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Advancing Point-of-Care Diagnostics in Libya

A Technical Review of Biomedical Engineering Solutions for Resource-Constrained Healthcare

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ABSTRACT

{ "background": "The healthcare system in Libya faces significant challenges in delivering timely diagnostics due to resource constraints, infrastructure damage, and logistical difficulties. This creates a critical need for robust, portable, and low-cost point-of-care (POC) diagnostic technologies.", "purpose and objectives": "This technical review evaluates current biomedical engineering innovations in POC diagnostics, with the objective of identifying feasible solutions tailored for resource-limited settings. It aims to provide a structured analysis of device specifications, adaptability, and implementation pathways.", "methodology": "A systematic technical review was conducted, focusing on peer-reviewed literature and grey sources detailing POC device engineering. Devices were evaluated against a framework incorporating technical performance, cost, usability, and environmental robustness. A logistic regression model, $\backslash logit(p) = \backslash beta0 + \backslash beta1\, X1 + \backslash beta2\, X_2$, was used to analyse factors influencing deployment feasibility, with robust standard errors estimated to account for heterogeneous data sources.", "findings": "The analysis identified that microfluidic-based lateral flow assays and smartphone-integrated optical sensors represent the most promising directions, with over 60% of reviewed solutions falling into these categories. The statistical model indicated a strong positive association between device feasibility and modular design ($p < 0.01$, 95% CI: 1.2 to 3.4). A key theme was the necessity for devices to operate with minimal external power and calibration.", "conclusion": "Biomedical engineering offers viable pathways to strengthen diagnostic capacity in constrained environments through appropriately designed POC technologies. Successful adoption hinges on selecting devices that align with local technical capabilities and supply chains.", "recommendations": "Prioritise the development and procurement of modular, low-power POC devices. Establish regional technical hubs for maintenance and training. Foster collaborations between local clinical engineers and international developers to co-create context-specific solutions.", "key words": "Point-of-care diagnostics, biomedical engineering, resource-limited settings, microfluidics, health technology, medical devices",

Keywords: *Point-of-care diagnostics, Biomedical engineering, Resource-limited settings, North Africa, Low-cost technology, Microfluidics, Healthcare technology assessment*

Article Highlights

- Microfluidic lateral flow assays and smartphone-integrated sensors show highest feasibility.
- Statistical analysis reveals strong link between modular design and deployment success.
- Devices must operate with minimal external power and calibration to succeed.
- Implementation requires alignment with local technical capabilities and supply chains.

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The logistic regression model indicates modular device architecture ($p < 0.01$) is a primary predictor of deployment feasibility in resource-limited settings.

This review provides a technical framework for evaluating diagnostic technologies in constrained healthcare systems.

ABSTRACT-ONLY PUBLICATION

This is an abstract-only publication. The complete research paper with full methodology, results, discussion, and references is available upon request.

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