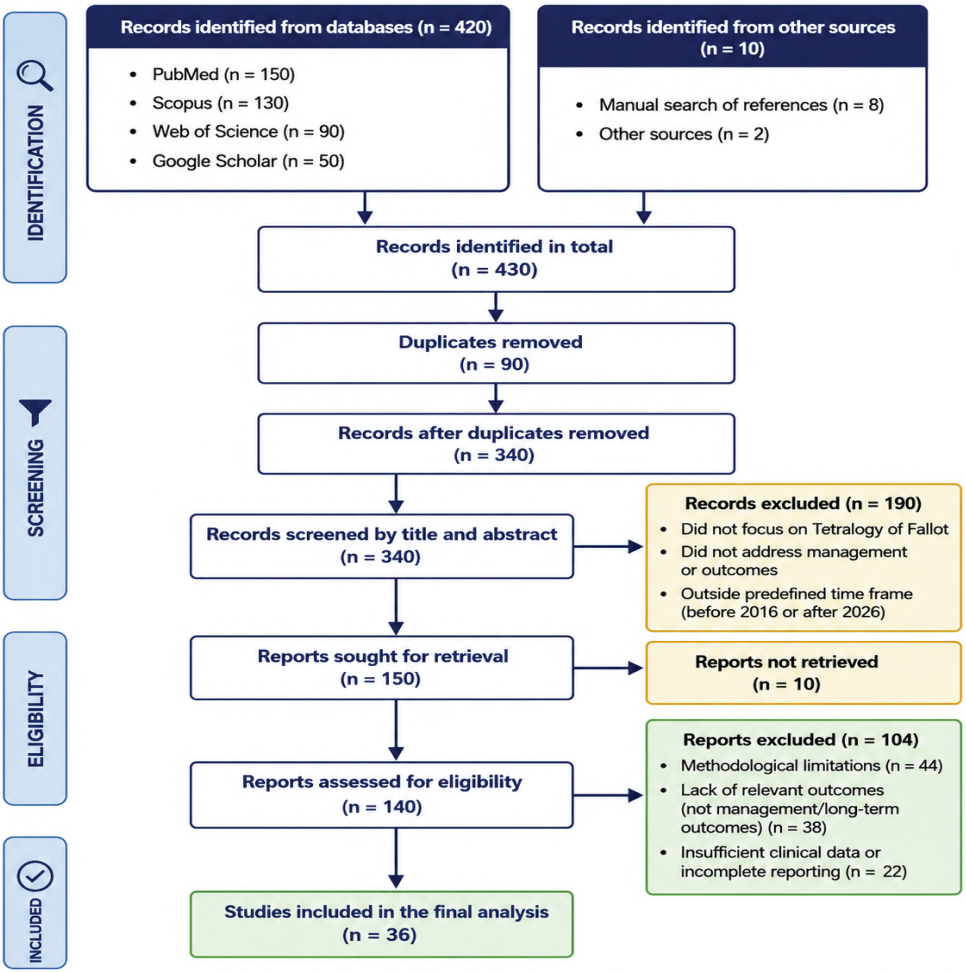

Figure 1. PRISMA flow diagram

Quality Appraisal

Although a formal scoring system was not applied due to the narrative design, methodological quality was assessed using criteria adapted from established appraisal tools (Newcastle-Ottawa Scale and AMSTAR principles), including:

- clarity of study design
- adequacy of sample size
- relevance and definition of outcomes
- completeness and transparency of reporting

Studies with significant methodological limitations, insufficient clinical data, or lack of relevance were excluded during full-text screening.

Data Extraction

Data from included studies were systematically extracted into a structured framework including:

- Author, year, and country
- Study design and population
- Clinical focus or intervention
- Outcomes measured
- Key findings

These data were summarized in Table 1 to facilitate comparison across studies.

Data Synthesis

Due to heterogeneity in study designs, populations, and reported outcomes, a quantitative meta-analysis was not feasible. Instead, a thematic narrative synthesis was conducted. The evidence was grouped into key clinical domains, including surgical strategies and timing of repair, long-term outcomes, right ventricular function and pulmonary valve disease, arrhythmias, imaging and follow-up, neurodevelopment and quality of life, as well as adult outcomes and healthcare system factors.

This approach enabled the identification of consistent patterns across studies, areas of agreement, and existing gaps in the current evidence base.

RESULTS

Guidelines and Long-Term Management

Current evidence highlights the central role of international guidelines in the management of patients with repaired Tetralogy of Fallot. Both European and American recommendations emphasize risk-based follow-up strategies and timely intervention tailored to evolving clinical findings (1,2).

These guidelines consistently underline the importance of risk stratification, particularly in relation to arrhythmias, ventricular function, and the progression of right ventricular outflow tract (RVOT) dysfunction. More recent scientific statements further reinforce the need for targeted monitoring of arrhythmic risk and neurodevelopmental outcomes as part of comprehensive care pathways(9,10).

Surgical Strategies and Timing of Repair

Across the included studies, surgical management strategies have evolved significantly, particularly in neonates and infants. Contemporary data suggest that both primary repair and staged palliation remain viable options, with the choice largely dependent on patient characteristics such as age, weight, and clinical stability (20-22).

Several studies indicate that early repair during infancy is feasible and may be beneficial in selected patients, although it carries increased perioperative risk in certain high-risk groups (23,24). In contrast, staged palliation may provide clinical stabilization prior to complete repair, particularly in symptomatic or low-weight neonates (25,26).

Large registry data also demonstrate variability in surgical practices across centers, reflecting differences in institutional expertise and patient selection (27).

Short- and Long-Term Clinical Outcomes

Overall survival following repair of Tetralogy of Fallot is reported to be excellent across most studies. However, morbidity remains clinically significant, particularly over long-term follow-up. Cohort and registry studies consistently show that reintervention, especially related to RVOT dysfunction, is common over time (3,4).

Long-term outcomes are influenced by anatomical variability, surgical technique, and the presence of genetic conditions, with certain subgroups demonstrating higher rates of complications and mortality (5).

In addition, evidence suggests that ventricular dysfunction, including left ventricular involvement, is associated with worse cardiovascular outcomes (28).

Right Ventricular Function and Pulmonary Valve Disease

Right ventricular dysfunction and pulmonary regurgitation emerge as central determinants of long-term outcomes. Multiple studies highlight the progressive nature of RV dilation and its association with adverse clinical outcomes (6).

Pulmonary valve replacement (PVR) is identified as a key intervention for managing late complications, although optimal timing remains a matter of ongoing debate (7,29).

Both surgical and percutaneous approaches are used in clinical practice, with evidence suggesting that each has specific advantages depending on patient characteristics (30,31).

Arrhythmias and Electrophysiological Complications

Arrhythmias represent one of the most significant late complications following TOF repair. Ventricular tachycardia and the risk of sudden cardiac death remain major concerns, particularly in adult populations (9).

Electrophysiological studies demonstrate that anatomical isthmuses created during surgical repair serve as substrates for ventricular arrhythmias (32). Noninvasive tools, including electrocardiography, may aid in identifying high-risk patients (33).

These findings support proactive rhythm surveillance and early risk-directed intervention in vulnerable subgroups.

Imaging and Follow-Up Strategies

Advanced imaging plays a critical role in both diagnosis and long-term follow-up. Cardiac magnetic resonance (CMR) is widely regarded as the gold standard for assessing right ventricular size and function, as well as pulmonary regurgitation (34).

Multimodality imaging, including echocardiography and CT, provides complementary information and supports comprehensive patient evaluation (35).

Emerging techniques such as 3D imaging further enhance anatomical and functional assessment, particularly in complex cases (34,35).

Neurodevelopment and Quality of Life

Beyond cardiovascular outcomes, several studies highlight the importance of neurodevelopmental and psychosocial aspects. Evidence suggests that patients with TOF may experience cognitive and behavioral challenges, particularly those with complex clinical histories (11).

Despite these challenges, overall quality of life is generally reported to be favorable in many patients, although variability exists depending on treatment strategies and long-term complications (12).

Adult Outcomes and Chronic Disease Burden

As survival improves, an increasing number of patients with repaired TOF reach adulthood, bringing new clinical challenges. Long-term follow-up studies indicate that while mortality remains relatively low, morbidity is substantial, with a high burden of arrhythmias, heart failure, and need for reintervention (15,36).

Heart failure is increasingly recognized as a major complication in this population, particularly in the presence of ventricular dysfunction (8).

Global and Health System Perspectives

Finally, disparities in access to care significantly influence outcomes. Studies focusing on low- and middle-income countries highlight delays in diagnosis, limited access to surgery, and challenges in long-term follow-up (13).

In contrast, reports from specialized centers, including regional data, demonstrate improved outcomes when appropriate surgical expertise and follow-up systems are available).

DISCUSSION

Interpretation of Main Findings

The present review confirms that, although surgical repair of Tetralogy of Fallot has led to excellent survival, the condition remains associated with substantial long-term morbidity (3,4). Across the included studies, a consistent pattern emerges: patients increasingly survive into adulthood, but many develop late complications that necessitate continuous risk-based monitoring and intervention (15,36).

However, the available evidence remains heterogeneous. Most studies are observational cohort or registry-based analyses, with limited comparative data, which restricts the ability to draw definitive conclusions regarding optimal management strategies.

These findings support the view that TOF should be interpreted as a chronic clinical trajectory rather than a definitively corrected defect, in line with international guidelines (1,2). The shift toward evaluating functional status, complication burden, and patient-centered outcomes reflects a broader transformation in congenital heart disease care.

Surgical Strategies and Timing of Repair

One of the central issues identified in this review is the ongoing debate regarding optimal surgical strategy and timing of repair. The evidence suggests that both primary repair and staged palliation remain valid approaches, with decisions largely guided by patient-specific factors such as age, weight, and clinical stability (20,21).

Early repair during infancy has become increasingly common and may offer advantages in terms of physiological correction and avoidance of prolonged cyanosis (38). However, this approach may be associated with higher perioperative risk in vulnerable groups, particularly low-weight or symptomatic neonates (23,24).

In contrast, staged palliation may provide a safer pathway for selected high-risk patients, allowing stabilization before complete repair (25,26). The variability observed across studies and centers (39), highlights the absence of a universally optimal strategy, reinforcing the importance of individualized surgical planning rather than a uniform approach (2).

Long-Term Outcomes and Reintervention

Although survival following repair is consistently reported as excellent, long-term outcomes are characterized by progressive morbidity and a high rate

of reintervention, particularly related to right ventricular outflow tract dysfunction (3,4).

Nevertheless, the strength of this evidence is influenced by several limitations. Most studies originate from high-income settings and specialized centers, potentially limiting generalizability. In addition, heterogeneity in surgical techniques, follow-up duration, and patient selection contributes to variability in reported outcomes.

While ventricular dysfunction has been consistently associated with adverse prognosis (28), uncertainty persists regarding optimal thresholds and timing for intervention, particularly for pulmonary valve replacement, highlighting a persistent gap in current evidence.

Arrhythmias and Risk Stratification

Arrhythmias remain one of the most clinically significant late complications following TOF repair, with ventricular tachycardia and sudden cardiac death representing major concerns (9).

Although electrophysiological mechanisms are increasingly understood, much of the evidence is based on observational and mechanistic studies rather than prospective trials (32). As a result, risk stratification strategies, while improving, remain imperfect and may vary across clinical settings (33). This limits the precision of current risk prediction models and underscores the need for standardized, evidence-based stratification tools.

Beyond Cardiac Outcomes: Neurodevelopment and Quality of Life

Increasing attention has been directed toward outcomes beyond traditional cardiovascular parameters. Evidence suggests that patients with Tetralogy of Fallot may experience neurodevelopmental and psychosocial challenges, particularly in complex clinical cases or following early-life interventions (11).

Despite these challenges, quality of life is often reported as favorable, indicating the potential for successful long-term adaptation (12). However, variability across studies suggests that these outcomes are influenced by a combination of medical, psychological, and social factors.

This highlights the need to integrate neurodevelopmental assessment and psychosocial support into routine clinical pathways rather than considering them secondary outcomes.

Lifelong Care and Health System Challenges

The increasing survival of patients with repaired TOF has shifted the burden toward long-term disease management within healthcare systems. As survival improves, an increasing number of adults with repaired TOF require specialized long-term care. Despite relatively low mortality, morbidity remains substantial, with a high burden of arrhythmias, heart failure, and repeated interventions (8,15,36).

This highlights the importance of dedicated adult congenital heart disease services and structured transition from pediatric to adult care.

At the same time, important disparities in access to care persist. Evidence from low- and middle-income countries indicates delays in diagnosis, limited access to surgical treatment, and challenges in long-term follow-up (13), whereas outcomes are generally more favorable in settings with established multidisciplinary care systems.

Although data from the Albanian context remain limited, available evidence suggests that satisfactory outcomes can be achieved when appropriate expertise and infrastructure are in place (37) , emphasizing the need for further regional research and system-level development.

Clinical and Research Implications

This review supports the recognition of Tetralogy of Fallot as a lifelong condition requiring structured, risk-based follow-up. Continuous rhythm monitoring and advanced imaging, particularly cardiac magnetic resonance, are essential for the early detection of right ventricular dysfunction, pulmonary regurgitation, and arrhythmic risk. Optimizing long-term outcomes requires multidisciplinary care and a well-coordinated transition from pediatric to adult services.

The identification of neurodevelopmental and psychosocial challenges further supports the integration of patient-centered care, including early screening and targeted interventions to improve quality of life.

From a research perspective, the predominance of observational studies limits the strength of current evidence. Future research should focus on developing standardized risk stratification models, refining the timing of key interventions such as pulmonary valve replacement, and conducting multicenter studies that include diverse populations, particularly from low- and middle-income settings.

Lastly, integrating clinical outcomes with patient-reported measures is essential to better capture the overall burden of disease and to guide personalized, lifelong management strategies.

Limitations

This review has several limitations that should be considered when interpreting the findings. First, the narrative design does not allow for quantitative synthesis or formal comparison across studies, which may limit the strength of conclusions. Second, the included studies were heterogeneous in terms of design, population, and outcomes, making direct comparisons challenging. Finally, the limited availability of data from certain regions, particularly low- and middle-income countries, may affect the generalizability of the findings.

CONCLUSION

Tetralogy of Fallot should be understood as a condition characterized by progressive clinical complexity rather than a definitively corrected defect. Despite excellent survival, the persistent burden of late complications underscores the need for risk-guided intervention, improved stratification strategies, and integrated long-term care models. Addressing existing evidence gaps and disparities in care will be essential to optimizing outcomes across diverse healthcare settings.

Ethical Consideration

Review articles are exempted from an institutional review board (IRB)/Ethical approval.

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REFERENCES

1. Stout KK, Daniels CJ, Aboulhosn JA, Bozkurt B, Broberg CS, Colman JM, et al. 2018 AHA/ACC guideline for the management of adults with congenital heart disease. J Am Coll Cardiol. 2019;73(12):e81-e192. doi:10.1016/j.jacc.2018.08.1029.
2. Baumgartner H, De Backer J, Babu-Narayan SV, Budts W, Chessa M, Diller GP, et al. 2020 ESC guidelines for the management of adult congenital heart disease. Eur Heart J. 2021;42(6):563-645. doi:10.1093/eurheartj/ehaa554.
3. Ishigami S, et al. Long-term outcomes of tetralogy of Fallot repair: A 30-year experience with 960 patients. J Thorac Cardiovasc Surg. 2024;167(1):289-302.e11. doi:10.1016/j.jtcvs.2023.04.015.
4. Smith CA, et al. Long-term outcomes of tetralogy of Fallot. JAMA Cardiol. 2019;4(1):34-43. doi:10.1001/jamacardio.2018.4255.
5. Blais S, et al. The 30-year outcomes of tetralogy of Fallot according to native anatomy and genetic conditions. Can J Cardiol. 2021;37(6):877-886. doi:10.1016/j.cjca.2020.10.002.
6. Geva T, et al. Long-term management of right ventricular outflow tract dysfunction in repaired tetralogy of Fallot: A scientific statement from the American Heart Association. Circulation. 2024;150(25). doi:10.1161/CIR.0000000000001291.
7. Mongeon FP, et al. Pulmonary valve replacement for pulmonary regurgitation in adults with tetralogy of Fallot: A meta-analysis. Can J Cardiol. 2019;35(12):1772-1783. doi:10.1016/j.cjca.2019.08.031.
8. Mueller AS, McDonald DM, Singh HS, Ginns JN. Heart failure in adult congenital heart disease: tetralogy of Fallot. Heart Fail Rev. 2020;25(4):583-598. doi:10.1007/s10741-019-09903-0.
9. Krieger EV, et al. Arrhythmias in repaired tetralogy of Fallot: A scientific statement from the American Heart Association. Circ Arrhythm Electrophysiol. 2022;15(11). doi:10.1161/HAE.0000000000000084.
10. Sood E, et al. Neurodevelopmental outcomes for individuals with congenital heart disease: updates in neuroprotection, risk-stratification, evaluation, and management. Circulation. 2024;149(13). doi:10.1161/CIR.0000000000001211.
11. Kordopati-Zilou A, et al. Neurodevelopmental outcomes in tetralogy of Fallot: a systematic review. Children (Basel). 2022;9(2):264. doi:10.3390/children9020264.
12. Nicholson GT, et al. Health-related quality of life after neonatal treatment of symptomatic tetralogy of Fallot: insights from the Congenital Cardiac Research Collaborative. Pediatr Cardiol. 2025;46(8):2303-2314. doi:10.1007/s00246-024-03650-2.
13. Dib N, et al. Tetralogy of Fallot in low- and middle-income countries. CJC Pediatr Congenit Heart Dis. 2024;3(2):67-73. doi:10.1016/j.cjcpc.2023.12.002.
14. Halfon N, Hochstein M. Life course health development: an integrated framework for developing health, policy, and research. Milbank Q. 2002;80(3):433-479. doi:10.1111/1468-0009.00019.
15. Dennis M, Moore B, Kotchetkova I, Pressley L, Cordina R, Celermajer DS. Adults with repaired tetralogy: low mortality but high morbidity up to middle age. Open Heart. 2017;4(1):e000564. doi:10.1136/openhrt-2016-000564.
16. Engel GL. The biopsychosocial model and the education of health professionals. Ann N Y Acad Sci. 1978;310(1):169-181. doi:10.1111/j.1749-6632.1978.tb22070.x.
17. Granton J, Cheng D. Risk stratification models for cardiac surgery. Semin Cardiothorac Vasc Anesth. 2008;12(3):167-174. doi:10.1177/1089253208323681.
18. Glasgow RE, Orleans CT, Wagner EH, Curry SJ, Solberg LI. Does the chronic care model serve also as a template for improving prevention? Milbank Q. 2001;79(4):579-612. doi:10.1111/1468-0009.00222.
19. DeWaters AL, Miller EL, Haidet P, Gonzalo JD. Systems-based practice: expert perspectives on the origin and evolution of an ambiguous competency. Acad Med. 2024;99(4):424-429. doi:10.1097/ACM.0000000000005478.
20. Goldstein BH, et al. Comparison of management strategies for neonates with symptomatic tetralogy of Fallot. J Am Coll Cardiol. 2021;77(8):1093-1106. doi:10.1016/j.jacc.2020.12.048.
21. Qureshi AM, et al. Comparison of management strategies for neonates with symptomatic tetralogy of Fallot and weight <2.5 kg. J Thorac Cardiovasc Surg. 2022;163(1):192-207.e3. doi:10.1016/j.jtcvs.2021.01.100.

22. Ye XT, et al. Young infants with symptomatic tetralogy of Fallot: shunt or primary repair? JTCVS Open. 2024;19:241-256. doi:10.1016/j.xjon.2024.04.003.
23. Martins IF, Doles IC, Bravo-Valenzuela NJM, dos Santos AOR, Varella MSP. When is the best time for corrective surgery in patients with tetralogy of Fallot between 0 and 12 months of age? Braz J Cardiovasc Surg. 2018;33(5). doi:10.21470/1678-9741-2018-0019.
24. Ho AB, Bharucha T, Jones E, Thuraisingham J, Kaarne M, Viola N. Primary surgical repair of tetralogy of Fallot at under three months of age. Asian Cardiovasc Thorac Ann. 2018;26(7):529-534. doi:10.1177/0218492318803037.
25. Law MA, et al. Palliation strategy to achieve complete repair in symptomatic neonates with tetralogy of Fallot. Pediatr Cardiol. 2022;43(7):1587-1598. doi:10.1007/s00246-022-02886-0.
26. Giacobbe M, et al. Outcome of tetralogy of Fallot through initial palliation and surgical repair. Pediatr Cardiol. 2025. doi:10.1007/s00246-025-04021-1.
27. Clarke NS, et al. Contemporary patterns of care in tetralogy of Fallot: analysis of The Society of Thoracic Surgeons data. Ann Thorac Surg. 2023;116(4):768-775. doi:10.1016/j.athoracsur.2023.05.035.
28. Egbe AC, et al. Left ventricular systolic dysfunction and cardiovascular outcomes in tetralogy of Fallot: systematic review and meta-analysis. Can J Cardiol. 2019; 35(12):1784-1790. doi:10.1016/j.cjca.2019.07.634.
29. Roy LO, et al. Outcomes after pediatric pulmonary valve replacement in patients with tetralogy of Fallot. Can J Cardiol. 2024;40(12):2461-2472. doi:10.1016/j.cjca.2024.06.009.
30. Meca Aguirrezabalaga JA, Silva Guisasola J, Díaz Méndez R, Escalera Veizaga AE, Hernández-Vaquero Panizo D. Pulmonary regurgitation after repaired tetralogy of Fallot: surgical versus percutaneous treatment. Ann Transl Med. 2020;8(15):967. doi:10.21037/atm.2020.03.81.
31. Egbe AC, Vallabhajosyula S, Connolly HM. Trends and outcomes of pulmonary valve replacement in tetralogy of Fallot. Int J Cardiol. 2020;299:136-139. doi:10.1016/j.ijcard.2019.07.063.
32. Kapel GFL, et al. Arrhythmogenic anatomical isthmuses identified by electroanatomical mapping are the substrate for ventricular tachycardia in repaired tetralogy of Fallot. Eur Heart J. 2016;37(35):2688-2699. doi:10.1093/eurheartj/ehw202.
33. Brouwer C, Kapel GFL, Jongbloed MRM, Schalij MJ, de Riva Silva M, Zeppenfeld K. Noninvasive identification of ventricular tachycardia-related anatomical isthmuses in repaired tetralogy of Fallot. JACC Clin Electrophysiol. 2018;4(10):1308-1318. doi:10.1016/j.jacep.2018.06.017.
34. Valente AM, Geva T. How to image repaired tetralogy of Fallot. Circ Cardiovasc Imaging. 2017;10(5):e004270. doi:10.1161/CIRCIMAGING.116.004270.
35. Sánchez Ramírez CJ, Pérez de Isla L. Tetralogy of Fallot: cardiac imaging evaluation. Ann Transl Med. 2020;8(15):966. doi:10.21037/atm.2020.02.18.
36. Woo JP, McElhinney DB, Lui GK. The challenges of an aging tetralogy of Fallot population. Expert Rev Cardiovasc Ther. 2021;19(7):581-593. doi:10.1080/14779072.2021.1940960.
37. Prifti E. Repair of complete atrioventricular septal defect with tetralogy of Fallot. Transl Pediatr. 2017;5(1):1-7. doi:10.21037/tp.2017.01.01.
38. Yang S, et al. Impact of timing on in-patient outcomes of complete repair of tetralogy of Fallot in infancy: an analysis of the United States National Inpatient 2005-2011 database. BMC Cardiovasc Disord. 2019;19(1):46. doi:10.1186/s12872-019-0999-1.
39. Callahan CP, et al. Early outcomes for management of atrioventricular septal defect-tetralogy of Fallot in the last decade: a Congenital Heart Surgeons' Society study. World J Pediatr Congenit Heart Surg. 2025;16(2):262-272. doi:10.1177/21501351241293158.
40. Koppel CJ, Driesen BW, de Winter RJ, van den Bosch AE, van Kimmenade R, Wagenaar LJ, et al. The first multicentre study on coronary anomalies in the Netherlands: MuSCAT. Neth Heart J. 2021;29(6):311-317. doi:10.1007/s12471-021-01556-9.
41. Leonardi B, Secinaro A, Calvieri C, Perrone MA, Gimigliano F, Muscogiuri G, et al. The role of 3D imaging in the follow-up of patients with repaired tetralogy of Fallot. Eur Rev Med Pharmacol Sci. 2019;23(4):1698-1709. doi:10.26355/eurrev_201902_17132.

Table 1. Article selected for narrative review.

Author (Year)	Country	Study Type	Population	Intervention / Focus	Outcomes Measured	Key Findings
Baumgartner et al. (2021) (2)	Europe	ESC Guideline	Adults with congenital heart disease	ACHD management	Follow-up, reintervention, arrhythmias, imaging	Provides European recommendations for lifelong ACHD care, including repaired TOF.
Stout et al. (2019) (1)	USA	AHA/ACC Guideline	Adults with congenital heart disease	ACHD management	Surveillance, risk stratification, intervention	Defines structured follow-up and management principles for adult TOF patients.
Krieger et al. (2022) (9)	USA	AHA Scientific Statement	Repaired TOF patients	Arrhythmias	VT, sudden death risk, ECG, ablation, ICD	Arrhythmias remain a major late complication after TOF repair.
Sood et al. (2024) (10)	USA	AHA Scientific Statement	CHD patients	Neurodevelopment	Cognitive, behavioral, psychosocial outcomes	CHD patients need neurodevelopmental risk stratification and long-term monitoring.
Clarke et al. (2023) (27)	USA	Registry study	Pediatric TOF patients	Surgical care patterns	Repair type, palliation, mortality, morbidity	Contemporary TOF care shows changing surgical strategies across centers.
Ishigami et al. (2024) (3)	Australia	Retrospective cohort	Repaired TOF patients	Long-term surgical outcomes	Survival, reoperation, RVOT gradient	Excellent long-term survival, but reoperation remains common over time.
Smith et al. (2019) (4)	USA	Registry cohort	Pediatric repaired TOF	Long-term outcomes	Survival, mortality risk, staged repair	Long-term survival is excellent; staged and non-valve-sparing repair linked with worse survival.
Blais et al. (2021) (5)	Canada	Population cohort	TOF patients	Native anatomy/ genetics	30-year outcomes, morbidity, mortality	Outcomes vary by anatomy and genetic conditions.
Roy et al. (2024) (29)	Canada	Cohort study	Pediatric TOF patients	Pulmonary valve replacement	Reintervention, valve outcomes	Pediatric PVR is important for managing late RVOT dysfunction.
Goldstein et al. (2021) (20)	USA	Multicenter cohort	Symptomatic neonates	Primary repair vs staged repair	Mortality, complications, reintervention	Management strategy influences early risk and later outcomes.
Qureshi et al. (2022) (21)	USA/ Multicenter	Multicenter cohort	Neonates <2.5 kg	Repair vs palliation	Mortality, morbidity, complete repair	Low-weight neonates require individualized treatment strategy.
Law et al. (2022) (25)	USA/ Multicenter	Cohort study	Symptomatic neonates	Palliation before repair	Complete repair, outcomes	Palliation can help stabilize high-risk neonates before full repair.
Geva et al. (2024) (6)	USA	AHA Scientific Statement	Repaired TOF patients	RVOT dysfunction	PR, RV dilation, PVR timing	Provides updated guidance for long-term RVOT dysfunction management.
Ye et al. (2024) (22)	Australia	Cohort study	Young symptomatic infants	Shunt vs primary repair	Mortality, morbidity, reintervention	Treatment should be tailored according to infant risk profile.
Giacobbe et al.(2025) (26)	UK/Europe	Cohort study	TOF patients	Palliation and repair	Survival, reintervention, outcomes	Initial palliation followed by repair can achieve acceptable outcomes.
Callahan et al. (2025) (39)	USA/ Multicenter	Multicenter study	AVSD–TOF patients	Surgical management	Early mortality, complications	Complex AVSD–TOF has improving early outcomes with specialized care.
Yang et al. (2019) (38)	USA	Database study	Infants with TOF	Timing of repair	In-hospital outcomes, mortality, complications	Timing of repair influences inpatient outcomes.
Martins et al. (2018) (23)	Brazil	Observational study	Infants 0–12 months	Timing of corrective surgery	Early outcomes, complications	Early repair during infancy may be beneficial when clinically appropriate.

Ho et al. (2018) (24)	UK	Retrospective study	Infants <3 months	Primary early repair	Mortality, morbidity, recovery	Primary repair under 3 months can be feasible in selected patients.
Egbe et al. (2019) (28)	USA	Systematic review/meta-analysis	TOF patients	LV systolic dysfunction	Mortality, CV outcomes	LV dysfunction is associated with adverse cardiovascular outcomes.
Koppel et al. (2020) (40)	Netherlands	Meta-analysis	TOF patients	Coronary anomalies	Prevalence, surgical relevance	Coronary anomalies are clinically important for surgical planning.
Kordopati-Zilou et al. (2022) (11)	Greece/ Europe	Systematic review	TOF patients	Neurodevelopment	Cognitive, motor, behavioral outcomes	TOF patients may have neurodevelopmental vulnerabilities.
Kapel et al. (2017) (32)	Europe	Electrophysiology study	Repaired TOF patients	VT substrate	Anatomical isthmuses, VT	Anatomical isthmuses are key substrates for ventricular tachycardia.
Brouwer et al. (2018) (33)	Netherlands	Observational EP study	Repaired TOF patients	Noninvasive VT assessment	ECG, VT-related isthmuses	ECG may help identify VT-related anatomical substrates.
Valente & Geva (2017) (34)	USA	Expert review	Repaired TOF patients	Imaging follow-up	CMR, RV size/ function, PR	CMR is essential for monitoring repaired TOF.
Ramírez & de Isla (2020) (35)	Spain	Review	TOF patients	Cardiac imaging	Echo, CT, CMR	Multimodality imaging supports diagnosis and follow-up.
Leonardi et al. (2019) (41)	Italy	Observational/review imaging study	Repaired TOF patients	3D imaging	Anatomy, RV assessment	3D imaging improves anatomical and functional evaluation.
Egbe et al. (2020) (28)	USA	Observational/database study	TOF patients	Pulmonary valve replacement	Trends, outcomes	PVR use and outcomes are central to late TOF management.
Aguirreza-balaga et al. (2020) (30)	Spain	Review	Repaired TOF patients	Surgical vs percutaneous PVR	PR, RV remodeling, reintervention	Both surgical and percutaneous approaches are important for PR management.
Mongeon et al. (2019) (7)	Canada	Meta-analysis/ guideline report	Adults with TOF	Pulmonary valve replacement	Mortality, RV function, symptoms	PVR improves selected outcomes, but timing remains complex.
Mueller et al. (2020) (8)	USA	Review	Adults with TOF	Heart failure	HF mechanisms, outcomes	Heart failure is an increasing concern in aging repaired TOF patients.
Woo et al. (2021) (36)	USA	Review	Aging TOF population	Adult complications	Arrhythmias, HF, PVR, morbidity	Repaired TOF is now a chronic lifelong condition with late morbidity.
Dennis et al. (2017) (15)	Australia	Cohort study	Adults with repaired TOF	Adult outcomes	Mortality, morbidity, complications	Mortality is low, but morbidity remains high into middle age.
Nicholson et al. (2025) (12)	USA/ Multicenter	Cohort study	Neonatally treated TOF patients	Quality of life	HRQoL, functional outcomes	Quality of life after neonatal treatment is generally favorable but variable.
Dib et al. (2024) (13)	LMIC/global	Review	TOF patients in LMICs	Health systems/ access to care	Surgery access, outcomes, disparities	LMIC settings face delays, resource limitations, and follow-up challenges.
Prifti (2017) (37)	Albania	Clinical/ surgical report	AVSD with TOF	Surgical repair in Albanian context	Technical repair, perioperative considerations	Useful for addressing the Albanian/regional surgical context.