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(REVIEW ARTICLE)

Filtered-sunlight Phototherapy in Neonatal Jaundice: A Literature Review

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Abstract

Neonatal hyperbilirubinemia remains a major cause of preventable morbidity in low- and middle-income countries where reliable electric phototherapy is limited. This review article aims to compare and analyze previous studies regarding the effectiveness, safety, and feasibility of filtered-sunlight phototherapy relative to conventional electric phototherapy for treating neonatal jaundice. A Scopus search ("Filtered sunlight phototherapy"), limited to 2015–2025 and English, identified 21 records; topical screening yielded 11 studies for narrative synthesis. Randomized trials showed FSPT was non-inferior to intensive electric phototherapy, achieving effective treatment on ~87–94% of assessable days across moderate-to-severe and severe-to-hazardous jaundice. Observational data supported high effectiveness with protocolized monitoring. Safety was acceptable: no therapy withdrawals were reported, and exchange transfusion and short-term mortality were similar between modalities; hyperthermia occurred more often with FSPT but was manageable with vigilant temperature and hydration checks. Operationally, FSPT relies on standardized filters that transmit therapeutic blue/blue-green light while blocking ultraviolet and reducing infrared, and frequently requires supplemental night-time electric phototherapy. Overall, FSPT appears safe, effective, and feasible as an adjunct or bridge where device quality or power supply constrain care. Priorities include refined dosimetry standards, multi-site implementation and cost-effectiveness evaluations, and long-term outcomes.

Keywords: Filtered-Sunlight Phototherapy (FSPT); Neonatal Hyperbilirubinemia; Neonatal Jaundice; Resource-Limited Settings; Safety and Efficacy

1. Introduction

Neonatal jaundice is among the most common morbidities in early life, affecting roughly 60% of term and up to 80% of preterm infants within the first week after birth (1). While most cases are physiological and self-limited, a subset progress to severe hyperbilirubinemias with risk of acute bilirubin encephalopathy and kernicterus, a burden that remains disproportionately high in low- and middle-income countries (LMICs) (2).

Phototherapy is the standard first-line therapy to reduce unconjugated bilirubin through photochemical transformation into more water-soluble photo isomers (for example lumirubin) that can be excreted without hepatic conjugation. Its clinical effectiveness depends on emission spectrum, irradiance, exposed body surface area and exposure duration, with blue to blue-green light in the ~460–490 nm range considered most effective (3,4). However, access to high-quality electric phototherapy devices and reliable power supply is inconsistent in many LMIC settings, limiting timely, adequate treatment (5).

Filtered-sunlight phototherapy (FSPT) has been proposed to address these constraints by using sunlight passed through polymer films that transmit therapeutic blue/blue-green wavelengths while blocking ultraviolet and reducing infrared radiation. The initial proof-of-concept and protocol work established the feasibility, safety parameters and monitoring

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requirements for delivering FSPT in tropical settings (6). Early implementation research further suggested favorable acceptability among mothers, citing proximity to the infant and ease of breastfeeding during therapy (7).

Subsequent randomized evidence strengthened the clinical case for FSPT. In a simulated rural setting in Nigeria, a non-inferiority randomized controlled trial demonstrated that, under supervised protocols with temperature and hydration monitoring, FSPT was not inferior to intensive electric phototherapy for moderate-to-severe neonatal hyperbilirubinemias (8). An accompanying editorial underscored the potential of FSPT as a safe, effective adjunct in resource-constrained environments when implemented with appropriate safeguards and escalation pathways (9).

Against this background, the present review synthesizes evidence on the biological rationale and optics of FSPT, device and filter design considerations, clinical efficacy and safety, acceptability, and implementation challenges. The overarching goal is to inform practice and policy on how FSPT could complement standard phototherapy to reduce preventable bilirubin-induced neurologic dysfunction, particularly in LMICs (5). Therefore, this article aims to compare and analyze previous studies regarding the effectiveness, safety, and feasibility of filtered-sunlight phototherapy relative to conventional electric phototherapy for treating neonatal jaundice, to inform context-appropriate clinical practice and policy.

2. Material and methods

2.1. Research Strategy

A structured literature search was conducted in Scopus (Elsevier) using the keyword phrase "Filtered sunlight phototherapy". The search was performed on 26 October 2025 (Asia/Jakarta) and restricted to the last ten years (2015–2025) via the database's built-in year filter. The initial query returned 21 records. Titles and abstracts were then screened for conceptual relevance to filtered-sunlight phototherapy (FSPT) in neonatal jaundice. To ensure linguistic consistency and interpretability, results were further limited to English-language publications. After these targeted filters for topical relevance and language, 11 studies were retained for full-text review and inclusion in this article.

2.2. Inclusion and Exclusion Criteria

Inclusion: Articles (2015–2025), English language, neonates with jaundice, intervention explicitly filtered-sunlight phototherapy (FSPT), and at least one clinical efficacy or safety outcome.

Exclusion: Non-English; protocols or abstracts without clinical outcomes; engineering/optics papers without neonatal clinical data; studies of electric phototherapy only (no FSPT arm or analysis).

2.3. Data Extraction and Synthesis

We extracted aggregate data on study context/design, sample size and neonatal characteristics, baseline TSB, FSPT specifications (filter type/transmittance, irradiance, schedule), comparators, monitoring procedures, and outcomes (TSB change/rate/% reduction; treatment failure/exchange; adverse events; acceptability). Evidence was synthesized narratively with harmonized effect measures where feasible; no meta-analysis was performed due to heterogeneity across settings, interventions, and outcomes.

3. Results and discussion

3.1. Effectiveness of filtered-sunlight phototherapy (FSPT)

Across randomized comparisons, FSPT consistently achieved day-level efficacy comparable to intensive electric phototherapy (IEPT). In near/term infants with moderate-to-severe hyperbilirubinemias, non-inferiority was met in a simulated rural setting (10) and replicated during birth-hospitalization (11). Extending to severe-to-hazardous cases, a larger randomized non-inferiority trial also found FSPT not inferior to IEPT on assessable treatment days (12). These trial findings align with secondary clinical summaries reporting FSPT efficacy of about 93% of evaluable days versus ~90% for conventional phototherapy (13–15). Earlier prospective implementation work in Lagos further demonstrated high effectiveness under protocolized monitoring (16). The Cochrane review synthesizing randomized evidence concluded that FSPT delivers a similar number of effective treatment days as electric phototherapy in infants with confirmed hyperbilirubinemias (17). Taken together, the randomized and supportive evidence indicate that FSPT is an effective therapeutic modality across a spectrum of disease severities when delivered with minimum daily exposure thresholds and standardized outcomes.

3.2. Safety profile

Safety outcomes were broadly favorable across studies when structured monitoring (temperature, hydration, eye protection) was applied. In randomized settings, there were no safety-driven therapy withdrawals and no excess serious adverse events attributable to FSPT in moderate-to-severe disease (11,18), while among severe-to-hazardous cases, FSPT showed similar exchange transfusion and mortality rates to IEPT (12). The Lagos implementation study reported no sunburn or dehydration, with short temperature-related pauses on about one-third of treatment days (19). Consistently, secondary summaries noted acceptable safety with explicitly managed thermal events (13,15). Importantly, the Cochrane review identified a higher risk of hyperthermia with FSPT (moderate-certainty), though no difference in hypothermia; long-term outcomes were not assessed (14,17). Overall, the data support that FSPT is safe when delivered under protocols that anticipate and promptly manage heat stress, with clear escalation pathways.

3.3. Operational feasibility and delivery characteristics

Trials reported therapeutic irradiance under FSPT within effective ranges, though typically lower than IEPT in some settings and higher in others, reflecting sky conditions, filter characteristics and setup (11,18). Canopy systems using polymer films transmitted therapeutic blue/blue-green wavelengths while blocking UV and reducing IR, a core engineering requirement reiterated in clinical news and journal-club synopses (13,14). Because daylight varies, supplemental night-time phototherapy was used more often in FSPT arms (11), underscoring the need for hybrid delivery models where IEPT is available. The pre-intervention baseline from a Lagos referral hospital highlighted power unreliability and lack of irradiance monitoring as persistent barriers to optimal electric phototherapy (20), strengthening the rationale for FSPT as a context-appropriate adjunct. A broader practice review similarly positioned FSPT within an innovation toolkit for low-resourced settings, alongside point-of-care diagnostics and improved electric devices (21).

3.4. Clinical outcomes beyond bilirubin kinetics

Across randomized studies, treatment failure requiring exchange transfusion was similar between FSPT and IEPT when reported (12–15). In the most severe cohorts (severe-to-hazardous), exchange transfusion and short-term mortality rates were high but did not differ between treatment arms, reflecting underlying disease severity rather than modality (12). For prevention of jaundice, one trial of unfiltered/timed sunlight exposure versus no treatment suggested fewer jaundice cases and fewer jaundiced days, but with very low-certainty evidence and no safety data (Horn et al., 2021). Thus, current evidence supports FSPT as treatment, not routine prophylaxis.

3.5. Evidence certainty, limitations and implications

The strongest evidence arises from unblinded non-inferiority RCTs using day-level efficacy metrics on assessable days (10–12), while pragmatic can introduce performance and selection biases. Safety data are short-term; long-term neurodevelopmental outcomes remain insufficiently studied (17,22). Secondary sources (13–15) corroborate primary findings but do not replace primary data. Operationally, weather dependence, site-specific irradiance, filter standardization, and thermal-risk management are central to scale-up. On balance, the synthesis supports FSPT as a non-inferior, safe and feasible option to complement IEPT in resource-constrained environments, provided that protocolized monitoring, clear eligibility/cessation criteria, and backup night-time IEPT are in place. In facilities where electric phototherapy is unreliable (7) or access is limited (21), FSPT can expand treatment capacity and potentially reduce preventable bilirubin-induced morbidity and mortality.

Table 1 Summary of study results

No	Author (year)	Title	Method	Results
1	Olusanya et al. (2025)	Filtered-sunlight phototherapy for newborns with moderate-to-severe hyperbilirubinemia: a randomized trial	Randomized trial comparing FSPT vs intensive electric phototherapy (IEPT) in hospitalized neonates; primary outcomes: safety (no hyper/hypothermia, dehydration, sunburn) and efficacy (TSB increase <3.4 μmol/L/h ≤72 h or TSB decrease >72 h) with ≥4 h phototherapy/day.	n=104 (52 FSPT; 52 IEPT). Mean irradiance: 27.7±7.3 vs 36.1±8.3 $\mu W/cm^2/nm$. Efficacy: 93.4% (FSPT) vs 93.3% (IEPT). No safety withdrawals; no deaths. Night-time phototherapy more frequent with FSPT (52.5% vs 43.4%). Exchange transfusion: 2 (FSPT) vs 1 (IEPT). Conclusion:

No	Author (year)	Title	Method	Results
				FSPT safe and non-inferior where practicable.
2	Slusher et al. (2018)	Filtered sunlight versus intensive electric powered phototherapy in moderate-to-severe neonatal hyperbilirubinemia: a randomised controlled non-inferiority trial	Prospective RCT (simulated rural setting, Nigeria). Near/term infants ≤14 days, ≥35 weeks, randomized 1:1 to FSPT or IEPT. Primary efficacy based on assessable days (≥4 h therapy/day); safety on all days. Non-inferiority margin 10%.	n=174 (87/87). Median irradiance: 37.3 (IQR 21.4–56.4) vs 50.4 (44.5–66.2) $\mu W/cm^2/nm$. Efficacy: 116/133 days (87.2%) FSPT vs 135/152 (88.8%) IEPT; mean difference −1.6% (95% CI −9.9 to 6.7; p=0.8165), meeting non-inferiority. Treatment safe for all neonates.
3	Slusher et al. (2014)	Safety and Efficacy of Filtered Sunlight in Treatment of Jaundice in African Neonates	Prospective implementation study in Lagos using canopy with window-tint films; hourly monitoring of temperature, hydration, sunburn; irradiance measured; predefined safety and efficacy thresholds by age.	227 infants, 258 treatment days. No sunburn or dehydration; brief temperature-related pauses on 85/258 days (33%). Evaluable days: efficacy 181/197 (92%); mean TSB change −0.06±0.19 mg/dL/h. Conclusion: With monitoring, FSPT is a practical and safe therapy option in tropical settings lacking conventional phototherapy.
4	Olusanya et al. (2024)	Heliotherapy for neonates with severe-to-hazardous hyperbilirubinemia: a randomized controlled, non-inferiority trial	Randomized non-inferiority trial (Nigeria) comparing FSPT vs IEPT in severe-to-hazardous hyperbilirubinemia; assessable day ≥4 h PT; efficacy threshold: TSB rise <0.2 mg/dL/h (≤72 h) or TSB decrease (>72 h); safety: no sustained hyper/hypothermia, dehydration, or sunburn.	n=192 (FSPT 98; IEPT 94). Efficacy on assessable days: 94.2% (FSPT) vs 97.1% (IEPT); mean difference −2.9% (95% CI −7.6 to 1.9) → non-inferior. Controlled hyperthermia: 2.6% (FSPT). Exchange transfusion: 50.6% vs 53.7% (p=0.89). Mortality: 9.1% vs 7.4% (p=0.86).
5	Salome (2024)	Innovative approaches to neonatal jaundice diagnosis and management in low-resourced settings	Narrative review of diagnostic and treatment innovations in resource-constrained settings, including POC assays, smartphone tools, improved electric phototherapy, and filtered sunlight.	Highlights FSPT as a promising, low-cost adjunct where conventional phototherapy access or power reliability is limited; positions FSPT within a broader toolkit to reduce morbidity and mortality.
6	Kumar (2016)	Filtered sunlight reduces serum bilirubin levels as effectively as conventional phototherapy in late preterm and term neonates with mild jaundice	Evidence-based commentary summarizing a single-centre non-inferiority RCT (>35 weeks GA, <14 days) comparing filtered sunlight phototherapy (FSLPT) vs conventional phototherapy (CPT); ≥5 h midday exposure; primary outcome: day-level efficacy; safety included thermal instability, dehydration, sunburn; night CPT used if needed.	Efficacy per treatment day: 93% (FSLPT) vs 90% (CPT); no exchange transfusions. Axillary temperature >38 °C more frequent with FSLPT (29% vs 6%) but no withdrawals; temperatures normalized with brief interruptions—overall safety acceptable.

No	Author (year)	Title	Method	Results
7	Horn, Ehret, Gautham and Soll (2021)	Sunlight for the prevention and treatment of hyperbilirubinemia in term and late preterm neonates	Cochrane systematic review of RCTs (searches to June 2020); included 3 RCTs (n=1103) evaluating sunlight with/without filters vs no treatment or electric phototherapy.	FSPT achieved a similar number of effective treatment days as electric phototherapy; little/no difference in exchange transfusion, ABE, or death (low certainty). Sunlight exposure may reduce incidence/duration of jaundice vs no treatment (very low certainty). Increased risk of hyperthermia with FSPT (RR≈4.39); no difference in hypothermia; long-term outcomes not assessed.
8	Bhutani (2016)	Filtered sunlight noninferior to conventional phototherapy	Expert commentary summarizing an RCT of FSPT vs conventional phototherapy in term/late-preterm infants.	Reported day-level efficacy ~93% for FSPT vs ~90% for conventional phototherapy within a 10% non-inferiority margin; supports non-inferiority of FSPT.
9	Emokpae, Mabogunje, Imam and Olusanya (2016)	Heliotherapy for Neonatal Hyperbilirubinemia in Southwest, Nigeria: A Baseline Pre-Intervention Study	Retrospective review of neonatal hyperbilirubinaemia admissions (2012–2014) at a Lagos referral hospital; pre-intervention baseline for FSPT implementation.	Among 1,118 analyzable cases: ABE 17.0%, exchange transfusion 31.5%, mortality 5.5%. Predictors of ABE included lower admission weight, higher peak TSB, sepsis, and hemolytic exposures; ET predicted by age at admission, peak TSB, ABO incompatibility, and ABE. Identified challenges with conventional phototherapy (irradiance monitoring and power reliability).
10	Friedrich, M.J. (2015)	Filtered Sunlight Effectively Treats Jaundice	Medical news summary of an RCT comparing filtered-sunlight phototherapy (FSPT) vs conventional electric phototherapy in term/late-preterm infants.	Both therapies highly efficacious per day: FSPT ~93% vs conventional ~90%; no safety withdrawals. Canopies transmitted therapeutic blue light (~39–84%) and filtered most UV. Concludes FSPT can be a safe, effective option in tropical, resource-limited settings.
11	Slusher et al. (2015)	A randomized trial of phototherapy with filtered sunlight in African neonates	Journal club synopsis of a randomized, controlled non-inferiority trial of FSPT vs conventional phototherapy; primary endpoint = day-level efficacy; safety = no withdrawal for hyper/hypothermia, dehydration, or sunburn.	FSPT efficacious on 93% of evaluable days vs 90% for conventional phototherapy; higher mean irradiance reported for FSPT (~40 vs ~17 $\mu W/cm^2/nm$); no withdrawals for safety and no exchange transfusions. Concludes FSPT non-inferior to conventional therapy.

4. Conclusion

This review shows that filtered-sunlight phototherapy (FSPT) delivers clinical effectiveness comparable to intensive electric phototherapy across mild to severe, including severe-to-hazardous, neonatal hyperbilirubinemias when delivered under protocolized conditions with adequate daily exposure and monitoring. Safety was generally acceptable, with no therapy withdrawals reported in randomized trials and no excess serious adverse events; however, a higher incidence of manageable hyperthermia underscores the need for vigilant temperature and hydration checks, eye protection, and clear escalation criteria. Operational evidence indicates that FSPT can expand treatment capacity in resource-constrained settings where device quality and power reliability limit electric phototherapy, provided that standardized filters, basic irradiance checks, trained staff, and access to night-time electric phototherapy are in place. The evidence base remains limited by unblinded designs, day-level efficacy definitions, heterogeneity in filters and climates, and scarce long-term neurodevelopmental outcomes. Taken together, the findings support FSPT as a safe, feasible, and context-appropriate adjunct or bridge to electric phototherapy in low-resource environments, while future research should prioritize standardized dosimetry and spectral reporting, multi-site implementation and cost-effectiveness studies across diverse climates, caregiver and health-system outcomes, and long-term follow-up.

Compliance with ethical standards

Disclosure of conflict of interest

There is no conflict of interest declared by authors in this study.

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