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In 2019, the general chemistry proficiency testing program of the Korean Association of External Quality Assessment Service consisted of routine chemistry and urine chemistry programs including 30 and 13 test items, respectively. The test method classification system in the urine chemistry program was revised. The routine chemistry program was conducted four times a year, and the urine chemistry program was conducted twice a year. Statistical analysis data for the test method and reagent companies were reported based on the information and results of the test items provided by each institution. The statistics included the number of participating institutes, mean, standard deviation, coefficient of variation (CV), median, and the minimum and maximum values for each group. Each report included tables, histograms, Levey-Jennings charts, and the standard deviation index showing the statistics of each test item. In the routine chemistry program, more than 1,000 institutions performed 17 test items, and the number is continuously increasing. Alkaline phosphatase and lactate dehydrogenase were found to have relatively high CVs because of the differences in the results obtained using different test methods; however, the CVs for others were within 10%. In the urine chemistry program, albumin and protein showed relatively high CVs.

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Key Words Proficiency testing, General chemistry, Korean Association of External Quality Assessment Service

서론

대한임상검사정도관리협회 신빙도조사사업은 2016년부터 차세대 신빙도조사사업으로 대폭 확장 개편되어 시행되고 있다. 2019년에는 6개 대분류에 65개 프로그램 단위별 운영체제로 확대되었고, 프로그램별 검사종목도 326종목으로 증가하였다[1-3]. 임상화학 분야는 6개의 대분류 중 하나로서 일반화학검사 등 10개의 중분류 분야로 구성되어 있고, 이들은 일반화학검사와 요화학검사 등 24개의 세부 프로그램으로 나뉜다. 일반화학검사와 요화학검사

프로그램에는 각각 30종과 13종의 검사항목이 포함되어 있다.

2019년 대한임상검사정도관리협회의 신빙도조사사업으로 시행되었던 일반화학검사와 요화학검사에 대한 신빙도조사사업 결과를 분석하여 보고하고자 한다.

재료 및 방법

1. 대상

일반화학검사 프로그램은 연 4회에 걸쳐, 회차별로 3개의 정도

관리물질이 이용되어 시행되었다. 물질은 냉장상태가 유지될 수 있도록 아이스팩이 내장된 특수 제작박스에 넣어 참여 등록기관을 대상으로 각 회차별로 2월, 4월, 9월과 10월에 발송되었다. 요화학검사 프로그램은 연 2회에 걸쳐, 회차별로 3개의 정도관리물질이 이용되었고 1회차와 2회차를 각각 3월과 10월에 발송하였다.

2. 정도관리물질과 검사항목

일반화학검사의 정도관리물질은 Bio-Rad사(Bio-Rad Laboratories, Hercules, CA, USA)의 사람 혈청을 기질로 한 분말제품을 사용하였다(Table 1). 요화학검사의 정도관리물질도 Bio-Rad사의 Lyphocheck Quantitative Urine Control (Bio-Rad Laboratories)을 사용하였다(Table 2). 사전에 공지된 일정에 따라 참여기관에서는 수령한 물질에 대한 검사 시행 후 지정된 회신 마감일 이내에 대한임상검사정도관리협회 신빙도조사사업

홈페이지(<http://eqas.keqas.org>)에 결과를 입력하였다. 기기회사와 시약회사로부터 제공된 검사항목별 검사방법, 기기와 시약에 대한 데이터베이스가 구축되었고, 이를 토대로 참여기관이 홈페이지상에서 해당 검사항목에 대한 검사정보 선택과 결과 입력이 가능하도록 하였다.

3. 결과 판정 및 분석

일반화학검사와 요화학검사 각각에 대해서, 각 기관에서 입력한 각 검사항목에 대한 정보와 결과를 기반으로 검사방법, 기기, 시약에 따라 통계분석을 시행하였다. 결과보고서는 전체 참여기관의 특성을 보여주는 공통보고서와 개별기관에 대한 평가결과를 보여주는 기관별 보고서로 구성되어 있다. 공통보고서에는 전체 참여기관에 해당하는 통계, 검사방법을 기준분류로 하여 분석한 통계결과와 시약회사를 세 분류로 하여 분석한 통계결과를 각각 제

Table 1. Control material used for analysis and release dates of the trials of general chemistry in 2019

Trial	Material no.	Manufacturer	Product name	Lot no.	Released date
1st	CC-19-01	Bio-Rad	Lyphocheck assayed & unassayed chemistry control	28821	
	CC-19-02	Bio-Rad	Lyphocheck assayed & unassayed chemistry control	28822	18 February
	CC-19-03	Bio-Rad	Lyphocheck assayed & unassayed chemistry control	26451	
2nd	CC-19-04	Bio-Rad	Lyphocheck assayed & unassayed chemistry control	28832	
	CC-19-05	Bio-Rad	Lyphocheck assayed & unassayed chemistry control	26431	22 April
	CC-19-06	Bio-Rad	Lyphocheck assayed & unassayed chemistry control	26432	
3rd	CC-19-07	Bio-Rad	Lyphocheck assayed & unassayed chemistry control	26461	
	CC-19-08	Bio-Rad	Lyphocheck assayed & unassayed chemistry control	26462	2 September
	CC-19-09	Bio-Rad	Lyphocheck assayed & unassayed chemistry control	28812	
4th	CC-19-10	Bio-Rad	Lyphocheck assayed & unassayed chemistry control	26452	
	CC-19-11	Bio-Rad	Lyphocheck assayed & unassayed chemistry control	28841	14 October
	CC-19-12	Bio-Rad	Lyphocheck assayed & unassayed chemistry control	28842	

The instrument was from the following company: Bio-Rad Laboratories (Hercules, CA, USA).

Table 2. Control material used for analysis and release dates of the trials of urine chemistry in 2019

Trial	Material no.	Manufacturer	Product name	Lot no.	Released date
1st	CUC-19-01	Bio-Rad	Lyphocheck Quantitative Urine Control	63422	
	CUC-19-02	Bio-Rad	Lyphocheck Quantitative Urine Control	63431	11 March
	CUC-19-03	Bio-Rad	Lyphocheck Quantitative Urine Control	63432	
2nd	CUC-19-04	Bio-Rad	Lyphocheck Quantitative Urine Control	63432	
	CUC-19-05	Bio-Rad	Lyphocheck Quantitative Urine Control	63441	28 October
	CUC-19-06	Bio-Rad	Lyphocheck Quantitative Urine Control	63442	

The instrument was from the following company: Bio-Rad Laboratories (Hercules, CA, USA).

시하였다.

제시된 통계결과에는 각 그룹별 참여기관 수, 평균, 표준편차, 변동계수, 중앙값, 최소값과 최대값이 포함되도록 하였고 참여기관 수, 중앙값, 최소값과 최대값은 이상치를 제거하지 않은 상태에서 산출된 결과를 제시하였고 평균, 표준편차와 변동계수는 각 군별로 이상치를 제거한 후 산출된 수치를 나타냈다. 해당 분류에서 이상치를 제거한 후 기관 수가 8개 미만인 경우 평균, 표준편차

와 변동계수를 제시하지 않았고 기관 수가 3개 미만인 경우 중앙값도 제시하지 않았다. 이상치는 각 해당 분류에서 75퍼센타일 값(Q3)과 25퍼센타일 값(Q1)의 차(Q3-Q1, interquartile range, IQR)의 1.5배를 초과하여 Q1보다 낮거나 Q3보다 높은 결과값(<Q1-1.5 IQR 또는 >Q3+1.5 IQR)으로 설정하였다.

개별보고서는 각 검사항목별로 통계결과를 보여주는 표, 히스토그램과 레비-제닝스 차트로 구성하였다. 통계치를 제시한 표에

Table 3. Number of laboratories that participated in each test of general chemistry in 2019

Test	Trials			
	1st	2nd	3rd	4th
Alanine aminotransferase	1,687	1,707	1,724	1,742
Albumin	1,560	1,581	1,590	1,609
Alkaline phosphatase	1,487	1,507	1,511	1,533
Amylase	822	821	828	841
Aspartate aminotransferase	1,687	1,706	1,723	1,741
Bilirubin, direct	815	815	815	823
Bilirubin, total	1,564	1,585	1,595	1,614
Calcium	742	738	750	754
Chloride	1,076	1,079	1,087	1,096
Cholesterol, total	1,674	1,694	1,710	1,728
Creatine kinase	676	676	682	692
Creatinine	1,656	1,675	1,697	1,711
Gamma-glutamyl transferase	1,633	1,651	1,665	1,683
Glucose	1,664	1,683	1,701	1,719
High-density lipoprotein cholesterol	1,541	1,559	1,578	1,595
Iron	422	419	424	428
Lactate dehydrogenase	908	912	915	926
Lipase	413	413	429	437
Low-density lipoprotein cholesterol	922	924	938	951
Magnesium	291	292	298	298
Osmolality	151	154	154	157
Phosphorus	688	688	699	700
Potassium	1,086	1,087	1,098	1,107
Protein, total	1,538	1,558	1,565	1,585
Sodium	1,086	1,087	1,098	1,107
Total CO ₂	217	220	222	225
Total iron-binding capacity	385	380	384	388
Triglyceride	1,625	1,645	1,664	1,680
Urea nitrogen	1,611	1,632	1,648	1,669
Uric acid	1,260	1,273	1,281	1,291

는 각 기관의 결과값과 각 분류별로 분석된 통계결과를 제시하였고 기준분류와 세분류에서는 standard deviation index (SDI)를 함께 제시하였다. 전체 결과에 대해서는 SDI를 제시하지 않았고 각 그룹에서 이상치 제거 후 기관 수가 8개 미만일 경우 SDI를 제시하지 않았다. 표준편차가 0이지만 기관의 결과값이 평균과 다를 경우에도 SDI를 제시하지 않았다.

히스토그램에서는 전체 기관의 분포와 기준 분류별 분포를 제시하였고 각 기관의 위치를 표시하였다. 레비-제닝스 차트는 기준 분류별 SDI를 이용하여 작성하였다.

결과 및 고찰

일반화학검사 프로그램에서는 1,000개 이상의 기관이 참여하는 검사항목은 alanine aminotransferase (ALT), albumin, alkaline phosphatase, aspartate aminotransferase (AST), total bilirubin, chloride, total cholesterol, creatinine, gamma-glutamyl transferase, glucose, high density lipoprotein cholesterol, potassium, total protein, sodium, triglyceride, urea nitrogen과 uric acid 등이었고, 회차를 거듭할수록 참가기관 수가 증가하였다(Table 3). 요화학검사 프로그램에서는 2018년부터 시행되고 있는 요 human chorionic gonadotropin 정성검사에 참여하는 기관이 가장 많았고 creatinine 검사가 뒤를 이었다(Table 4).

Table 4. Number of laboratories that participated in each test of urine chemistry in 2019

Test	Trials	
	1st	2nd
Albumin	183	184
Calcium	161	158
Chloride	188	182
Creatinine	220	218
Glucose	140	138
Magnesium	111	111
Phosphorus	143	141
Potassium	189	183
Protein	190	189
Sodium	191	186
Urea nitrogen	163	161
Uric acid	155	151
Urine human chorionic gonadotropin (qualitative)	241	242

일반화학검사 프로그램에서 변동계수는 각 검사항목별 회차별로 상대적으로 정도관리물질의 농도가 낮을수록 높은 경향을 보였다(Table 5). 대부분 10% 이내의 변동계수를 보였지만 alkaline phosphatase, amylase, direct bilirubin, high density lipoprotein cholesterol, lactate dehydrogenase (LDH)와 lipase는 10% 이상의 높은 변동계수를 보였다. 물론 동일한 검사법을 사용하는 군에서는 비교적 작은 변동계수를 보였으나 alkaline phosphatase와 LDH는 검사법 간에 결과의 차이가 유의하게 큼으로써 변동계수도 상대적으로 큰 것으로 관찰되었다(Table 5). 요화학검사 프로그램에서 각 검사항목별 변동계수는 대부분 10% 이내의 값을 보였으나 albumin과 protein은 각각 14.6%–29.3%와 7.4%–8.7%로 상대적으로 높은 변동계수를 보였다(Table 6). 변동계수는 각 기관의 상대적 위치를 나타내는 SDI와도 관련되므로 변동계수가 큰 경우 SDI는 상대적으로 작아질 수 있으므로 결과해석 시 유의하여야 한다.

일반화학검사에서 시범종목으로 시행되었던 추정 신사구체 여과율 검사는 정확도기반 creatinine 검사프로그램으로 이관되었다. 한 가지 검사방법이 전체의 80%를 넘는 검사로는, ALT의 LDH without pyridoxal-5-phosphate (P5P)법, albumin의 dye binding bromocresol green법, AST의 malate dehydrogenase without P5P법, total cholesterol의 cholesterol esterase법, gamma-glutamyl transpeptidase의 gamma-glutamyl-carboxy-nitroanilide법, magnesium의 colorimetry-xylidyl blue법, osmolality의 freezing point depression osmometer법, total protein의 Biuret법, total CO₂의 phosphoenolpyruvate carboxylase법, urea nitrogen의 urease with glutamate dehydrogenase법과 uric acid의 uricase법이 있었으며, 예년과 비슷한 경향을 보였다(Table 7). 요화학검사 프로그램에도 새로운 검사방법 분류체계가 적용되었다. 일반화학검사와 달리 요화학검사에서 albumin의 측정법으로는 immunoturbidimetry법이 주로 이용되었고 protein의 측정법으로 dye binding using pyrogallol red법과 turbidimetry using benzethonium chloride법이 이용되었다(Table 8). Sodium, potassium과 chloride 등의 전해질검사에는 대부분의 검사기관이 희석 이온선택전극법을 이용하였다.

2019년 일반화학검사 프로그램과 요화학검사 프로그램의 신빙도조사 결과에 대해 보다 자세한 통계분석 결과는 대한임상검사정도관리협회 신빙도조사사업 홈페이지(<http://eqas.keqas.org>)에서 조회가 가능하다.

Table 5. Peer-group coefficients of variation (%) according to the test and trials of general chemistry in 2019

Test	Trials													
	CC-19-01	CC-19-02	CC-19-03	CC-19-04	CC-19-05	CC-19-06	CC-19-07	CC-19-08	CC-19-09	CC-19-10	CC-19-11	CC-19-12		
Alanine transaminase	6.5	6.0	7.1	5.5	7.2	5.7	5.4	6.9	5.6	5.6	7.0	5.8		
Albumin	4.8	5.4	5.1	5.5	4.9	5.4	5.3	5.2	5.5	5.3	5.2	5.4		
Alkaline phosphatase	43.5	35.8	43.3	36.3	45.5	38.1	35.7	42.5	34.6	34.4	42.6	35.8		
Amylase	12.6	18.4	12.5	17.5	12.8	18.0	18.6	12.4	18.7	18.2	12.4	18.3		
Aspartate aminotransferase	5.5	4.1	5.2	4.3	5.3	4.3	4.2	5.8	4.2	4.6	5.0	4.6		
Bilirubin, direct	20.1	16.3	20.5	17.4	17.3	17.1	11.4	18.0	15.1	15.5	18.7	17.2		
Bilirubin, total	10.1	6.6	10.4	6.3	10.3	6.2	5.7	10.6	6.3	5.6	9.7	6.0		
Calcium	3.9	2.9	4.0	2.8	4.2	2.9	2.7	4.2	2.9	2.6	4.2	2.5		
Chloride	3.0	2.8	2.9	2.6	2.0	2.6	2.4	2.3	2.5	2.4	2.1	2.7		
Cholesterol, total	3.1	4.7	3.1	4.6	2.9	4.9	4.5	3.0	4.6	4.4	2.8	4.6		
Creatine kinase	3.2	4.2	3.3	4.1	3.6	4.2	3.9	2.7	4.0	4.1	3.2	4.1		
Creatinine	13.6	7.2	12.1	7.3	11.9	7.3	7.4	12.0	7.2	6.9	17.1	6.7		
Gamma-glutamyl transferase	7.7	7.6	7.5	7.9	7.5	7.8	7.8	7.6	7.7	7.8	7.6	7.4		
Glucose	3.9	3.1	4.1	2.8	3.9	2.9	2.9	3.7	2.8	2.8	3.5	2.7		
High-density lipoprotein cholesterol	11.3	12.2	11.4	12.7	12.1	12.6	12.5	12.9	12.1	12.0	12.3	12.0		
Iron	3.3	4.1	3.4	3.4	3.3	3.7	3.6	3.3	3.8	3.9	3.2	4.1		
Lactate dehydrogenase	36.9	40.7	37.1	41.6	37.2	41.7	41.5	37.5	41.4	41.4	37.6	41.5		
Lipase	10.8	13.7	10.8	14.2	10.0	14.4	14.7	12.4	14.2	19.0	11.7	15.9		
Low-density lipoprotein cholesterol	6.1	5.0	6.2	9.6	6.0	5.6	4.7	6.7	4.7	4.5	8.5	4.7		
Magnesium	3.4	3.0	3.5	3.3	3.7	2.2	3.1	3.8	3.0	2.0	3.7	2.1		
Osmolality	1.5	1.3	1.5	1.1	1.2	1.0	1.0	1.2	1.1	1.0	1.1	1.0		
Phosphorus	3.5	2.8	2.3	2.5	2.2	2.3	2.3	2.5	2.4	2.4	2.3	2.8		
Potassium	1.9	2.3	1.8	2.4	0.0	2.4	2.2	1.9	2.2	2.1	2.0	2.1		
Protein, total	3.4	3.8	3.4	3.8	3.3	3.6	3.5	3.2	3.6	3.6	2.9	3.6		
Sodium	1.2	1.3	1.4	1.3	1.2	1.2	1.3	1.4	1.3	1.3	1.4	1.3		
Total CO ₂	6.5	6.5	6.7	5.3	6.0	5.8	5.5	5.9	5.2	5.1	5.5	6.2		
Total iron-binding capacity	3.5	3.2	3.6	3.0	3.6	3.1	3.1	3.3	3.2	3.2	3.3	3.6		
Triglyceride	3.9	5.9	3.5	5.2	3.8	5.4	5.3	3.8	5.1	5.9	3.6	5.5		
Urea nitrogen	4.8	4.2	4.9	4.1	4.8	4.5	4.7	5.0	4.4	4.2	4.7	4.4		
Uric acid	3.5	3.6	3.4	3.7	3.4	3.6	3.5	3.3	3.4	3.3	3.4	3.1		

Table 6. Peer-group coefficients of variation (%) according to the test and trials of urine chemistry in 2019

Test	Trials					
	CUC-19-01	CUC-19-02	CUC-19-03	CUC-19-04	CUC-19-05	CUC-19-06
Albumin	19.1	29.3	19.2	15.8	27.0	14.6
Calcium	2.6	3.8	2.7	2.2	4.0	2.4
Chloride	2.0	7.3	2.1	2.1	7.0	2.2
Creatinine	4.3	5.2	5.0	4.8	4.7	4.7
Glucose	2.0	3.6	2.2	2.4	3.6	2.3
Magnesium	4.0	3.9	4.1	3.3	3.0	3.1
Phosphorus	2.6	2.8	2.9	2.2	2.2	1.8
Potassium	3.3	1.9	2.9	2.7	1.9	2.7
Protein	8.7	8.6	8.0	8.1	7.4	8.6
Sodium	1.2	2.7	1.2	1.3	2.5	1.1
Urea nitrogen	3.6	3.9	3.5	3.2	3.6	3.4
Uric acid	3.5	4.7	3.6	3.7	5.7	3.8

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2. Lee YW. Annual report on the external quality assessment scheme for general chemistry in Korea (2017). J Lab Med Qual Assur 2018;40:113-27.
3. Lee YW, Jeon BR, Kim JG, Jun SH, Yun YM, Chun S, et al. Annual report on the external quality assessment scheme for routine clinical chemistry in Korea (2016). J Lab Med Qual Assur 2017;39:61-75.

Table 7. Distribution of analytical methods (principle) used and coefficients of variation (%) according to the principle of general chemistry in 2019

Test/method	Trials															
	1st				2nd				3rd				4th			
	Lab*	CC-19-01	CC-19-02	CC-19-03	Lab	CC-19-04	CC-19-05	CC-19-06	Lab	CC-19-07	CC-19-08	CC-19-09	Lab	CC-19-10	CC-19-11	CC-19-12
Alanine aminotransferase	1,685	6.5	6.0	7.1	1,707	5.5	7.2	5.7	1,724	5.4	6.9	5.6	1,742	5.6	7.0	5.8
Dry chemistry	9	16.7	3.6	18.7	9	3.4	16.9	5.0	9	0.9	1.6	3.6	8	2.1	5.2	2.2
LDH with P5P	15	15.2	3.6	14.9	15	5.3	12.7	3.5	20	12.5	10.6	13.9	21	13.7	17.0	13.2
LDH without P5P	1,631	6.4	5.9	7.1	1,647	5.4	7.0	5.4	1,666	5.4	5.9	5.6	1,686	5.6	6.9	5.4
Other method	30	9.4	8.1	8.8	36	8.8	10.8	10.2	29	8.2	10.3	7.7	27	5.7	8.7	7.3
Albumin	1,558	4.8	5.4	5.1	1,581	5.5	4.9	5.4	1,590	5.3	5.2	5.5	1,609	5.3	5.2	5.4
Dye binding-BCG	1,526	4.8	5.4	5.1	1,544	5.1	5.0	5.4	1,562	5.3	5.1	5.4	1,580	5.3	5.2	5.4
Dye binding-BCP	8	5.3	6.6	6.9	9	5.6	5.4	5.7	7	6.1	2.3	2.2	8	4.0	4.2	4.1
Other method	24	3.6	3.1	3.9	28	3.2	2.0	2.9	21	6.2	4.1	5.3	21	5.5	4.0	3.2
Alkaline phosphatase	1,485	43.5	35.8	43.3	1,507	36.3	45.5	38.1	1,511	35.7	42.5	34.6	1,533	34.4	42.6	35.8
Other method	22	35.6	31.3	36.6	26	22.2	38.9	16.6	20	30.7	39.3	29.2	20	11.0	39.6	26.4
PNPP, AMP buffer	869	13.5	16.2	13.4	874	16.3	14.7	16.9	882	16.5	14.1	16.2	892	16.8	14.1	16.9
PNPP, DEA buffer	159	11.4	10.5	9.3	165	9.1	9.1	9.0	167	9.6	9.3	8.5	168	8.2	9.4	8.8
PNPP, EAE buffer	435	5.8	4.8	5.8	442	4.3	6.2	5.1	442	4.6	5.8	4.5	453	4.2	5.7	4.1
Amylase	820	12.6	18.4	12.5	821	17.5	12.8	18.0	828	18.6	12.4	18.7	841	18.2	12.4	18.3
Dry chemistry	9	7.2	3.8	7.8	8	2.9	6.1	2.8	8	2.8	8.4	2.3	8	2.8	7.0	2.6
Hydrolysis of 2-chloro-4-nitrophenyl-azido-deoxy-maltopentaoside	5	1.0	0.3	0.9	4	1.5	2.8	3.0	4	2.0	0.9	1.2	3	0.9	0.6	0.7
Hydrolysis of 2-chloro-4-nitrophenyl-galactopyranosylmaltoside	108	2.1	1.6	2.0	110	1.5	2.0	1.6	119	1.5	1.7	1.4	123	1.0	1.7	1.3
Hydrolysis of 2-chloro-4-nitrophenyl-D-maltotriose	215	5.3	2.7	4.7	222	2.6	3.0	2.7	218	3.2	3.0	2.4	221	2.4	3.1	3.2
Hydrolysis of 4,6-ethylidene-4-nitrophenyl-maltoheptaose	348	4.0	4.7	4.0	346	4.7	4.0	4.9	357	4.5	3.9	4.6	364	4.5	5.3	4.6
Hydrolysis of 4-nitrophenylbenzyl-maltopentaose	125	12.1	19.3	12.0	121	19.5	12.3	19.6	116	20.6	10.3	20.7	117	19.9	11.5	19.8
Other method	10	15.6	20.0	15.4	10	11.9	11.4	11.6	6	17.5	11.0	18.5	5	20.6	10.8	18.2

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Table 7. Continued

Test/method	Trials															
	1st				2nd				3rd				4th			
	Lab*	CC-19-01	CC-19-02	CC-19-03	Lab	CC-19-04	CC-19-05	CC-19-06	Lab	CC-19-07	CC-19-08	CC-19-09	Lab	CC-19-10	CC-19-11	CC-19-12
Aspartate aminotransferase	1,685	5.5	4.1	5.2	1,706	4.3	5.3	4.3	1,723	4.2	5.8	4.2	1,741	4.6	5.0	4.6
Dry chemistry	9	2.7	1.9	3.0	9	2.3	8.4	3.5	9	1.5	1.1	3.2	8	1.7	3.9	3.2
MDH with P5P	15	8.2	2.7	7.6	15	5.9	6.3	5.7	15	4.4	4.8	2.9	16	4.5	2.8	3.4
MDH without P5P	1,631	5.0	4.1	5.2	1,646	4.3	5.2	4.3	1,671	4.4	5.7	4.2	1,690	4.5	5.0	4.6
Other method	30	7.3	4.3	7.5	36	5.7	7.5	6.9	28	4.9	8.2	5.9	27	5.2	6.5	4.8
Bilirubin, direct	814	20.1	16.3	20.5	815	17.4	17.3	17.1	815	11.4	18.0	15.1	823	15.5	18.7	17.2
Copper ion oxidation	50	3.4	12.4	0.0	50	14.5	13.2	14.3	50	13.8	13.8	15.5	48	13.2	15.6	14.2
Diazonium salt with blank	329	22.4	5.1	23.2	327	5.1	18.8	3.8	333	6.3	18.2	4.6	335	4.7	21.7	5.3
Diazo-sulfanilic acid with blank	44	40.5	35.0	36.4	46	27.7	34.1	27.1	46	31.1	38.1	31.6	46	25.7	36.8	24.1
Diazo-sulfanilic acid without blank	17	39.2	26.3	17.8	17	23.7	35.5	19.6	19	15.9	34.6	16.4	20	20.2	28.4	20.2
Enzymatic oxidation	6	20.2	16.2	19.4	6	16.4	16.0	17.3	5	5.3	6.4	7.1	5	5.6	3.4	6.3
Other method	16	33.9	30.3	22.6	17	18.9	27.9	27.4	10	28.4	20.3	21.4	10	18.7	29.8	18.2
Vanadate oxidation	352	11.4	12.8	10.3	352	9.7	2.6	10.8	352	11.6	6.5	13.0	359	12.9	13.3	13.5
Bilirubin, total	1,562	10.1	6.6	10.4	1,585	6.3	10.3	6.2	1,595	5.7	10.6	6.3	1,614	5.6	9.7	6.0
Copper ion oxidation	94	8.1	5.7	8.7	95	6.8	8.7	7.1	109	6.3	7.3	6.6	106	6.3	6.6	5.1
Diazo-caffeine, sodium benzoate with blank	7	9.9	8.3	10.4	8	10.2	14.8	11.5	7	8.8	17.7	14.1	7	8.2	7.8	7.1
Diazo-dimethyl sulfoxide with blank	126	8.2	5.5	8.0	132	6.8	12.2	8.1	135	8.6	11.3	7.2	140	7.0	7.3	7.2
Diazo-dimethyl sulfoxide without blank	99	11.7	6.3	10.8	101	4.6	12.9	5.1	101	7.8	13.4	6.5	106	5.8	9.3	6.1
Diazo-diphenylamine with blank	9	8.2	6.7	12.2	9	3.9	9.6	9.3	9	3.6	4.2	4.8	8	5.1	6.5	4.6
Diazonium salt-surfactant with blank	493	11.8	6.8	11.9	497	6.1	12.1	5.8	504	5.1	10.9	5.7	508	5.6	8.8	5.7
Diazonium salt-surfactant without blank	35	13.3	13.0	12.7	35	11.8	15.6	12.4	35	10.5	14.4	10.0	34	8.4	6.6	7.1
Enzymatic oxidation	21	12.0	4.8	10.2	18	6.6	10.4	6.0	19	8.6	14.7	9.7	19	5.3	12.0	4.1
Other method	36	12.6	5.4	10.4	41	7.8	12.9	7.4	34	3.8	7.4	5.5	34	5.7	12.2	5.2
Vanadate oxidation	640	5.5	4.4	2.8	644	4.0	5.5	3.7	637	3.3	4.6	3.2	646	2.5	5.4	2.8

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Table 7. Continued

Test/method	Trials															
	1st			2nd			3rd			4th						
	Lab*	CC-19-01	CC-19-02	CC-19-03	Lab	CC-19-04	CC-19-05	CC-19-06	Lab	CC-19-07	CC-19-08	CC-19-09	Lab	CC-19-10	CC-19-11	CC-19-12
Calcium	741	3.9	2.9	4.0	738	2.8	4.2	2.9	750	2.7	4.2	2.9	754	2.6	4.2	2.5
Colorimetry arsenazo III	160	3.0	3.6	2.3	159	2.9	2.6	3.4	161	3.0	3.2	3.0	166	2.8	2.4	2.6
Colorimetry_methylxlenol blue	28	2.9	3.1	2.9	32	1.8	2.5	2.7	37	1.4	2.2	1.3	40	1.8	2.1	1.7
Colorimetry_OCPC	410	2.9	2.6	3.4	406	2.8	3.3	2.7	407	2.7	3.5	3.0	404	2.6	2.9	2.5
NM-BAPTA	137	1.6	1.6	1.6	136	1.4	1.7	1.6	139	1.3	1.4	1.2	141	1.5	1.0	0.7
Other method	5	1.0	2.6	1.6	4	2.9	4.7	3.7	6	1.3	5.5	3.0	3	2.1	3.2	2.4
Chloride	1,075	3.0	2.8	2.9	1,079	2.6	2.0	2.6	1,087	2.4	2.3	2.5	1,096	2.4	2.1	2.7
ISE, diluted	573	3.1	2.4	3.1	576	2.2	2.1	2.1	590	2.1	2.7	2.2	595	1.8	2.5	2.0
ISE, undiluted	469	2.3	2.8	2.9	471	2.1	1.6	2.1	470	2.6	2.1	2.6	478	2.6	1.7	2.1
Other method	33	2.7	3.5	2.4	32	4.4	2.2	4.0	27	2.3	2.3	2.8	23	4.7	3.8	5.5
Cholesterol, total	1,672	3.1	4.7	3.1	1,694	4.6	2.9	4.9	1,710	4.5	3.0	4.6	1,728	4.4	2.8	4.6
Cholesterol esterase	1,643	3.2	4.6	3.1	1,659	4.6	2.9	5.0	1,683	4.5	3.0	4.6	1,702	4.4	2.7	4.6
Other method	29	2.4	6.3	2.9	35	4.5	2.4	4.9	27	4.9	4.3	5.2	26	4.3	3.7	4.2
Creatine kinase	675	3.2	4.2	3.3	676	4.1	3.6	4.2	682	3.9	2.7	4.0	692	4.1	3.2	4.1
Creatine phosphate to creatine	219	3.3	2.8	3.2	217	2.2	3.4	2.0	230	2.2	3.1	2.0	231	2.4	3.1	2.4
Creatine phosphate to creatine with activator	442	2.8	4.7	3.4	445	4.8	3.3	4.8	441	4.8	2.7	4.7	450	4.8	3.1	5.0
Dry chemistry	6	12.1	7.8	11.0	5	8.1	7.3	7.4	5	1.8	3.3	1.2	5	3.1	4.8	4.4
Other method	8	4.6	1.6	4.7	9	4.4	4.9	3.0	6	3.0	1.8	3.5	6	4.5	5.1	4.4
Creatinine	1,654	13.6	7.2	12.1	1,675	7.3	11.9	7.3	1,697	7.4	12.0	7.2	1,711	6.9	17.1	6.7
Enzymatic method	76	38.4	6.5	16.2	81	4.1	12.2	3.3	94	4.7	7.6	4.3	100	4.1	14.5	4.6
Kinetic Jaffe with compensation	379	12.6	7.4	11.5	386	7.2	10.9	7.4	374	5.0	4.7	5.3	370	4.0	8.0	4.0
Kinetic Jaffe without compensation	904	10.9	5.8	7.6	914	6.7	6.7	6.5	944	5.8	7.8	6.0	957	5.8	11.4	5.9
Other method	27	8.9	10.1	9.1	31	12.9	17.8	13.4	32	11.3	13.1	11.3	26	7.4	26.8	6.9
Rate blanked compensated kinetic Jaffe method	268	6.0	3.7	4.8	263	3.5	4.6	3.7	253	3.4	5.0	3.7	258	3.0	5.2	3.3

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Table 7. Continued

Test/method	Trials															
	1st				2nd				3rd				4th			
	Lab*	CC-19-01	CC-19-02	CC-19-03	Lab	CC-19-04	CC-19-05	CC-19-06	Lab	CC-19-07	CC-19-08	CC-19-09	Lab	CC-19-10	CC-19-11	CC-19-12
Gamma-glutamyl transpeptidase	1,631	7.7	7.6	7.5	1,651	7.9	7.5	7.8	1,665	7.8	7.6	7.7	1,683	7.8	7.6	7.4
Gamma-glutamyl-carboxy-nitroanilide	1,577	7.7	7.6	7.5	1,590	7.9	7.5	7.7	1,611	7.8	7.6	7.6	1,630	7.8	7.4	7.4
Gamma-glutamyl-p-nitroanilide	17	6.2	5.3	2.1	18	9.9	9.6	11.1	19	8.3	9.6	9.0	21	7.6	7.9	8.3
G-glutamyl-p-nitroanilide (dry chemistry)	9	8.2	3.7	4.3	9	1.7	3.8	1.7	9	2.0	4.1	4.4	8	2.1	6.4	1.5
Other method	28	7.7	6.7	6.5	34	9.1	9.0	9.7	26	7.4	7.3	6.8	24	7.1	7.9	3.0
Glucose	1,662	3.9	3.1	4.1	1,683	2.8	3.9	2.9	1,701	2.9	3.7	2.8	1,719	2.8	3.5	2.7
Glucose oxidase	440	4.4	4.1	4.2	446	3.8	4.4	3.9	449	3.8	4.2	3.6	450	3.3	3.7	3.4
Hexokinase	1,193	3.3	2.8	2.9	1,204	2.4	3.1	2.6	1,224	2.6	3.3	2.6	1,242	2.5	3.2	2.5
Other method	29	4.0	4.0	5.5	33	3.5	4.6	3.7	28	4.6	5.7	4.4	27	3.9	5.4	3.3
High-density lipoprotein cholesterol	1,539	11.3	12.2	11.4	1,559	12.7	12.1	12.6	1,578	12.5	12.9	12.1	1,595	12.0	12.3	12.0
Enzymatic with detergent	605	9.2	10.2	9.4	625	10.8	9.1	10.4	707	11.2	10.9	11.2	713	11.0	9.5	10.5
Enzymatic with immunoinhibition	221	4.0	3.6	3.1	224	3.2	3.5	3.3	224	3.2	3.5	4.6	227	5.3	4.3	3.4
Enzymatic with others	196	11.6	13.1	12.3	196	11.8	10.8	13.3	189	12.8	8.6	12.9	198	11.0	10.2	12.5
Enzymatic with polyanion precipitation	178	12.4	12.8	10.2	180	14.5	10.1	13.1	186	11.0	13.8	10.4	184	11.5	13.7	14.0
Enzymatic with polyethylene glycol	311	4.2	3.6	4.3	302	3.9	4.4	3.4	243	3.1	3.1	3.3	247	2.9	2.3	3.1
Other method	27	12.3	10.0	12.0	31	8.9	13.3	8.4	27	11.7	13.5	13.4	24	12.4	12.2	12.5
Iron	421	3.3	4.1	3.4	419	3.4	3.3	3.7	424	3.6	3.3	3.8	428	3.9	3.2	4.1
Bathophenanthroline without deproteinization	139	1.3	2.8	1.4	136	1.9	1.4	2.3	138	2.5	1.3	2.0	137	2.3	1.4	1.3
Ferrozine without deproteinization	147	1.9	3.8	1.9	146	2.4	1.4	2.3	148	2.4	1.6	2.7	150	2.4	1.3	2.4
Nitroso-PSAP without deproteinization	45	1.2	2.1	1.5	48	2.6	1.8	2.9	48	2.3	1.5	2.6	51	2.7	1.2	2.7
Pyridyl azo dye ascorbate without deproteinization	4	5.2	9.4	5.4	4	3.7	5.9	9.0	3	12.4	5.1	9.1	3	26.0	3.5	20.0
Tripyridyltriazine without deproteinization	81	1.2	2.3	1.0	84	2.1	0.8	2.3	84	1.4	1.0	2.0	84	2.0	1.2	1.5

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Table 7. Continued

Test/method	Trials															
	1st				2nd				3rd				4th			
	Lab*	CC-19-01	CC-19-02	CC-19-03	Lab	CC-19-04	CC-19-05	CC-19-06	Lab	CC-19-07	CC-19-08	CC-19-09	Lab	CC-19-10	CC-19-11	CC-19-12
Lactate dehydrogenase	907	36.9	40.7	37.1	912	41.6	37.2	41.7	915	41.5	37.5	41.4	926	41.4	37.6	41.5
Lactate to pyruvate	486	4.7	4.8	4.9	498	5.0	4.7	4.9	516	4.9	5.0	5.0	520	4.8	5.0	5.0
Other method	11	34.2	37.8	36.3	11	40.0	39.2	40.5	9	36.7	34.8	36.5	7	36.6	34.2	36.1
Pyruvate to lactate	405	7.4	7.8	7.7	397	7.2	7.6	7.3	384	7.2	7.4	7.1	393	7.0	7.0	6.8
Pyruvate to lactate (dry chemistry)	5	2.3	3.9	3.4	6	3.8	5.6	3.8	6	1.6	2.9	2.7	6	2.0	4.1	2.0
Lipase	413	10.8	13.7	10.8	413	14.2	10.0	14.4	429	14.7	12.4	14.2	437	19.0	11.7	15.9
Hydrolysis of 1,2-diglyceride with quinone dye	84	3.6	2.3	3.7	89	3.5	4.0	2.4	88	1.8	3.1	2.2	90	2.8	3.8	2.3
Hydrolysis of 1,2-O-dilauryl-rac-glycero-3-glutaric acid-(6'-methylresorufin) ester	315	10.6	15.0	10.5	313	22.5	10.8	22.8	330	26.5	11.8	25.9	335	24.5	10.9	24.2
Hydrolysis of 1-oleoyl-2,3-diacylglycerol	10	2.4	3.1	2.4	9	3.9	1.8	3.2	9	0.0	2.8	0.0	9	4.9	3.4	3.6
Low-density lipoprotein cholesterol	920	6.1	5.0	6.2	924	9.6	6.0	5.6	938	4.7	6.7	4.7	951	4.5	8.5	4.7
Enzymatic with detergent	653	5.6	5.0	5.5	660	9.7	6.0	5.9	715	4.4	6.3	3.9	728	4.3	8.9	4.6
Enzymatic with others	225	6.9	7.2	7.1	226	5.9	5.7	5.4	186	8.4	7.2	7.8	187	6.0	5.7	6.2
Enzymatic with polyethylene glycol	30	5.9	6.2	6.3	28	9.7	6.1	8.4	28	8.4	8.2	8.6	29	7.4	10.2	6.9
Other method	12	9.8	7.6	8.6	10	9.5	4.4	7.2	9	7.5	11.1	7.4	7	5.7	11.4	7.3
Magnesium	291	3.4	3.0	3.5	292	3.3	3.7	2.2	298	3.1	3.8	3.0	298	2.0	3.7	2.1
Colorimetry_Xylidyl blue	287	3.4	3.0	3.5	290	3.3	3.7	2.2	295	3.1	3.8	3.0	296	2.0	3.7	2.1
Osmolality	151	1.5	1.3	1.5	154	1.1	1.2	1.0	154	1.0	1.2	1.1	157	1.0	1.1	1.0
Freezing point depression osmometer	143	1.4	1.3	1.5	148	1.1	1.2	1.0	148	1.0	1.2	1.1	150	1.0	1.1	1.0
Other method	8	2.0	1.8	1.4	6	0.8	1.1	1.5	6	0.9	1.0	0.7	7	0.9	1.8	1.4
Phosphorus	687	3.5	2.8	2.3	688	2.5	2.2	2.3	699	2.3	2.5	2.4	700	2.4	2.3	2.8
Enzymatic	5	1.6	3.9	5.6	4	5.3	9.5	6.4	3	4.8	7.8	4.8	3	2.7	4.2	6.0
Molybden blue colorimetry	161	2.2	1.4	2.3	164	1.8	2.1	1.3	174	1.9	2.3	2.1	175	1.7	2.1	1.9
Other method	3	8.1	5.8	11.1	2	8.9	12.9	10.9	3	6.3	15.1	8.9	2	2.9	0.0	3.8
Phosphomolybdate	518	3.6	2.4	2.3	518	2.2	2.3	2.1	519	2.3	2.6	2.6	520	2.9	3.4	2.3

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Table 7. Continued

Test/method	Trials															
	1st				2nd				3rd				4th			
	Lab*	CC-19-01	CC-19-02	CC-19-03	Lab	CC-19-04	CC-19-05	CC-19-06	Lab	CC-19-07	CC-19-08	CC-19-09	Lab	CC-19-10	CC-19-11	CC-19-12
Potassium	1,085	1.9	2.3	1.8	1,087	2.4	0.0	2.4	1,098	2.2	1.9	2.2	1,107	2.1	2.0	2.1
ISE, diluted	575	1.8	1.4	1.7	577	1.4	0.0	1.6	592	1.5	0.0	1.4	597	1.5	1.7	1.4
ISE, undiluted	477	2.0	1.5	0.0	478	2.6	0.0	1.4	479	1.5	1.9	2.4	487	1.6	2.2	1.5
Other method	33	3.0	4.2	2.2	32	5.4	2.2	5.4	27	2.5	3.4	2.9	23	3.1	2.9	2.4
Protein, total	1,536	3.4	3.8	3.4	1,558	3.8	3.3	3.6	1,565	3.5	3.2	3.6	1,585	3.6	2.9	3.6
Biuret method	1,509	3.3	3.8	3.4	1,529	3.7	3.3	3.6	1,543	3.5	3.2	3.6	1,563	3.6	2.8	3.6
Other method	27	3.7	5.0	4.3	29	5.6	5.5	5.0	22	8.5	6.9	8.8	22	7.2	5.8	6.8
Sodium	1,085	1.2	1.3	1.4	1,087	1.3	1.2	1.2	1,098	1.3	1.4	1.3	1,107	1.3	1.4	1.3
ISE, diluted	547	0.7	1.2	1.0	553	1.1	1.0	1.1	569	1.2	0.7	1.1	575	0.8	1.1	1.2
ISE, undiluted	505	1.5	1.7	1.4	502	1.6	1.2	1.4	502	1.5	1.4	1.5	509	1.4	1.4	1.4
Other method	33	2.0	1.5	1.8	32	1.6	1.9	1.5	27	1.4	2.2	1.9	23	1.4	1.6	1.1
Total CO ₂	217	6.5	6.5	6.7	220	5.3	6.0	5.8	222	5.5	5.9	5.2	225	5.1	5.5	6.2
Other method	5	11.0	13.4	10.9	6	6.5	8.8	5.4	3	3.1	4.4	4.8	3	3.2	4.4	2.2
Phosphoenolpyruvate carboxylase	212	6.4	6.5	6.6	214	5.3	5.9	5.8	219	5.5	5.9	5.2	222	5.1	5.5	6.2
Total iron-binding capacity	384	3.5	3.2	3.6	380	3.0	3.6	3.1	384	3.1	3.3	3.2	388	3.2	3.3	3.6
Bathophenanthroline	130	2.1	2.4	2.1	124	2.7	2.0	2.6	124	2.3	1.5	2.7	123	2.4	1.9	2.3
Chromazural B	25	3.9	2.6	3.7	25	2.8	2.5	3.7	22	4.2	5.7	4.5	24	4.8	4.5	5.2
Ferrozine	112	2.3	3.4	2.8	110	2.8	2.4	2.8	114	3.1	2.3	3.7	115	3.5	2.3	3.2
Nitroso-PSAP	114	2.7	2.3	3.0	119	2.1	2.5	2.4	121	2.2	2.6	2.4	123	2.2	2.6	2.4
Other method	3	2.8	8.1	3.6	2	1.6	3.4	1.8	3	25.1	15.0	25.2	3	21.5	11.8	21.7
Triglyceride	1,623	3.9	5.9	3.5	1,645	5.2	3.8	5.4	1,664	5.3	3.8	5.1	1,680	5.9	3.6	5.5
Enzymatic with free glycerol elimination	527	3.0	2.7	2.6	529	2.7	2.9	3.0	555	3.2	2.7	2.5	566	2.9	2.5	3.3
Enzymatic without free glycerol elimination	1,071	4.3	6.7	4.2	1,085	6.4	4.5	6.5	1,083	6.2	4.6	6.4	1,089	7.0	4.4	6.6
Other method	25	4.3	4.3	4.5	31	6.8	5.8	7.0	26	8.3	8.0	7.0	25	7.5	4.3	6.1

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Table 7. Continued

Test/method	Trials															
	1st				2nd				3rd				4th			
	Lab*	CC-19-01	CC-19-02	CC-19-03	Lab	CC-19-04	CC-19-05	CC-19-06	Lab	CC-19-07	CC-19-08	CC-19-09	Lab	CC-19-10	CC-19-11	CC-19-12
Urea nitrogen	1,609	4.8	4.2	4.9	1,632	4.1	4.8	4.5	1,648	4.7	5.0	4.4	1,669	4.2	4.7	4.4
Other method	28	5.4	4.2	6.1	32	5.8	4.6	6.4	25	9.1	8.9	9.0	25	5.4	6.8	5.0
Urease with colorimetry	16	4.2	8.3	1.2	17	8.4	1.3	8.5	15	5.8	3.8	6.6	15	6.2	4.2	5.7
Urease with GLDH	1,564	4.8	4.2	4.9	1,582	4.1	4.6	4.5	1,607	4.4	4.9	4.3	1,628	4.2	4.7	4.3
Uric acid	1,258	3.5	3.6	3.4	1,273	3.7	3.4	3.6	1,281	3.5	3.3	3.4	1,291	3.3	3.4	3.1
Other method	17	4.5	3.8	3.9	18	4.0	5.8	4.3	14	4.9	8.6	5.2	12	9.1	9.8	7.3
Uricase	1,235	3.4	3.5	3.4	1,249	3.6	3.4	3.5	1,261	3.4	3.2	3.4	1,273	3.3	3.3	3.1
Uricase (dry chemistry)	6	1.9	2.4	1.0	6	1.6	2.4	2.1	6	0.6	1.7	0.6	6	1.3	2.4	1.3

Abbreviations: LDH, lactate dehydrogenase; P5P, pyridoxal-5-phosphate; BCG, bromocresol green; BCP, bromocresol purple; PNPP, para nitrophenylphosphate; AMP, 2-amino-2-methyl-1-propanol; DEA, diethanolamine; EAE, 2-ethylaminoethanol; MDH, malate dehydrogenase; OCP, o-cresolphthalein complexone; NM-BAPTA, 5-nitro-5'-methyl-BAPTA; ISE, ion-selective electrodes; Nitroso-PSAP, 2-nitroso-5-(N-propyl-N-sulfolpropylamino)-phenol; GLDH, glutamate dehydrogenase.

*Number of laboratories participated in Korean External Quality Assessment Service 2019.

Table 8. Distribution of analytical methods (principle) used and coefficients of variation (%) according to principle of urine chemistry in 2019

Test/method	Trials							
	1st				2nd			
	Lab*	CUC-19-01	CUC-19-02	CUC-19-03	Lab	CUC-19-04	CUC-19-05	CUC-19-06
Albumin	183	19.1	29.3	19.2	184	15.8	27.0	14.6
Immunoturbidimetry	173	17.9	28.7	18.1	174	15.4	27.1	14.1
Other method	8	46.6	69.2	47.6	6	10.2	29.9	11.0
Calcium	161	2.6	3.8	2.7	158	2.2	4.0	2.4
Colorimetry_arsenazo III	24	4.0	3.4	3.8	25	2.7	2.5	2.8
Colorimetry_methylxlenol blue	8	2.0	2.7	1.3	11	1.8	3.3	1.5
Colorimetry_OCPC	74	2.6	3.5	2.7	66	3.1	4.8	3.0
NM-BAPTA	52	1.7	2.9	1.6	53	1.2	2.0	1.5
Other method	3	3.7	1.2	2.9	3	2.7	3.7	4.2
Chloride	188	2.0	7.3	2.1	182	2.1	7.0	2.2
ISE, diluted	182	2.0	7.1	2.1	178	2.0	7.0	2.2
ISE, undiluted	4	22.8	19.3	12.5	2	61.6	33.4	70.9
Creatinine	220	4.3	5.2	5.0	218	4.8	4.7	4.7
Enzymatic method	9	5.3	4.9	5.0	9	5.2	4.4	5.0
Kinetic Jaffe without compensation	187	4.2	4.9	4.4	185	4.5	4.4	4.3
Rate blanked compensated kinetic Jaffe method	22	2.4	3.5	3.7	20	3.3	3.5	3.8
Glucose	140	2.0	3.6	2.2	138	2.4	3.6	2.3
Hexokinase	140	2.0	3.6	2.2	138	2.4	3.6	2.3
Magnesium	111	4.0	3.9	4.1	111	3.3	3.0	3.1
Colorimetry_Xylidyl blue	110	4.0	3.9	4.1	110	3.3	2.9	3.2
Phosphorus	143	2.6	2.8	2.9	141	2.2	2.2	1.8
Molybden blue colorimetry	16	3.8	2.1	3.9	16	2.4	1.6	2.0
Phosphomolybdate	127	2.6	3.0	2.7	125	2.1	2.3	1.8
Potassium	189	3.3	1.9	2.9	183	2.7	1.9	2.7
ISE, diluted	183	3.4	1.8	2.9	179	2.7	1.9	2.7
ISE, undiluted	4	16.7	7.1	24.1	2	38.6	37.6	56.4
Protein	190	8.7	8.6	8.0	189	8.1	7.4	8.6
Biuret method	5	2.1	8.8	2.2	5	2.1	5.0	2.2
Dye binding using pyrogallol red	112	8.6	9.9	8.1	111	7.8	10.2	8.5
Turbidimetry using benzethonium chloride	72	3.9	6.6	3.6	72	3.1	5.0	2.7

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Table 8. Continued

Test/method	Trials							
	1st				2nd			
	Lab*	CUC-19-01	CUC-19-02	CUC-19-03	Lab	CUC-19-04	CUC-19-05	CUC-19-06
Sodium	191	1.2	2.7	1.2	186	1.3	2.5	1.1
ISE, diluted	183	1.2	2.7	1.2	180	1.3	2.5	1.1
ISE, undiluted	5	3.0	4.6	2.9	3	51.9	34.3	61.6
Urea nitrogen	163	3.6	3.9	3.5	161	3.2	3.6	3.4
Urease with GLDH	163	3.6	3.9	3.5	161	3.2	3.6	3.4
Uric acid	155	3.5	4.7	3.6	151	3.7	5.7	3.8
Uricase	154	3.6	4.7	3.6	150	3.7	5.7	3.8

Abbreviations: OCPC, o-cresolphthalein complexone; NM-BAPTA, 5-nitro-5'-methyl-BAPTA; ISE, ion-selective electrodes; GLDH, glutamate dehydrogenase.

*Number of laboratories participated in Korean External Quality Assessment Service 2019.