Single-Capillary Dual Point-of-Care Testing to Support Cardio-Renal Diagnostic Decision-Making in Ambulatory Care

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Abstract. ***Objective***. Integrated interpretation of renal function and natriuretic peptides is essential in ambulatory cardio-renal care. This study evaluated whether a single-capillary dual point-of-care testing (POCT) strategy combining creatinine/eGFR and NT-proBNP could support real-time, integrated clinical decision-making during a single consultation. ***Methods***. In this exploratory, single-center, real-world study that was designed as a feasibility study focusing on workflow integration and clinical usability, capillary creatinine/eGFR and NT-proBNP were evaluated using a single-fingerstick dual-POCT workflow in two exploratory clinical subgroups recruited according to their respective clinical indications. Analytical agreement was assessed using Passing–Bablok regression (slope, intercept, and 95% confidence intervals) and Bland–Altman analysis. Agreement at guideline-based clinical thresholds (eGFR ≤60 mL/min/1.73m²; NT-proBNP ≥125 ng/L) was evaluated using Cohen's kappa. Workflow feasibility and time-to-result were also documented. ***Results***. Forty-three patients underwent creatinine/eGFR testing, and a separate subgroup of 22 patients underwent NT-proBNP testing, reflecting different clinical indications and real-world recruitment during this exploratory feasibility study. Passing–Bablok regression showed good agreement with slopes close to unity and no significant systematic bias. Bland–Altman analysis demonstrated clinically acceptable limits of agreement. Diagnostic agreement at clinical thresholds was substantial for eGFR (κ= 0.71) and perfect for NT-proBNP (κ=1.00), with no clinically relevant misclassification. Dual biomarker results were available within approximately 15 minutes, enabling same-visit clinical decisions. ***Conclusions***. A single-capillary dual-biomarker POCT workflow enables rapid and reliable cardio-renal assessment within one ambulatory visit. Its primary value lies in integrated, threshold-based clinical interpretation enabled by the simultaneous availability of complementary biomarkers, rather than analytical comparison alone.

Key words: Point-of-care testing, cardio-renal syndrome, NT-proBNP, creatinine, ambulatory care.

Introduction

Cardiovascular and renal diseases frequently coexist and interact, increasing diagnostic complexity in ambulatory care [1,2]. NT-proBNP is a cornerstone biomarker for heart failure triage, while creatinine and estimated glomerular filtration rate (eGFR) guide renal risk stratification and therapeutic safety [3]. Renal dysfunction significantly influences natriuretic peptide due to reduced renal clearance, and interpretation of NT-proBNP without concurrent knowledge of eGFR may result in diagnostic uncertainty [4]. Importantly, NT-proBNP elevations may occur even in the absence of heart failure in patients with impaired renal function, highlighting the need for integrated interpretation of cardiac and renal biomarkers. Conversely, renal biomarkers alone provide limited insight into cardiac stress.

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Point-of-care testing (POCT) has emerged as a strategy to reduce time-to-decision and bring actionable diagnostic information directly into the consultation [5,6]. Although individual POCT platforms for creatinine and NT-proBNP have been analytically validated, their combined use within a single capillary workflow enabling integrated cardio-renal interpretation has not been evaluated from a clinical pathway perspective [7,8]. The novelty of this study lies in assessing the clinical and operational value of simultaneous biomarker availability rather than analytical validation alone.

Materials and Methods

This exploratory, single-center observational study was designed as a real-world feasibility study was conducted at Cliniques Universitaires Saint-Luc in Brussels, Belgium. Adult patients attending ambulatory consultations in cardiology, nephrology, dialysis, or primary care were included when cardio-renal assessment was clinically indicated. Forty-three patients were included in the creatinine/eGFR evaluation subgroup and 22 patients in the NT-proBNP evaluation subgroup. These exploratory cohorts were recruited according to their respective clinical indications in routine ambulatory practice. In patients undergoing NT-proBNP assessment, the dual-POCT workflow enabled simultaneous acquisition of renal and cardiac biomarker information from a single capillary fingerstick. The study was approved by the Ethics Committee of Cliniques Universitaires Saint-Luc (approval number B4032024000084), and all participants provided written informed consent.

Capillary blood samples were collected from a fingertip using a lancet. For creatinine/eGFR, measurements were performed immediately using the Nova StatSensor Xpress Creatinine POCT device (Nova Biomedical, Waltham, MA, USA). For NT-proBNP, capillary blood was applied to the LumiraDx NT-proBNP test strip on the LumiraDx Platform (LumiraDx, London, UK). Paired venous blood samples were collected simultaneously and sent to the central laboratory for analysis. Central laboratory measurements were performed on a Roche Cobas 8000 analyzer (Roche Diagnostics, Basel, Switzerland) for both creatinine and NT-proBNP. eGFR was calculated the CKD-EPI 2021 equation without race adjustment, using the same equation for both capillary and venous measurements to ensure comparability.

Clinical interpretation relied on established guideline thresholds consistent with ESC heart failure and KDIGO chronic kidney disease recommendations of eGFR ≤60 mL/min/1.73m² to indicate impaired renal function and NT-proBNP ≥125 ng/L as a referral threshold in ambulatory patients. Agreement at these thresholds was assessed using Cohen's kappa coefficient. Analytical agreement between capillary POCT and central laboratory measurements was evaluated in accordance with CLSI EP09 recommendations. Passing–Bablok regression analysis was performed to estimate slope and intercept, along with their 95% confidence intervals, to assess proportional and constant bias. Agreement was further evaluated using Bland–Altman analysis, including mean bias and 95% limits of agreement. Predefined acceptability criteria were based on clinically relevant analytical performance and biological variation principles rather than strict analytical equivalence.

Results

POCT precision met predefined acceptability criteria. The coefficient of variation for creatinine ranged from 1.0% to 3.2%; for NT-proBNP, it ranged from 4.2% to 6.1%. Passing–Bablok regression analysis demonstrated slopes close to unity and intercepts not significantly different from zero for both creatinine and NT-proBNP, indicating absence of significant proportional or constant bias **(Figure 1)**. The 95% confidence intervals for slope and intercept supported analytical comparability between POCT and central laboratory methods. Bland–Altman analysis showed a limited mean bias with 95% limits of agreement within clinically acceptable ranges **(Figure 1)**. Observed analytical differences did not translate into clinically meaningful misclassification at decision thresholds.

The clinical value of this approach lies in the combined availability of both biomarkers rather than their independent analytical performance. The simultaneous reporting of eGFR and NT-proBNP enabled integrated cardio-renal interpretation during the same consultation, particularly in patients with borderline values or complex comorbidities.

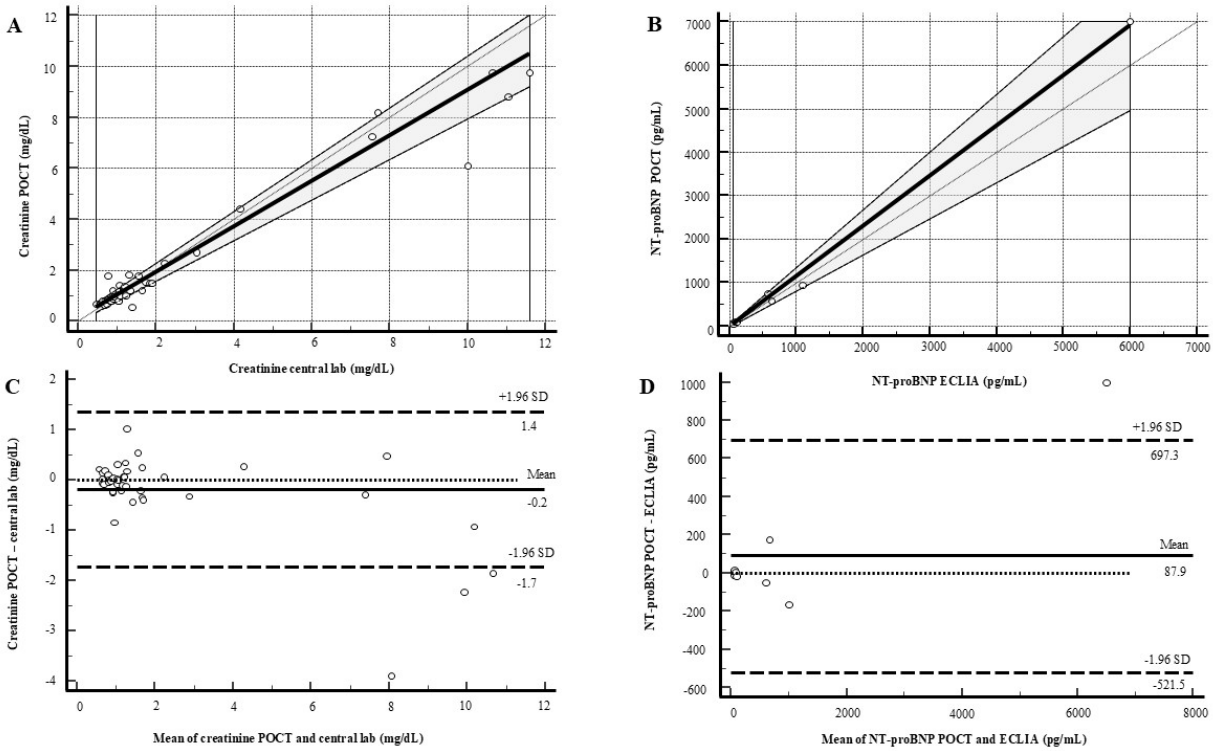

Figure 1. *Passing–Bablok regression analysis comparing capillary point-of-care testing (POCT) and central laboratory measurements for* ***(A)*** *creatinine (n=43) and* ***(B)*** *NT-proBNP n=22). The solid line represents the Passing–Bablok regression, while the dashed line indicates the line of identity (y = x). Bland–Altman plots illustrating the agreement between capillary POCT and central laboratory measurements for* ***(C)*** *creatinine and* ***(D)*** *NT-proBNP. The central solid line represents the mean difference (bias), and the dashed lines indicate the 95% limits of agreement.*

At the eGFR ≤60 mL/min/1.73m² threshold, 37 of 43 patients were correctly classified, corresponding to substantial agreement with the central laboratory method (κ=0.71). Discordant cases occurred predominantly near the decision threshold or in patients with complex renal conditions such as transplant recipients or dialysis patients. Importantly, these discrepancies did not result in clinically meaningful misclassification that affected clinical management as POCT results were interpreted in the context of the overall clinical picture and used as a triage tool rather than a standalone diagnostic method. At the NT-proBNP ≥125 ng/L threshold, all 22 patients were correctly classified, yielding perfect agreement (κ=1.00). POCT values reported outside the analytical range did not affect classification as the decision threshold lay within the validated measurement interval.

From a workflow perspective, results were available within seconds, and NT-proBNP results were available within approximately 12 minutes, enabling immediate clinical decisions including therapeutic adjustment, referral for echocardiography, and medication safety assessment. The **Figure 2** is intended as a conceptual illustration of the integrated workflow rather than a technical representation, highlighting the feasibility of obtaining and interpreting dual biomarker results within a single consultation.

In several cases, same-visit results supported immediate diuretic adjustment, expedited referral for echocardiography, or supported medication safety assessments based on renal function.

Discussion

This exploratory study demonstrates that a single-capillary dual POCT strategy enables reliable, classification-based cardio-renal assessment within one ambulatory consultation. Agreement at clinically relevant thresholds was substantial for renal function and perfect for NT-proBNP, supporting the

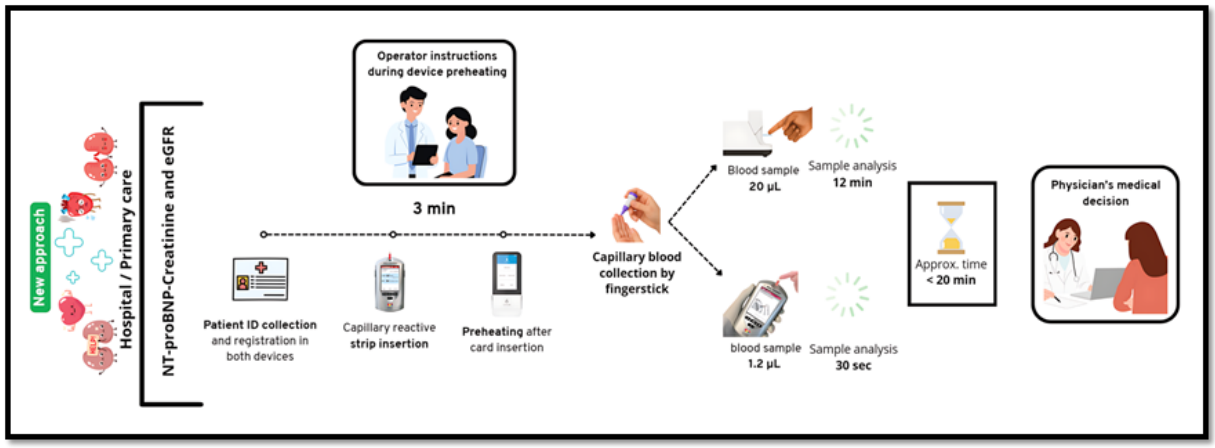

Figure 2. *Workflow of single-capillary multi-biomarker POCT for cardio-renal care. After patient identification and device preparation, capillary blood is collected by fingerstick and analysed simultaneously on two POCT platforms: Nova StatSensor for creatinine/eGFR (sample volume 1.2 µL, analysis time 30 sec) and LumiraDx for NT-proBNP (sample volume 20 µL, analysis time ~12 min). The total process, including device preheating and operator handling, is completed within 20 minutes, enabling same-visit physician decision-making in both hospital and primary care settings.*

use of this approach for decision-oriented clinical practice. In ambulatory care, diagnostic decisions are frequently based on guideline-defined cut-offs rather than small numerical differences, making threshold agreement more clinically meaningful than minor analytical deviations.

A key finding is the importance of integrated interpretation of NT-proBNP and renal function, particularly given that NT-proBNP levels may be elevated in the absence of heart failure due to impaired renal clearance [1,4]. By combining eGFR and NT-proBNP, this approach helps distinguish cardiac-driven elevations from renal-related increases, thereby reducing diagnostic uncertainty.

The principal value of this approach lies in workflow integration. By reducing time-to-decision and enabling same-visit management adjustments, dual POCT may streamline ambulatory diagnostic pathways and enhance clinical efficiency [5,6]. The clinical utility of this approach lies in enabling real-time decision-making, including therapeutic adjustment, referral decisions, and medication safety evaluation. Importantly, in ambulatory care, clinical decisions are primarily threshold-based, which justifies focusing on agreement at clinically relevant cut-offs rather than continuous correlation. Discordant results near thresholds did not affect management because they occurred in clinically complex patients were interpreted within the broader clinical context; central laboratory testing remained the reference when it was needed. This confirms the role of POCT as a complementary triage tool aligned with guideline-based care.

The added value of dual POCT lies in enabling immediate, integrated interpretation rather than replacing central laboratory testing. This strategy may support more efficient triage, reduce diagnostic uncertainty, and facilitate earlier therapeutic decisions in cardio-renal patients.

This study has several limitations that should be acknowledged. First, the sample size was modest, particularly for NT-proBNP, and reflects an exploratory, real-world design. Second, the single-center setting may limit generalizability. Third, clinical outcomes and cost-effectiveness were not assessed and should be explored in future multicenter studies. Finally, while analytical agreement was acceptable, POCT results should always be interpreted within the broader clinical context, particularly in patients with complex renal conditions. Future multicenter studies are needed to assess clinical impact, healthcare utilization, and economic value.

Conclusions. A single-capillary dual POCT workflow combining creatinine/eGFR and NT-proBNP provides rapid, reliable, and guideline-aligned

cardio-renal assessment within a single ambulatory visit. Its main contribution lies in enabling integrated, same-visit clinical decision-making through simultaneous biomarker interpretation. This approach complements rather than replaces central laboratory testing.

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