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Clinical, Operative, and Economic Outcomes of the Point-of-Care Blood Gases in the Nephrology Department of a Third-Level Hospital

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• ***Context.***—**Point-of-care testing allows rapid analysis and short turnaround times. To the best of our knowledge, the present study assesses, for the first time, clinical, operative, and economic outcomes of point-of-care blood gas analysis in a nephrology department.**

Objective.—**To evaluate the impact after implementing blood gas analysis in the nephrology department, considering clinical (differences in blood gas analysis results, critical results), operative (turnaround time, elapsed time between consecutive blood gas analysis, preanalytical errors), and economic (total cost per process) outcomes.**

Design.—**A total amount of 3195 venous blood gas analyses from 688 patients of the nephrology department before and after point-of-care blood gas analyzer installation were included. Blood gas analysis results obtained by ABL90 FLEX PLUS were acquired from the laboratory information system. Statistical analyses were performed using SAS 9.3 software.**

Results.—**During the point-of-care testing period, there was an increase in blood glucose levels and a decrease in pCO2, lactate, and sodium as well as fewer critical values (especially glucose and lactate). The turnaround time and the mean elapsed time were shorter. By the beginning of this period, the number of preanalytical errors increased; however, no statistically significant differences were found during year-long monitoring. Although there was an increase in the total number of blood gas analysis requests, the total cost per process decreased.**

Conclusions.—**The implementation of a point-of-care blood gas analysis in a nephrology department have a positive impact on clinical, operative, and economic terms of patient care.**

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A point-of-care testing (POCT) system is defined as clinical laboratory testing conducted close to the site of patient care, typically by clinical personnel whose primary training is not in the clinical laboratory sciences or conducted by patients. This definition can include anything from small and simple devices using qualitative determination methods to complex analyzers able to measure or calculate multiple parameters, requiring small sample volumes.[1] These systems are being increasingly used in daily clinical practice and can improve patient care by providing an immediate result that will allow a more rapid diagnosis or treatment.[2–4] This immediate processing also prevents samples from degrading during transportation to the laboratory, which is especially important in cases involving blood gas analysis (BGA), in which preanalytical factors and time frame are vital.[5,6] Despite these advantages, the results obtained by a POCT system are not always interchangeable with those obtained by traditional core laboratory instrumentation.[5,7,8] Moreover, inappropriate test use leads to unnecessary increases in cost of care and can undermine patient management.[2,7] Therefore, the utility of any POCT system must be evaluated for each patient and clinical environment before its implementation in clinical practice.[1,4,7,8]

Acid-base disturbances are characteristically common in nephrology departments. These imbalances can have either metabolic or respiratory origins, and can be compensated or not. There can also be cases of mixed disorders, with both metabolic and respiratory alterations simultaneously taking place.[9] From a clinical laboratory point of view, the diagnosis of these disturbances is made via BGA.[10] A systematic evaluation of clinical and blood gas parameters, anion gap and internal compensation mechanisms could lead to the origin of an acid-base imbalance and allows physicians to dismiss or confirm a mixed disturbance.[9,10] At the beginning of 2017, the nephrology department of our hospital sent the laboratory medicine department a request for the installation of a POCT blood gas analyzer. A POCT network, has been present at our hospital since 1998, led by laboratory medicine in collaboration with a large number of health professionals in various clinical settings. Currently, the laboratory and POCT network are accredited by the

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International Organization for Standardization 15189 and 22870, respectively; and includes 29 blood gas analyzers, 266 glucometers, 2 HbA1c devices, and 1 sweat test device. There is a qualification program that assesses all professionals that use the analyzers have received formal education on its management. The laboratory also periodically analyzes performance key indicators and processes internal and external quality controls in order to guarantee the correct performance of all the components of the network at any given time.

In order to evaluate the appropriateness of a POCT blood gas analyzer in the nephrology department, laboratory medicine conducted an assessment study in collaboration with nephrology. This evaluation included the types of patients managed in the department, activity volume, and the expected outcomes of the implementation of a POCT blood gas analyzer in such a clinical setting. Subsequently, the POCT Committee made the final decision and an ABL90 Flex Plus (Radiometer, Copenhagen, Denmark) blood gas analyzer was installed in the nephrology department in July 2017, after undergoing a method evaluation and confirming results interchangeability with other BGA analyzers of the Hospital's network and the laboratory biochemistry analyzers.

Despite this previous evaluation, it was important to assess the impact on patient care after installing the POCT BGA analyzer. Publications regarding POCT BGA are scarce, mostly limited to emergency and pulmonology settings.[2–4,7,8,11,12] Publications available about POCT methods aimed at nephrologic patients are mostly for diagnosis and do not include BGA.[13–16] To the best of our knowledge, the present study assesses clinical, operative, and economic outcomes of POCT BGA in a nephrology department for the first time.

The aim of the present study was to evaluate the impact after implementing BGA in the nephrology department, considering clinical (differences in BGA results, critical results), operative (turnaround time, elapsed time between consecutive BGA, preanalytical errors), and economic (total cost per process) outcomes.

MATERIALS AND METHODS

Participants

An observational ambispective study was conducted including patients with venous BGA sent to the laboratory from the nephrology department of our hospital during the last trimester of 2016 (LAB) and performed in their POCT BGA analyzer during last trimester of 2017 (POCT). Data from patients older than 18 years with at least 1 venous BGA sample obtained in daily clinical practice during 2016 or 2017 were collected from the laboratory information system. The details of the recruitment process are shown in Figure 1. The hospital's Research Ethics Committee approved the study, and informed consent was not required.

Methods

Clinical outcomes.—BGAs were performed using ABL90 Flex Plus blood gas analyzers (Radiometer) installed in either the laboratory (LAB) or the nephrology unit (POCT). Renal function tests were performed using a Dimension Vista 1500 system (Siemens Healthineers, Erlangen, Germany). Conversion factors from conventional units to International System units are listed in Table 1. Patients' data were collected from our laboratory information system and from medical records. These data included sociodemographic features, renal function tests (creatinine, glomerular filtration rate), date, time, and clinical setting (LAB or POCT) of the test request. Critical values established in our laboratory for pH, sodium, potassium, chloride, ionized calcium, glucose, lactate, and hemoglobin were evaluated.

Operative outcomes.—Differences between the POCT and LAB turnaround time (TAT) were calculated by means of a subset of 20 patients within the POCT period. Requests included both BGAs performed as POCT and laboratory tests. Therefore, the difference between the BGA measurement and the reception time of the other laboratory tests was calculated. Records of preanalytical errors (nonhomogen or insufficient material) were collected from the POCT data management system, AQURE (Radiometer).

Economic outcomes.—Variables to calculate the global cost per process were obtained from studies made previously in other clinical settings,[12] in collaboration with warehouse registries of direct costs of consumables and the Official State Gazette (Boletín Oficial del Estado) for cost per hour of health professionals' work (laboratory specialist, nephrologist, nurse, laboratory technician, and nursing assistant). The time taken for each step performed by experienced health professionals was estimated by observation.

Statistical Analysis

First, the homogeneity between patient populations during the LAB and POCT periods was assessed to detect any baseline differences in sex, age, and renal function. Linear models in accordance with data distribution were applied. Quantitative data followed a normal distribution and were described by average and standard deviation. Qualitative data were described by absolute frequencies and percentages.

A linear mixed model with fixed effect for BGA location and a random effect for participant, was used to analyze the BGA measurands over different episodes of care (described as a 24-hour period) within-between patients. The estimation method used restricted maximum likelihood. Unstructured covariance among repeated measures was applied based on model diagnostics. Least squares means from each BGA measurand by location were obtained and compared. All statistical tests were considered bilateral, and $P < .05$ was considered significant; 95% CIs were estimated. All statistical analyses were performed using SAS 9.3 software (SAS Institute Inc., Cary, NC, USA). Mean differences obtained for each measurand were also evaluated, taking into account the analytical performance specifications established by the laboratory (Table 2). Mean differences in TAT between periods were evaluated by a *t*-test of paired samples. Differences in total number of BGA critical results and number of preanalytical errors in the LAB and POCT periods were compared by a X^2 test and a phi coefficient for magnitude of effect (φ). Finally, total costs per process were estimated and represented in a bar graph.

RESULTS

The homogeneity test showed no significant differences in age ($P = .31$), creatinine ($P = .97$), or glomerular filtration rate ($P = .81$) (Figure 2, A–D). However, significant differences in sex distribution were detected, given men were more prevalent during the POCT period ($P < .001$). There was a statistically significant increase during the POCT period in oxyhemoglobin and glucose, and a decrease in partial pressure of carbon dioxide (pCO2), carboxyhemoglobin, lactate, and sodium. Furthermore, glucose, pCO2, lactate, and sodium differences exceeded the analytical performance specifications set in our laboratory (see Table 2). Data displayed in Table 3 show the BGA results in both periods and the differences found in the study.

A total amount of 61 of 1564 (3.9%) critical values during LAB and 43 of 1564 (2.6%) during POCT were detected (Table 4). This difference was statistically significant ($P = .04$), although the magnitude of effect was small ($\varphi = -0.08$). The critical value specifications of our laboratory and the number of BGAs that exceeded those limits are shown in

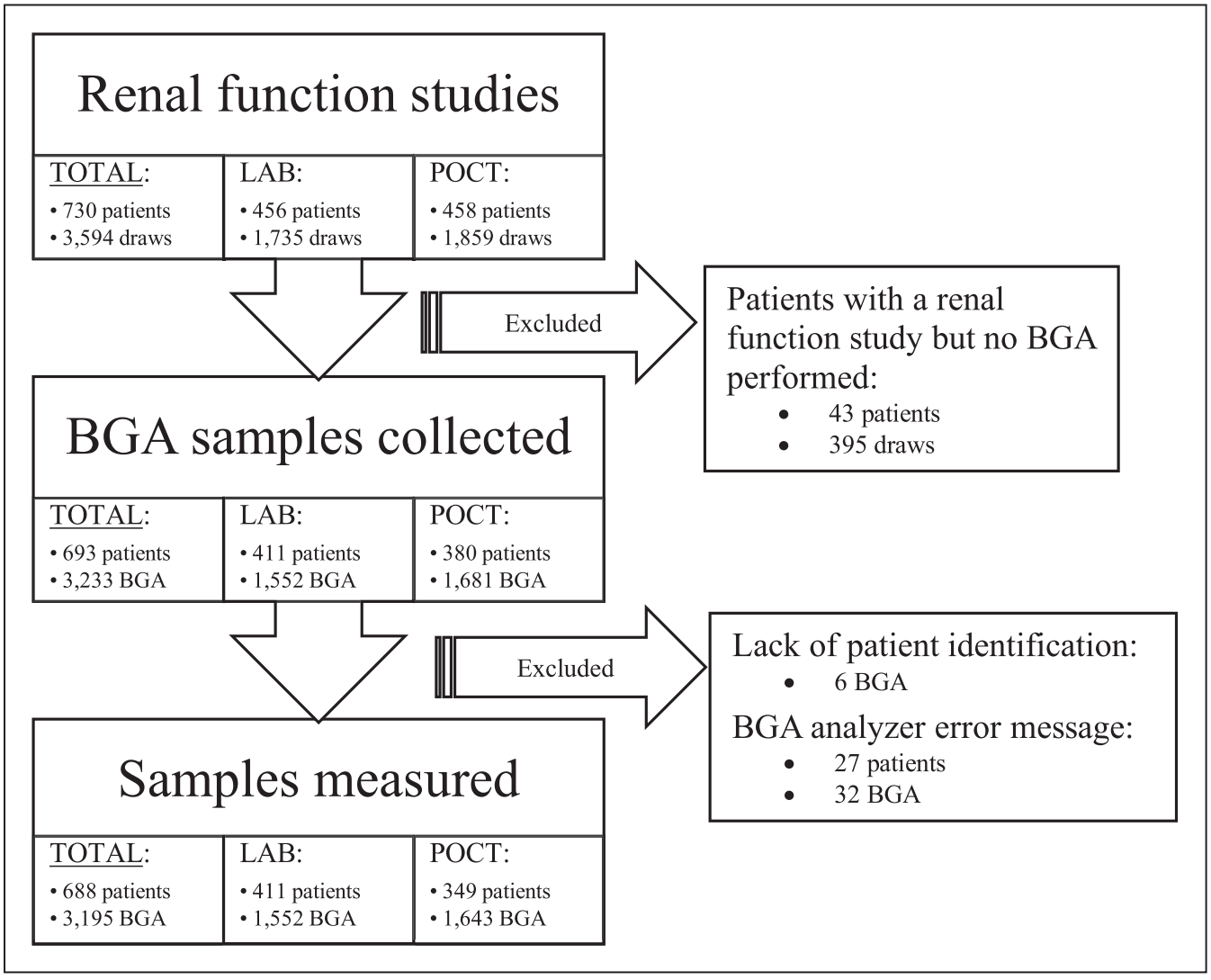

Figure 1. *Recruitment process flowchart. The figure shows the number of patients and the derived samples total and in both periods of time. Causes of exclusion are also shown. Abbreviations: BGA, blood gas analysis; LAB, laboratory period; POCT, point-of-care period.*

Table 1. Conversion Factors From Conventional to SI (System International) Units

Magnitude	Conventional Unit	SI Unit	Conversion Factor
pH	pH units	pH units	1
Oxygen partial pressure	mm Hg	mm Hg	1
Carbon dioxide partial pressure	mm Hg	mm Hg	1
Hemoglobin	g/dL	g/L	10
Lactate	mg/dL	mmol/L	0.111
Sodium	mEq/L	mmol/L	1
Potassium	mEq/L	mmol/L	1
Chloride	mEq/L	mmol/L	1
Ionized calcium	mEq/L	mmol/L	0.5
Glucose	mg/dL	mmol/L	0.0555
Creatinine	mg/dL	µmol/L	88.4

To convert values from conventional units to SI units, multiply by the conversion factor.

Table 2. Analytical Performance Specifications Established by the Laboratory for BGA Magnitudes

Magnitude	Allowable Error	%
pH	Desirable BV	1.01
Oxygen partial pressure	State-of-the-art (P90 EQA SEQC^{ML})	9.70
Carbon dioxide partial pressure	Desirable BV	2.68
Hemoglobin concentration	Minimum BV	2.80
Oxyhemoglobin fraction	Minimum BV	6.20
Carboxyhemoglobin fraction	Clinical use	20.00
Methemoglobin fraction	Clinical use	25.00
Lactate concentration	Desirable BV	7.98
Sodium concentration	Minimum BV	0.35
Potassium concentration	Minimum BV	2.70
Chloride concentration	Minimum BV	0.70
Ionized calcium concentration	Minimum BV	1.00
Glucose concentration	Desirable BV	3.50

Abbreviations: BGA, blood gas analysis; BV, biological variation; EQA, European Quality Assurance; SEQCML, Spanish Society of Laboratory Medicine.

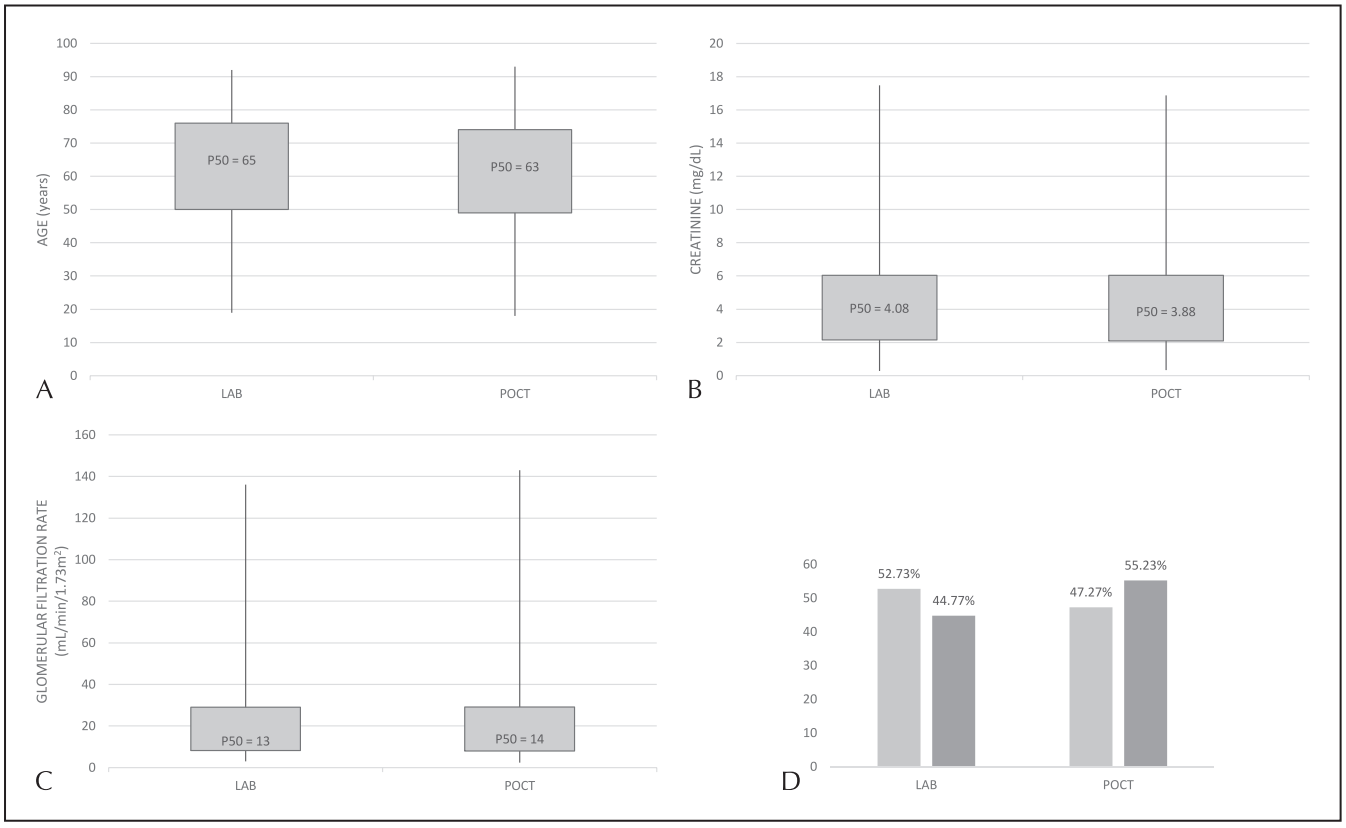

Figure 2. *A, Box plot showing patient distribution according to age. B, Box plot showing patient distribution according to blood creatinine. C, Box plot showing patient distribution according to glomerular filtration rate. D, Distribution of male (dark gray) and female (light gray) patients in LAB and POCT. Abbreviations: LAB, laboratory period; POCT, point-of-care period.*

Table 5. The higher number of critical results during the LAB period was especially remarkable for glucose (<45 mg/dL) and lactate (>45 mg/dL). There were 3 samples with critical values for both lactate and glucose, all collected during the LAB period. Although the number of critical results for potassium remained the same in both periods, maximum elapsed time between the critical result and the analytical evidence of its correction (read as a noncritical result in a subsequent sample) decreased from 1 week in LAB to 24 hours in POCT.

Table 3. POCT and LAB BGA Results and Differences Observed Between the 2 Periods

Magnitude	LAB Average	SE	95% CI	POCT Average	SE	95% CI	POCT Versus LAB	SE	95% CI	Difference (%)	*P* Value
pH	7.35	<0.01	(7.35–7.35)	7.38	<0.01	(7.37–7.38)	0.03	<0.01	(0.02–0.04)	0.39	<.001
Oxygen partial pressure, mm Hg	45.03	0.98	(43.11–46.95)	44.21	0.97	(42.30–46.11)	−0.82	1.38	(−3.53 to 1.89)	−1.83	.55
Carbon dioxide partial pressure, mm Hg	43.74	0.28	(43.19–44.29)	41.21	0.28	(40.66–41.76)	−2.53	0.40	(−3.30 to −1.75)	−5.78	<.001
Hemoglobin, g/dL	11.27	0.08	(11.10–11.43)	11.26	0.08	(11.10–11.42)	<0.01	−0.12	(−0.23 to 0.22)	−0.02	.98
Oxyhemoglobin, %	63.38	0.94	(61.54–65.23)	66.37	0.94	(64.53–68.21)	2.99	1.33	(0.38–5.59)	4.71	.03
Carboxyhemoglobin, %	1.28	0.04	(1.21–1.35)	1.11	0.04	(1.04–1.18)	−0.17	0.05	(−0.27 to −0.07)	−13.20	.001
Methemoglobin, %	0.96	0.01	(0.94–0.98)	0.98	0.01	(0.96–1.00)	0.03	0.01	(0.00–0.05)	2.69	.07
Lactate, mg/dL	0.21	<0.01	(0.20–0.22)	0.13	<0.01	(0.12–0.14)	−0.08	<0.01	(−0.09 to −0.07)	−37.83	<.001
Sodium, mEq/L	139.02	0.19	(138.65–139.39)	138.42	0.19	(138.05–138.79)	−0.60	0.27	(−1.12 to −0.08)	−0.43	.03
Potassium, mEq/L	4.42	0.03	(4.36–4.48)	4.35	0.03	(4.29–4.41)	−0.07	−0.04	(−0.15 to 0.01)	−1.57	.10
Chloride, mEq/L	104.39	0.23	(103.94–104.85)	103.92	0.23	(103.46–104.38)	−0.47	0.33	(−1.12 to 0.17)	−0.45	.15
Ionized calcium, mEq/L	0.59	<0.01	(0.58–0.59)	0.59	<0.01	(0.59–0.59)	<0.01	0.01	(−0.01 to 0.01)	0.07	.89
Glucose, mg/dL	113.23	2.19	(108.93–117.53)	128.09	2.22	(123.74–132.44)	14.86	3.12	(8.74–20.98)	13.12	<.001

Abbreviations: BGA, blood gas analysis; LAB, laboratory period; POCT, point-of-care period; SE, standard error.

Table 4. Total Amount of Critical Results During Laboratory (LAB) and Point-of-Care (POCT) Periods		
	Total of Results	Critical Results (%)
LAB	1552	61 (3.9)
POCT	1643	43 (2.6)

Regarding the difference in TAT between LAB and POCT, the observed mean was 89.5 minutes (95% CI 65.5–93.75), with a range between 25 and 120 minutes (Table 6). Elapsed time between requests was evaluated in 106 patients, who had 2 or more BGAs performed in a 24-hour period. The mean elapsed time was 511 minutes (8.5 hours) for LAB and 286 minutes (4.8 hours) for POCT. The difference found was statistically significant ($P < .001$).

Of 26 409 BGAs measured during the LAB period, 680 (2.61%) did not show a result due to a preanalytical error. During the POCT period, 2407 BGAs were measured in the nephrology department and 101 (4.2%) did not show a result. This increase in preanalytical errors was statistically significant ($P < .001$), although the magnitude of effect was small ($\varphi = -0.027$). Another comparison was made 1 year later, in June 2018. It showed 103 preanalytical errors of 3708 (2.78%) in the laboratory blood gas analyzers and 13 of 569 (2.28%) in the nephrology department, with no statistically significant difference ($P = .58$) (Table 7).

Total cost per process was estimated at €6.58 for each BGA taken during the LAB period and €4.76 during POCT, with a reduction of €1.82 (27.72%) per BGA, as shown in Figure 3. Although there were 91 (5.86%) additional BGA requests (1643 BGAs during POCT versus 1552 during LAB), the total costs decreased from €10 814 in LAB to €7815 in POCT, meaning a reduction of €2999 (23.49%). The time spent by staff members for every step of the BGA process is shown in Figure 4.

DISCUSSION

LAB and POCT populations had a homogeneous distribution regarding age, creatinine, and glomerular filtration, essential data for establishing basal renal function.[10,13,17] Taking this into account, we considered that differences found during the study were not due to basal variation among LAB and POCT patients. There was only heterogeneity in sex distribution, which might affect some of the differences obtained. Some population studies have shown that partial pressure of oxygen is higher in men,[18] whereas others did not find this difference but detected a higher pCO2 and lower pH, which could be explained by women's faster breathing rate.[19] This had to be considered during the evaluation of differences in BGA results of these measurands.

During the evaluation of differences in BGA results, attention was especially paid to those that, in addition to being statistically significant, exceeded the analytical performance specifications established by our laboratory (see Table 2) given those changes could impact patient care in a greater way. These measurands were glucose, pCO2, lactate, and sodium. The decrease detected in mean pCO2 was predictable because of the smaller time frame between sample collection and measurement, lowering both penetrance of environmental gas through the BGA syringe and cellular consumption.[6] The higher number of male patients in the POCT period could contribute to this result. However, given that the clinical implications of a variation of blood gases in venous blood are complex due to intra- and interindividual variation, these results should be carefully taken into account.

Analytical performance specifications for sodium concentration were based on biological variation minimum systematic error, a strict but reasonable criterion due to the high clinical impact of a minimal variation.[20] These specifications could explain the small differences found in our study that were considered clinically significant, although they could also be caused by the current level of technological development.[19,21] However, our hospital has implemented a monthly monitoring program for inaccuracy in blood gas analyzers, and none of the nephrology or laboratory analyzers surpassed the established limits; thus, it can be assumed the differences found were because of extra-analytical factors. The increase in mean concentrations of oxyhemoglobin and glucose, in contrast to the decrease of carboxyhemoglobin and lactate, can probably be explained by lower oxygen consumption by blood cells.[6] These changes could contribute to the higher pH found during the POCT period.

Hemoglobin concentration can be a useful measurement to assess the sample management skills of professionals, given it would be altered by poor sample homogenization.[21,22] In our case, although our analytical performance specifications for this parameter were high, there were no statistically significant differences found, which indicates similar sample management and processing in the nephrology department compared with the laboratory, and that the differences found were related to the patients' condition or the time until processing rather than to operator-dependent

Table 5. Critical Value Specifications and Number of Samples That Exceeded the Limits out of the Total Number of Samples That Showed a Result for Each Magnitude					
Magnitude	Lower Critical Value	Upper Critical Value	Total Critical Values, n (‰)	Critical Values/ Total in LAB, n (‰)	Critical Values/ Total in POCT, n (‰)
pH	<7.18	>7.6	19/3195 (0.6)	8/1552 (0.52)	11/1643 (0.67)
Hemoglobin, g/dL	<7.0	N/A	20/3191 (0.63)	12/1548 (0.78)	8/1643 (0.49)
Lactate, mg/dL	N/A	>45	21/3108 (0.68)	12/1532 (0.78)	9/1576 (0.57)
Sodium, mEq/L	<120	>160	3/3182 (0.09)	3/1548 (0.19)	0/1634 (0.0)
Potassium, mEq/L	<2.5	>6.5	25/3181 (0.79)	13/1549 (0.84)	12/1632 (0.74)
Chloride, mEq/L	<75	>125	1/3191 (0.03)	0/1548 (0.0)	1/1643 (0.06)
Ionized calcium, mEq/L	<1.2	>3.3	3/3184 (0.09)	3/1551 (0.19)	0/1633 (0.0)
Glucose, mg/dL	<45	>450	12/3074 (0.39)	10/1535 (0.65)	2/1539 (0.13)

Abbreviations: LAB, laboratory period; POCT, point-of-care period; N/A, not applicable.

Table 6. Time Spent Since the BGA Was Processed in the POCT BGA Analyzer Until Results From the Laboratory Were Released

PID	POCT BGA Analyzer	Laboratory Results	Difference
1	7:43	8:35	0:52
2	7:05	8:57	1:52
3	7:09	8:53	1:44
4	6:25	8:25	2:00
5	6:57	8:23	1:26
6	7:05	8:26	1:21
7	6:46	8:23	1:37
8	7:00	8:18	1:18
9	6:28	8:11	1:43
10	7:08	8:18	1:10
11	9:49	10:14	0:25
12	7:14	8:52	1:38
13	6:54	8:41	1:47
14	10:59	11:59	1:00
15	7:10	9:04	1:54
16	7:17	8:49	1:32
17	9:59	10:24	0:25
18	7:13	8:44	1:31
19	20:55	21:27	0:32
20	17:53	18:38	0:45

Abbreviations: BGA, blood gas analysis; PID, patient identification; POCT, point-of-care testing.

factors. At a clinical level, hemoglobin concentration is important to detecting hidden blood loss in postoperative patients, and for the monitoring of anemia associated to chronic kidney disease.[5,23]

Table 7. Preanalytical Errors in Samples Processed in the Blood Gas Analyzers of the Laboratory (LAB) and the Nephrology Department (POCT) During the Laboratory Period (2016) and Point-of-Care Period (2017), Plus Subsequent Study 1 Year Later (2018)

	Number of Samples Analyzed	Preanalytical Errors (%)
LAB (2016)	26 049	680 (2.61)
POCT (2017)	2407	101 (4.20)
LAB (2018)	3708	103 (2.78)
POCT (2018)	569	13 (2.28)

The number of critical results decreased after the incorporation of a POCT blood gas analyzer in the nephrology department. The greater number of critical results during the LAB period for glucose and lactate probably meant that a longer TAT meant more spurious results due to sample degradation during transport to the laboratory.[24] Subsequently, the POCT approach was more accurate and had less false-positive critical results. Having faster and more accurate results was especially relevant for glucose, given critical hypoglycemia could be managed by nurses immediately after being detected, rather than having to wait for the physician to complete the laboratory request. Faster detection of critical potassium levels is relevant to establishing adequate treatment for its correction, thus contributing to an operative improvement.

The differences in TAT were similar to those calculated in previous studies performed in other environments[12]; thus, although there was some dispersion these results were considered acceptable. Hospitalized nephrology patients

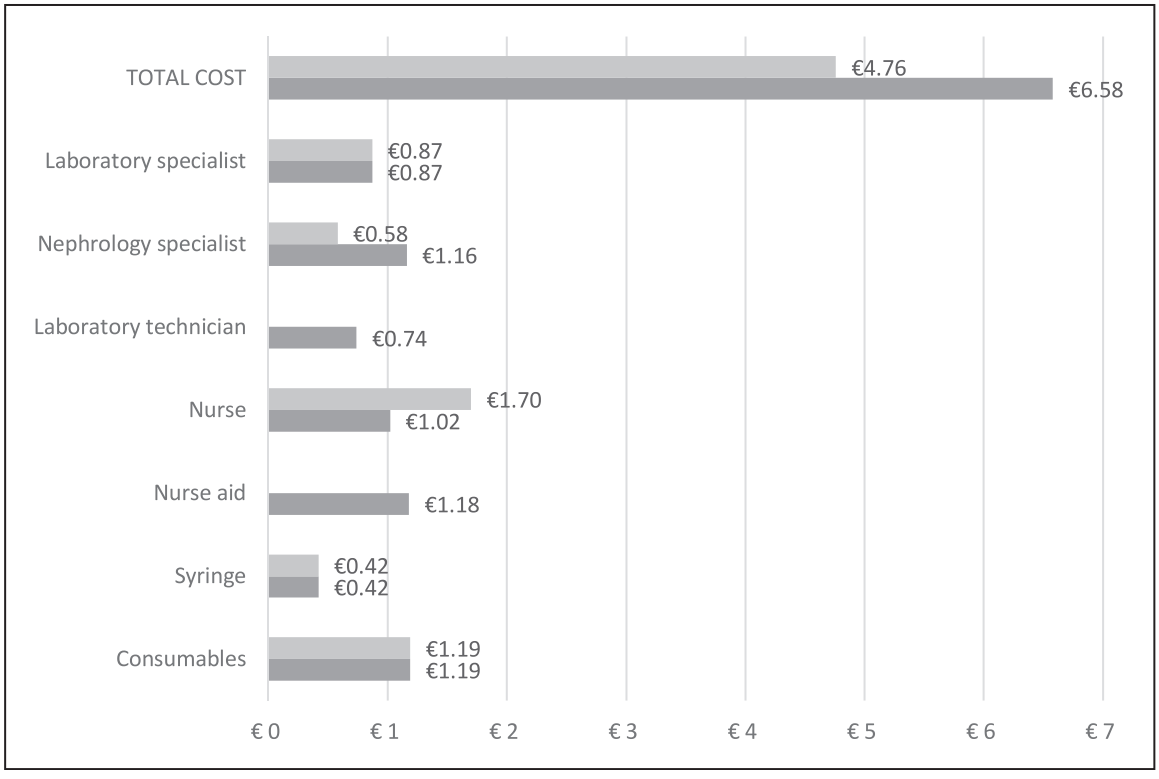

Figure 3. *Total cost per BGA in the LAB (dark gray) and POCT (light gray) periods. Abbreviations: BGA, blood gas analysis; LAB, laboratory period; POCT, point-of-care period.*

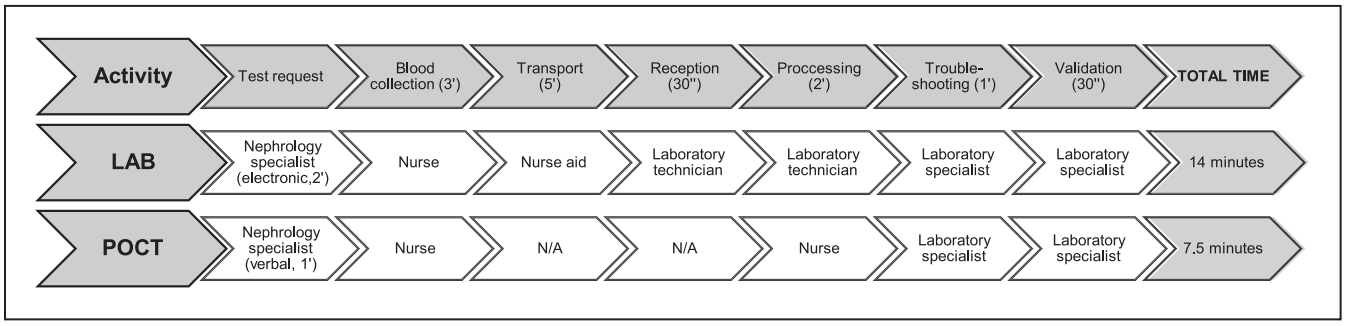

Figure 4. *Activities needed to achieve a BGA result, time spent and staff responsible at each step. Abbreviations: BGA, blood gas analysis; LAB, laboratory period; POCT, point-of-care period; N/A, not applicable.*

could benefit from a rapid response in the presence of hyponatremia or critical potassium levels, which are important prognostic markers.[20] Metabolic acidosis monitoring is also crucial in order to decrease mortality rates in these patients.[9] Further studies with larger samples and more thorough analyses of the implications of the TAT in the department daily practice and its integration with medical interventions or nursing would be necessary to achieve more accurate results in nephrology.

Regarding the elapsed time, easier access to BGA resulted in greater use and a shorter time frame between BGAs for each patient. Given patient populations are considered homogeneous, this variation cannot be explained by more severe pathologies; therefore, patients had closer monitoring during the POCT period. This closer monitoring is especially advisable during dialysis, given that oxygenation and electrolytic imbalances can occur abruptly and an immediate response considerably improves short- and long-term prognosis.[25,26] Electrolyte and pH levels are sufficient to prescribe an urgent hemodialysis and to adjust fluids in an emergency situation.[27,28] BGA can also be used to evaluate arteriovenous fistulas[29] and to monitor ionized calcium levels when citrate-dependent anticoagulants are applied to membranes and calcium needs to be restored after dialysis.[28] Postoperative transplanted patients also need close follow-up, which can be adequately performed by POCT blood gas analyzers.

However, we did not evaluate operative variables as timeframe until the establishment of an etiologic treatment, the length of stay of the patient in the hospital, or number of hospital-acquired infections; thus, all these operative benefits could only be inferred. Studies in other environments showed that rapid results can have an impact in the establishment of etiologic treatments and better clinical outcomes for patients.[2–4] More research would be needed to statistically assess these benefits in nephrology.

Because of the short time between the POCT analyzer installation and the beginning of the current study, we observed a number of samples with preanalytical errors during POCT within the acceptable range established by the laboratory that were higher than in the laboratory. Although all professionals of the nephrology department who could be involved in the POCT BGA measurements received initial training before the implementation of the BGA analyzer, there was still a learning curve that could explain that preanalytical errors were higher during the POCT period.[21,22] However, a close follow-up of this indicator as a part of the laboratory's monthly monitoring program during the next year showed that preanalytical errors had been reduced and were within acceptable ranges over time. Monitoring during the same 1-year period after analyzer installation showed that the learning curve resulted in the same amount of errors as those detected in the laboratory.

Global costs per process were remarkably lower in the POCT period, a finding that is in line with previous studies in other environments.[7,12] The fact that total costs were lower in the POCT period even when there were more BGAs performed, makes us conclude that POCT BGA allows a closer supervision of patients with no additional costs. In summary, based on this study, the implementation of a point-of-care BGA in a nephrology department have a positive impact on patient care in clinical, operative, and economic terms.

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