



Evaluating the Impact of Solar Direct-Drive Blood Bank Refrigeration on Emergency Surgical Blood Availability in Tigrayan District Hospitals

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Published: 26 June 2000 | **Received:** 16 January 2000 | **Accepted:** 05 May 2000

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DOI: [10.5281/zenodo.18531703](https://doi.org/10.5281/zenodo.18531703)

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Abstract

In the Tigray Region of Ethiopia, unreliable electricity compromises blood bank refrigeration, leading to critical shortages of safe blood for emergency surgeries in district hospitals. This contributes to preventable surgical mortality. Solar direct-drive refrigeration is a potential technological solution, but its specific impact on surgical blood availability in this context requires rigorous evaluation. This protocol details a study to evaluate the impact of installing solar direct-drive blood bank refrigerators on blood availability for emergency surgeries in Tigrayan district hospitals. Primary objectives are to: 1) quantify changes in blood unit availability for emergency procedures; 2) assess the reliability and temperature stability of the refrigeration units; and 3) document healthcare worker experiences with the technology. A mixed-methods, quasi-experimental design will be used. Quantitative data on blood unit inventory, wastage, and emergency surgical procedures will be collected retrospectively for 12 months pre-installation and prospectively for 12 months post-installation in three intervention hospitals. Three matched control hospitals will provide comparative data. Temperature monitoring data will be logged automatically. Qualitative data will be gathered via focus group discussions with laboratory and surgical staff to explore operational experiences and perceived impact. As this is a protocol for a future study, no empirical findings are available. Anticipated findings include a measurable increase in available blood units for emergency surgery and a reduction in stock-out days. Qualitative analysis is expected to reveal themes around improved staff confidence in blood supply and operational challenges. The study is designed to generate evidence on the operational effectiveness of solar direct-drive refrigeration in strengthening blood supply chains for emergency care in low-resource settings. The conclusions will inform future health technology investments and blood service policy in similar regions. Pending study outcomes, recommendations will be developed for policymakers and

hospital administrators regarding the scalability and integration of this technology into blood supply systems. blood bank, solar refrigeration, emergency surgery, blood availability, health technology, district hospitals, Ethiopia This protocol outlines a study designed to contribute empirical evidence on the impact of sustainable energy solutions on critical healthcare infrastructure, specifically blood bank systems, in a resource-constrained setting.

Keywords: *Blood transfusion services, Solar refrigeration, District hospitals, Emergency surgery, Sub-Saharan Africa, Health technology assessment, Blood availability*

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