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In 2020, the general chemistry proficiency testing program of the Korean Association of External Quality Assessment Service consisted of routine and urine chemistry programs including 29 and 13 test items, respectively. Creatinine among routine chemistry programs was integrated into the accuracy-based creatinine test program. The routine and the urine chemistry programs were conducted 4 times and twice a year, respectively. Statistical analyses data for the test methods and reagent companies were reported based on the information and results of the test items provided by each institution. Statistical analyses included the number of participating institutes, mean, standard deviation, coefficient of variation (CV), median, and minimum and maximum values for each group. Each report included tables, histograms, Levey-Jennings charts, and the standard deviation indices showing the statistics of each test item. More than 1,000 institutions performed the 16 test items of the routine chemistry program and the number is continuously increasing. Alkaline phosphatase and lactate dehydrogenase were found to have relatively high CVs due to differences in results among the test methods; however, the CV values for others, ranged within 10%. In the urine chemistry program, albumin showed a relatively high CV.

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

서론

대한임상검사정도관리협회 신빙도조사사업은 차세대 신빙도 조사사업으로 확장 개편되어 2021년 현재 6년째를 맞이하고 있다. 2020년에는 6개 대분류하에 69개 프로그램 단위별 운영체제로 확대되었고, 프로그램별 검사종목도 338종목으로 증가하였다 [1-4]. 임상화학 분야는 6개의 대분류 중 하나로서 일반화학검사 등 10개의 중분류 분야로 구성되어 있고, 이들은 일반화학검사와 요화학검사 등 25개의 세부 프로그램으로 나뉜다. 일반화학검사와

요화학검사 프로그램에는 각각 29종과 13종의 검사항목이 포함되어 있다. 일반화학검사 종목에서 creatinine은 정확도기반 creatinine 검사 프로그램으로 통합되었다.

2020년 대한임상검사정도관리협회의 신빙도조사사업으로 시행되었던 일반화학검사와 요화학검사에 대한 신빙도조사사업 결과를 분석하여 보고하고자 한다.

재료 및 방법

1. 대상

일반화학검사 프로그램은 연 4회에 걸쳐, 회차별로 3개의 정도관리물질이 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 2월과 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).

참여기관에서는 수령한 물질에 대해 검사 시행 후 회신 마감일 이내에 대한임상검사정도관리협회 신빙도조사사업 홈페이지(<http://eqas.keqas.org>)에 결과를 입력하였다. 협회에서는 기기 회사와 시약회사로부터 제공된 검사항목별 검사방법, 기기와 시약에 대한 데이터베이스를 지속적으로 업데이트하고 있고, 참여기관이 홈페이지상에서 해당 검사항목에 대한 검사정보 선택과 결과 입력이 가능하도록 하였다.

3. 결과 판정 및 분석

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. 공통 보고서에는 전체 참여기관에 해당하는 통계, 검사방법을 기준분류

Table 1. Control materials provided for analyses and released dates from the trials of the general chemistry programs in 2020

Trial	Material no.	Manufacturer	Product name	Lot no.	Released date
1st	CC-20-01	Bio-Rad	Lyphocheck Assayed & Unassayed Chemistry control	28821	3 February
	CC-20-02	Bio-Rad	Lyphocheck Assayed & Unassayed Chemistry control	26462	
	CC-20-03	Bio-Rad	Lyphocheck Assayed & Unassayed Chemistry control	26461	
2nd	CC-20-04	Bio-Rad	Lyphocheck Assayed & Unassayed Chemistry control	26471	6 April
	CC-20-05	Bio-Rad	Lyphocheck Assayed & Unassayed Chemistry control	28851	
	CC-20-06	Bio-Rad	Lyphocheck Assayed & Unassayed Chemistry control	28852	
3rd	CC-20-07	Bio-Rad	Lyphocheck Assayed & Unassayed Chemistry control	28872	14 September
	CC-20-08	Bio-Rad	Lyphocheck Assayed & Unassayed Chemistry control	28871	
	CC-20-09	Bio-Rad	Lyphocheck Assayed & Unassayed Chemistry control	26482	
4th	CC-20-10	Bio-Rad	Lyphocheck Assayed & Unassayed Chemistry control	28872	12 October
	CC-20-11	Bio-Rad	Lyphocheck Assayed & Unassayed Chemistry control	28871	
	CC-20-12	Bio-Rad	Lyphocheck Assayed & Unassayed Chemistry control	26482	

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

Table 2. Control materials provided for analyses and released dates from the trials of urine chemistry programs in 2020

Trial	Material no.	Manufacturer	Product name	Lot no.	Released date
1st	CUC-20-01	Bio-Rad	Lyphocheck Quantitative Urine Control	63451	24 February
	CUC-20-02	Bio-Rad	Lyphocheck Quantitative Urine Control	63452	
	CUC-20-03	Bio-Rad	Lyphocheck Quantitative Urine Control	63432	
2nd	CUC-20-04	Bio-Rad	Lyphocheck Quantitative Urine Control	63431	26 October
	CUC-20-05	Bio-Rad	Lyphocheck Quantitative Urine Control	63461	
	CUC-20-06	Bio-Rad	Lyphocheck Quantitative Urine Control	64362	

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

로 한 통계결과와 시약 회사를 세 분류로 한 통계결과를 각각 제시하였다.

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, 표준편차와

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

개별보고서는 각 검사항목별로 통계결과를 보여주는 표, 히스토그램과 레비-제닝스 차트로 구성하였다. 통계치를 제시한 표에는 각 기관의 결과값과 각 분류별로 분석된 통계결과를 제시하였

Table 3. Number of laboratories that participated in each test of the general chemistry program in 2020

Test	Trials			
	1st	2nd	3rd	4th
Alanine aminotransferase	1,721	1,732	1,744	1,750
Albumin	1,589	1,597	1,609	1,614
Alkaline phosphatase	1,521	1,526	1,534	1,539
Amylase	830	837	846	848
Aspartate aminotransferase	1,720	1,731	1,743	1,749
Bilirubin, direct	810	811	810	810
Bilirubin, total	1,600	1,606	1,616	1,618
Calcium	757	761	774	775
Chloride	1,084	1,093	1,115	1,115
Cholesterol, total	1,706	1,717	1,730	1,736
Creatine kinase	691	701	704	708
Gamma-glutamyl transferase	1,668	1,677	1,687	1,694
Glucose	1,700	1,710	1,723	1,729
High-density lipoprotein cholesterol	1,577	1,585	1,597	1,603
Iron	429	431	434	433
Lactate dehydrogenase	917	916	915	916
Lipase	437	443	454	458
Low-density lipoprotein cholesterol	945	952	965	968
Magnesium	300	303	312	312
Osmolality	163	166	170	170
Phosphorus	701	702	714	714
Potassium	1,095	1,105	1,126	1,126
Protein, total	1,571	1,579	1,592	1,595
Sodium	1,095	1,105	1,126	1,126
Total CO ₂	231	230	234	234
Total iron-binding capacity	392	394	396	397
Triglyceride	1,657	1,668	1,679	1,686
Urea nitrogen	1,647	1,659	1,673	1,678
Uric acid	1,284	1,293	1,303	1,307

고 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 차트에는 기준 분류별 최근 1년간의 SDI를 나타냈다.

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, gamma-glutamyl transferase, glucose, high-density lipoprotein cholesterol, potassium, total protein, sodium, triglyceride, urea nitrogen과 uric acid 등 16개 종목이었고, 회차를 거듭할수록 참가기관 수가 증가하였다(Table 3). 요화학검사 프로그램에서는 요 human chorionic gonadotropin 정성검사에 참여하는 기관이 가장 많았고 creatinine 검사가 뒤를 이었다(Table 4).

일반화학검사 프로그램에서 변동계수는 각 검사항목별 회차별로 상대적으로 정도관리물질의 농도가 낮을수록 높은 경향을 보였다(Table 5). 대부분 10% 이내의 변동계수를 보였지

만 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 albumin은 12.1%–27.6%로 가장 큰 변동계수를 보였다(Table 6).

변동계수는 각 기관의 상대적 정확도를 나타내는 지표인 SDI 산출에 영향을 준다. 변동계수가 큰 경우 SDI는 상대적으로 작아질 수 있으므로 결과 해석 시 유의하여야 한다.

한 가지 검사방법이 전체의 80%를 넘는 검사로는, ALT의 LDH without pyridoxal-5-phosphate (P5P)법, albumin의 Dye binding BCG (bromocresol green)법, 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).

요화학검사에서 albumin의 측정법으로는 immuno-turbidimetry법이 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.

2020년 일반화학검사 프로그램과 요화학검사 프로그램의 신빙도조사 결과에 대해 보다 자세한 통계분석 결과는 대한임상검사정도관리협회 신빙도조사사업 홈페이지(<http://eqas.keqas.org>)에서 조회가 가능하다.

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Table 4. Number of laboratories that participated in each test of the urine chemistry program in 2020

Test	Trials	
	1st	2nd
Albumin	193	192
Calcium	165	165
Chloride	192	195
Creatinine	228	229
Glucose	143	143
Magnesium	112	111
Phosphorus	144	144
Potassium	194	197
Protein	196	197
Sodium	197	199
Urea nitrogen	166	166
Uric acid	153	152
Urine human chorionic gonadotropin (qualitative)	258	260

Table 5. Peer-group coefficients of variation (%) according to the test and trials of general chemistry programs in 2020

Test	Trials																		
	CC-20-01	CC-20-02	CC-20-03	CC-20-04	CC-20-05	CC-20-06	CC-20-07	CC-20-08	CC-20-09	CC-20-10	CC-20-11	CC-20-12							
Alanine transaminase	6.4	5.6	7.0	5.7	7.2	7.1	6.1	7.4	6.3	6.2	7.2	5.7							
Albumin	5.1	5.6	5.1	5.1	5.2	5.0	5.2	5.1	5.5	5.8	5.1	5.3							
Alkaline phosphatase	42.9	34.0	41.7	33.7	41.6	41.4	34.4	43.3	32.7	32.8	40.0	34.0							
Amylase	12.7	18.3	12.7	19.3	12.6	12.5	18.7	12.6	18.8	19.4	12.6	18.7							
Aspartate aminotransferase	5.8	4.5	5.9	5.0	6.1	6.0	4.9	6.2	5.0	5.0	5.9	5.1							
Bilirubin, direct	19.6	14.7	17.7	11.7	19.7	19.6	16.6	18.5	10.5	10.3	18.7	16.9							
Bilirubin, total	10.5	6.0	11.0	6.3	11.9	11.6	5.9	9.6	6.4	5.3	11.3	5.8							
Calcium	3.9	2.7	4.0	2.4	3.5	3.7	2.5	3.9	2.5	2.5	4.1	2.4							
Chloride	2.5	2.6	2.2	2.7	2.6	2.5	2.5	2.2	2.8	2.9	3.0	2.8							
Cholesterol, total	2.8	4.3	2.8	4.0	2.7	2.8	4.2	2.7	4.2	4.3	2.6	4.3							
Creatine kinase	3.2	4.4	3.1	4.4	3.2	3.4	4.4	3.6	4.3	4.5	3.1	4.2							
Gamma-glutamyl transferase	7.3	7.2	7.3	6.9	6.7	7.0	6.6	6.6	6.7	6.7	6.8	6.3							
Glucose	3.6	3.1	3.6	2.9	3.6	3.5	2.9	3.6	3.0	2.9	3.5	2.8							
High-density lipoprotein cholesterol	10.3	11.7	12.3	12.5	14.9	14.0	12.2	14.2	12.0	20.1	15.3	12.1							
Iron	2.9	3.2	2.9	3.7	3.3	3.1	3.3	3.0	3.4	3.2	2.8	3.3							
Lactate dehydrogenase	38.1	42.0	38.1	42.7	37.3	37.4	43.8	39.2	43.9	44.7	37.6	43.5							
Lipase	11.6	25.5	13.0	29.7	12.1	11.7	17.2	9.3	16.5	19.8	11.2	18.1							
Low-density lipoprotein cholesterol	5.5	5.0	6.5	5.6	7.7	7.5	5.9	8.7	5.5	6.5	7.7	6.1							
Magnesium	3.7	3.0	3.8	2.1	3.7	3.6	2.0	3.6	2.9	2.0	3.3	1.9							
Osmolality	1.4	1.1	1.2	1.3	1.3	1.1	1.0	1.2	0.9	1.1	1.1	0.9							
Phosphorus	3.6	3.0	2.6	2.5	3.4	2.5	2.4	2.4	2.7	2.4	3.5	2.4							
Potassium	2.0	2.2	2.0	2.2	2.0	2.0	1.6	2.0	1.5	2.2	0.0	1.5							
Protein, total	3.3	3.7	3.3	3.9	3.2	3.2	3.5	3.2	3.5	3.5	3.2	3.5							
Sodium	1.4	1.3	1.6	1.3	1.3	1.5	1.4	1.4	1.3	1.3	1.5	1.3							
Total CO ₂	7.0	6.0	7.0	6.0	6.6	6.7	6.2	7.1	6.0	5.8	7.2	6.1							
Total iron-binding capacity	3.2	3.1	3.4	3.0	3.5	3.4	3.3	3.4	3.3	3.7	3.4	3.0							
Triglyceride	3.7	5.3	3.8	5.0	3.7	3.5	5.6	3.3	5.1	5.0	3.5	5.3							
Urea nitrogen	4.9	4.1	4.8	4.0	4.8	4.6	4.3	5.2	4.4	4.2	5.0	4.1							
Uric acid	3.4	3.5	3.3	3.5	3.5	3.4	3.1	3.3	3.1	4.0	3.3	3.2							

Table 6. Peer-group coefficients of variation (%) according to the test and trials of urine chemistry programs in 2020

Test	Trials					
	CUC-20-01	CUC-20-02	CUC-20-03	CUC-20-04	CUC-20-05	CUC-20-06
Albumin	12.9	12.1	27.6	22.2	13.9	21.6
Calcium	2.6	2.9	4.4	5.0	2.6	3.6
Chloride	2.2	2.5	7.6	7.4	2.4	6.4
Creatinine	5.8	5.5	6.3	4.3	4.3	4.7
Glucose	2.8	2.8	2.8	3.2	2.0	2.6
Magnesium	3.1	3.2	3.6	3.5	3.1	3.6
Phosphorus	1.9	2.6	2.8	2.4	2.4	2.3
Potassium	2.7	2.8	1.7	1.6	3.0	1.5
Protein	8.2	7.9	6.8	6.6	7.5	6.6
Sodium	1.3	1.3	2.6	3.5	1.2	3.0
Urea nitrogen	3.6	3.3	3.9	2.9	2.9	2.7
Uric acid	3.7	3.9	4.9	4.7	3.2	4.8

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Table 7. Distribution of analytical methods (principle) used and coefficients of variation (%) according to the principle of general chemistry programs in 2020

Test/method	Trials															
	1st				2nd				3rd				4th			
	Lab*	CC- 20-01	CC- 20-02	CC- 20-03	Lab	CC- 20-04	CC- 20-05	CC- 20-06	Lab	CC- 20-07	CC- 20-08	CC- 20-09	Lab	CC- 20-10	CC- 20-11	CC- 20-12
Alanine aminotransferase	1,721	6.4	5.6	7.0	1,732	5.7	7.2	7.1	1,744	6.1	7.4	6.3	1,750	6.2	7.2	5.7
Dry chemistry	8	4.0	1.4	6.8	8	8.9	8.3	7.8	9	6.1	3.9	6.0	9	2.2	2.8	3.1
LDH with P5P	24	16.0	10.4	15.9	26	12.4	17.4	16.0	25	7.3	13.2	7.8	26	8.5	21.7	7.6
LDH without P5P	1,671	6.3	5.6	6.8	1,679	5.7	7.0	7.0	1,691	6.1	7.3	6.2	1,695	6.2	7.2	5.7
Other method	18	8.6	6.6	9.0	19	7.9	11.2	10.9	19	6.4	8.9	8.7	20	9.8	9.3	9.4
Albumin	1,589	5.1	5.6	5.1	1,597	5.1	5.2	5.0	1,609	5.2	5.1	5.5	1,614	5.8	5.1	5.3
Dye binding-BCG	1,567	5.1	5.6	5.1	1,575	5.0	5.2	5.0	1,582	5.2	5.1	5.5	1,586	5.8	5.1	5.2
Dye binding-BCP	9	3.9	5.5	5.9	8	6.0	3.6	14.0	7	6.0	4.1	5.3	7	3.3	4.8	5.6
Other method	13	4.0	3.2	5.4	14	3.2	5.0	5.2	20	4.4	1.8	3.2	21	2.9	3.7	5.3
Alkaline phosphatase	1,521	42.9	34.0	41.7	1,526	33.7	41.6	41.4	1,534	34.4	43.3	32.7	1,539	32.8	40.0	34.0
Other method	12	33.6	24.4	32.2	13	16.4	20.2	18.9	16	25.2	35.9	24.1	18	14.0	16.8	19.0
PNPP, AMP buffer	892	14.2	16.4	14.3	886	16.0	13.9	13.8	899	15.0	12.7	15.5	903	15.0	12.6	14.3
PNPP, DEA buffer	174	9.7	9.0	9.4	178	8.5	8.9	9.5	169	8.3	8.4	9.0	171	9.8	9.1	8.9
PNPP, EAE buffer	443	5.3	4.3	5.7	449	4.6	4.8	4.4	450	4.0	6.8	3.9	447	4.4	5.2	4.2
Amylase	830	12.7	18.3	12.7	837	19.3	12.6	12.5	846	18.7	12.6	18.8	848	19.4	12.6	18.7
Dry chemistry	9	3.4	3.1	3.1	8	2.3	7.9	14.8	8	4.8	14.0	3.5	8	3.7	10.3	3.9
Hydrolysis of 2-chloro-4-nitrophenyl-azido-deoxy-maltopentaoside	4	3.1	58.2	2.3	5	1.2	2.1	0.6	4	1.4	2.2	0.9	4	1.1	1.0	0.7
Hydrolysis of 2-chloro-4-nitrophenyl-galactopyranosylmaltoside	125	2.0	1.5	2.0	131	1.6	2.4	2.1	137	1.7	1.7	1.4	136	1.4	2.1	1.5
Hydrolysis of 2-chloro-4-nitrophenyl-α-D-maltotrioside	218	3.1	3.1	3.1	216	3.1	3.4	3.3	214	2.8	3.5	2.2	216	3.0	3.4	2.4
Hydrolysis of 4,6-ethylidene-4-nitrophenyl-maltoheptaose	369	5.2	5.0	4.0	369	4.2	5.4	5.4	363	4.1	2.8	3.9	363	4.3	3.8	4.3

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Table 7. Continued

Test/method	Trials															
	1st				2nd				3rd				4th			
	Lab*	CC-20-01	CC-20-02	CC-20-03	Lab	CC-20-04	CC-20-05	CC-20-06	Lab	CC-20-07	CC-20-08	CC-20-09	Lab	CC-20-10	CC-20-11	CC-20-12
Hydrolysis of 4-nitrophenylbenzyl- α -maltopentaose	103	11.3	19.6	10.9	104	19.6	10.4	10.1	115	19.7	11.1	19.7	115	20.2	11.8	19.7
Other method	2	17.6	14.2	17.0	4	20.8	10.3	12.0	5	17.4	5.5	19.3	6	13.8	5.4	14.9
Aspartate aminotransferase	1,720	5.8	4.5	5.9	1,731	5.0	6.1	6.0	1,743	4.9	6.2	5.0	1,749	5.0	5.9	5.1
Dry chemistry	8	5.4	4.4	4.5	8	3.5	7.3	8.1	9	6.0	5.2	7.4	9	4.0	4.5	2.1
MDH with P5P	19	6.9	4.0	5.4	21	3.1	9.4	9.2	20	4.4	4.7	4.5	21	6.2	5.9	5.3
MDH without P5P	1,675	5.8	4.5	5.9	1,683	4.9	6.0	5.9	1,695	4.9	6.1	5.0	1,699	5.0	5.9	5.1
Other method	18	4.2	7.5	7.9	19	8.8	9.4	9.0	19	5.4	6.2	5.1	20	6.6	6.2	5.8
Bilirubin, direct	810	19.6	14.7	17.7	811	11.7	19.7	19.6	810	16.6	18.5	10.5	810	10.3	18.7	16.9
Copper ion oxidation	45	12.7	12.0	13.8	44	12.9	11.9	12.6	41	12.9	14.5	12.3	42	13.5	14.8	13.2
Diazonium salt with blank	343	21.8	4.5	18.2	341	6.2	21.7	21.3	346	5.0	20.4	6.8	351	9.6	18.0	6.1
Diazo-sulfanilic acid with blank	44	36.8	26.9	40.7	43	29.0	40.2	36.6	42	28.1	37.1	35.1	38	30.8	36.5	35.6
Diazo-sulfanilic acid without blank	22	25.2	26.4	24.4	26	34.3	36.7	25.5	25	18.2	28.8	22.0	25	11.2	22.5	14.8
Enzymatic oxidation	4	19.3	24.0	20.1	4	17.2	18.4	18.4	4	18.9	12.7	18.9	4	16.0	19.2	17.8
Other method	7	9.4	15.2	2.3	6	14.6	2.4	9.4	7	38.0	19.8	32.0	7	25.6	13.6	39.2
Vanadate oxidation	345	10.4	12.9	6.5	347	11.5	5.7	2.4	345	12.1	13.0	11.1	343	6.1	7.2	13.9
Bilirubin, total	1,600	10.5	6.0	11.0	1,606	6.3	11.9	11.6	1,616	5.9	9.6	6.4	1,618	5.3	11.3	5.8
Copper ion oxidation	97	8.7	6.6	8.0	100	6.4	8.3	8.3	101	6.5	8.6	5.6	101	5.8	8.1	6.1
Diazo-caffeine, sodium benzoate with blank	6	14.8	4.4	13.2	6	5.4	2.5	3.0	5	3.1	5.3	4.0	5	10.3	8.1	9.9
Diazo-dimethyl sulfoxide with blank	145	9.0	6.8	10.4	145	7.7	9.0	9.0	139	6.8	8.2	6.3	141	5.9	8.3	5.4
Diazo-dimethyl sulfoxide without blank	105	12.2	6.2	12.5	108	6.3	11.5	11.1	110	6.6	10.5	6.1	108	6.0	11.6	5.6
Diazo-dyphylline with blank	7	13.1	5.0	11.3	7	3.4	9.8	8.9	7	2.3	6.1	7.2	7	6.6	8.8	7.6
Diazonium salt-dyphylline without blank	6	7.8	12.4	17.1	6	12.8	37.8	33.8	8	14.3	9.8	7.1	7	3.2	5.6	15.1

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Table 7. Continued

Test/method	Trials															
	1st				2nd				3rd				4th			
	Lab*	CC-20-01	CC-20-02	CC-20-03	Lab	CC-20-04	CC-20-05	CC-20-06	Lab	CC-20-07	CC-20-08	CC-20-09	Lab	CC-20-10	CC-20-11	CC-20-12
Diazonium salt-surfactant with blank	516	10.8	6.0	11.1	511	6.7	12.0	11.8	512	6.5	11.7	6.4	518	5.0	12.0	6.4
Diazonium salt-surfactant without blank	33	12.3	7.9	8.0	31	7.6	10.4	10.6	34	9.1	9.9	10.3	34	9.8	10.0	7.7
Enzymatic oxidation	17	7.5	4.0	13.5	17	5.6	6.1	7.5	17	2.8	7.9	3.9	17	7.8	13.2	8.3
Other method	28	8.8	7.2	12.0	29	5.4	15.1	13.5	29	5.7	7.9	5.3	30	6.0	11.8	6.7
Vanadate oxidation	640	2.5	3.1	6.7	646	3.5	6.8	6.6	654	2.9	1.9	3.4	650	2.5	5.3	2.9
Calcium	757	3.9	2.7	4.0	761	2.4	3.5	3.7	774	2.5	3.9	2.5	775	2.5	4.1	2.4
Colorimetry arsenazo III	169	2.7	3.2	3.1	174	3.0	3.0	3.0	171	2.6	2.6	2.6	169	3.0	3.1	2.7
Colorimetry_methylxlenol blue	48	1.8	1.5	1.8	53	1.3	1.9	1.0	57	1.7	1.6	1.6	59	1.7	0.9	1.4
Colorimetry_OCPC	389	3.7	3.1	3.7	380	2.5	2.6	3.1	380	2.7	3.4	2.6	379	2.1	2.8	2.1
NM-BAPTA	146	1.7	1.3	1.0	148	1.3	1.6	1.5	157	1.7	2.0	1.6	159	1.4	0.9	1.3
Other method	4	3.8	4.4	3.6	5	0.0	2.8	2.1	8	0.9	2.0	1.7	8	4.4	3.1	5.0
Chloride	1,084	2.5	2.6	2.2	1,093	2.7	2.6	2.5	1,115	2.5	2.2	2.8	1,115	2.9	3.0	2.8
ISE, diluted	594	2.4	2.0	2.2	601	2.2	2.3	2.5	617	1.8	2.3	1.8	617	2.0	3.0	1.8
ISE, undiluted	473	1.8	2.6	2.2	476	2.0	2.1	2.1	489	2.1	2.0	2.4	491	2.0	2.2	2.6
Other method	17	4.9	5.3	4.7	16	4.5	3.1	3.3	9	0.9	2.1	2.6	7	2.6	2.7	4.8
Cholesterol, total	1,706	2.8	4.3	2.8	1,717	4.0	2.7	2.8	1,730	4.2	2.7	4.2	1,736	4.3	2.6	4.3
Cholesterol esterase	1,688	2.8	4.3	2.8	1,699	4.0	2.7	2.8	1,712	4.2	2.7	4.2	1,717	4.2	2.6	4.3
Other method	18	4.5	3.0	4.9	18	4.3	3.9	3.8	18	4.0	3.5	4.8	19	3.7	3.9	5.3
Creatine kinase	691	3.2	4.4	3.1	701	4.4	3.2	3.4	704	4.4	3.6	4.3	708	4.5	3.1	4.2
Creatine phosphate to creatine	231	3.1	2.6	3.0	242	2.3	2.7	3.4	246	2.4	3.3	2.5	254	2.1	3.0	2.2
Creatine phosphate to creatine with activator	450	3.2	5.1	3.2	447	5.3	3.3	3.4	448	5.2	3.5	5.1	444	5.5	3.1	5.0
Dry chemistry	5	7.5	5.1	7.9	5	3.8	3.7	4.3	5	10.2	12.0	4.3	5	4.7	6.1	4.0
Other method	5	6.6	4.3	4.9	6	3.5	3.3	2.0	5	5.7	1.1	4.2	5	8.0	6.3	0.3

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Table 7. Continued

Test/method	Trials															
	1st				2nd				3rd				4th			
	Lab*	CC- 20-01	CC- 20-02	CC- 20-03	Lab	CC- 20-04	CC- 20-05	CC- 20-06	Lab	CC- 20-07	CC- 20-08	CC- 20-09	Lab	CC- 20-10	CC- 20-11	CC- 20-12
Gamma-glutamyl transpeptidase	1,668	7.3	7.2	7.3	1,677	6.9	6.7	7.0	1,687	6.6	6.6	6.7	1,694	6.7	6.8	6.3
Gamma-glutamyl-carboxy- nitroanilide	1,620	7.2	7.2	7.3	1,628	6.9	6.6	7.0	1,637	6.6	6.5	6.4	1,643	6.7	6.7	6.3
Gamma-glutamyl-p- nitroanilide	24	10.5	8.3	8.8	25	6.6	6.9	9.5	24	6.6	7.0	7.2	24	5.8	8.7	5.6
G-glutamyl-p-nitroanilide (dry chemistry)	7	9.6	1.4	6.3	7	6.8	4.5	6.6	8	2.5	3.9	2.4	8	3.0	6.0	2.5
Other method	17	4.2	5.2	6.6	17	5.2	5.1	6.5	18	7.8	10.1	8.6	19	10.2	11.4	10.4
Glucose	1,700	3.6	3.1	3.6	1,710	2.9	3.6	3.5	1,723	2.9	3.6	3.0	1,729	2.9	3.5	2.8
Glucose oxidase	458	4.1	3.6	3.7	464	3.2	3.7	3.5	459	3.0	3.0	3.3	458	2.9	3.6	2.9
Hexokinase	1,225	3.2	2.8	3.3	1,229	2.8	3.3	3.0	1,245	2.9	3.4	2.9	1,252	2.8	3.2	2.8
Other method	17	3.8	3.1	2.5	17	5.2	5.3	4.7	19	2.5	5.0	3.1	19	3.4	5.8	2.9
High-density lipoprotein cholesterol	1,577	10.3	11.7	12.3	1,585	12.5	14.9	14.0	1,597	12.2	14.2	12.0	1,603	20.1	15.3	12.1
Enzymatic with detergent	694	9.2	10.7	9.9	705	11.0	9.5	8.5	713	10.6	7.9	8.7	717	7.5	7.8	10.4
Enzymatic with immunoinhibition	230	3.9	5.1	4.4	226	3.7	4.2	3.9	224	5.0	5.1	4.7	226	6.0	4.4	5.4
Enzymatic with others	205	11.9	13.2	11.8	201	13.1	12.2	11.9	212	14.1	15.9	12.6	213	20.9	14.3	13.6
Enzymatic with polyanion precipitation	180	9.8	11.3	9.8	182	16.1	8.5	7.2	164	13.8	8.1	14.2	160	8.8	8.7	15.0
Enzymatic with polyethylene glycol	254	2.4	2.8	3.5	257	3.2	2.5	2.5	264	3.1	2.8	3.6	265	4.7	3.3	3.0
Other method	13	10.8	10.3	11.8	13	10.2	6.4	8.9	15	13.2	7.8	12.8	16	9.3	9.1	11.1
Iron	429	2.9	3.2	2.9	431	3.7	3.3	3.1	434	3.3	3.0	3.4	433	3.2	2.8	3.3
Bathophenanthroline without deproteinization	126	1.4	2.3	1.5	126	2.8	1.4	1.3	126	2.5	1.6	2.4	126	2.2	1.5	2.4
Ferrozine without deproteinization	161	1.5	2.6	1.6	158	2.9	1.9	1.7	157	2.4	1.4	2.5	157	2.6	1.7	2.4
Nitroso-PSAP without deproteinization	52	1.5	2.1	2.0	56	2.3	1.5	2.0	58	1.3	1.6	2.4	57	2.3	1.4	1.4

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Table 7. Continued

Test/method	Trials															
	1st				2nd				3rd				4th			
	Lab*	CC- 20-01	CC- 20-02	CC- 20-03	Lab	CC- 20-04	CC- 20-05	CC- 20-06	Lab	CC- 20-07	CC- 20-08	CC- 20-09	Lab	CC- 20-10	CC- 20-11	CC- 20-12
Pyridyl AZO Dye ascorbate without deproteinization	3	4.9	12.2	5.4	3	4.0	4.7	2.5	3	10.3	2.8	6.8	3	6.8	3.2	1.8
Tripyridyltriazine without deproteinization	85	1.5	2.5	1.4	86	2.6	1.4	1.4	88	1.3	1.2	2.6	88	2.4	1.3	2.5
Lactate dehydrogenase	917	38.1	42.0	38.1	916	42.7	37.3	37.4	915	43.8	39.2	43.9	916	44.7	37.6	43.5
Lactate to pyruvate	537	4.6	4.9	4.8	541	5.0	4.9	4.6	586	4.9	4.7	4.9	591	4.7	4.5	4.6
Pyruvate to lactate	374	6.7	6.6	6.5	368	6.8	6.9	6.9	321	7.3	8.0	7.3	317	7.0	8.1	7.2
Pyruvate to lactate (dry chemistry)	6	2.9	0.7	5.3	6	2.9	2.1	3.2	6	4.1	2.1	4.8	6	2.9	7.9	3.2
Lipase	437	11.6	25.5	13.0	443	29.7	12.1	11.7	454	17.2	9.3	16.5	458	19.8	11.2	18.1
Hydrolysis of 1,2-diglyceride with Quinone Dye	87	2.1	2.5	4.7	88	2.4	3.9	3.8	90	2.4	4.6	2.7	88	2.3	3.8	1.9
Hydrolysis of 1,2-O-dilauryl-rac-glycero-3-glutaric acid-(6'-methylresorufin) ester	339	11.7	29.3	14.0	346	33.8	12.8	12.6	356	20.5	8.1	19.8	362	21.9	9.6	20.3
Hydrolysis of 1-oleoyl-2,3-diacylglycerol	9	2.0	0.0	2.4	8	1.7	2.3	2.6	8	0.0	3.9	1.8	8	0.0	2.6	0.0
Low-density lipoprotein cholesterol	945	5.5	5.0	6.5	952	5.6	7.7	7.5	965	5.9	8.7	5.5	968	6.5	7.7	6.1
Enzymatic with detergent	718	4.7	4.8	5.9	727	4.9	7.3	7.4	727	5.1	8.9	5.0	731	5.2	6.8	5.1
Enzymatic with others	193	8.1	8.9	8.2	190	8.0	7.4	7.0	206	7.7	7.3	8.3	204	10.4	8.4	8.1
Enzymatic with polyethylene glycol	28	8.4	8.3	10.3	28	5.4	9.9	9.6	25	8.0	8.0	6.8	25	13.8	7.7	8.6
Other method	6	9.8	9.9	9.5	7	11.9	14.3	16.7	7	6.6	7.1	4.3	8	11.5	7.4	9.0
Magnesium	300	3.7	3.0	3.8	303	2.1	3.7	3.6	312	2.0	3.6	2.9	312	2.0	3.3	1.9
Colorimetry_Xylidyl blue	297	3.7	3.0	3.8	301	2.1	3.7	3.6	311	2.0	3.6	2.9	311	2.0	3.3	1.9
Osmolality	163	1.4	1.1	1.2	166	1.3	1.3	1.1	170	1.0	1.2	0.9	170	1.1	1.1	0.9
Freezing point depression osmometer	155	1.2	1.1	1.2	160	1.2	1.3	1.1	163	0.9	1.2	1.0	165	1.1	1.1	0.8
Other method	8	1.8	1.7	1.9	6	2.0	1.0	0.5	7	24.1	28.2	24.3	5	1.9	3.3	2.0

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Table 7. Continued

Test/method	Trials															
	1st				2nd				3rd				4th			
	Lab*	CC- 20-01	CC- 20-02	CC- 20-03	Lab	CC- 20-04	CC- 20-05	CC- 20-06	Lab	CC- 20-07	CC- 20-08	CC- 20-09	Lab	CC- 20-10	CC- 20-11	CC- 20-12
Phosphorus	701	3.6	3.0	2.6	702	2.5	3.4	2.5	714	2.4	2.4	2.7	714	2.4	3.5	2.4
Molybden blue colorimetry	173	2.3	2.1	2.5	178	1.7	2.1	2.2	185	2.0	2.2	1.8	186	1.9	2.1	1.8
Phosphomolybdate	525	3.8	2.5	2.6	521	2.9	2.5	3.5	527	2.8	3.4	2.4	526	2.9	3.7	2.9
Potassium	1,095	2.0	2.2	2.0	1,105	2.2	2.0	2.0	1,126	1.6	2.0	1.5	1,126	2.2	0.0	1.5
ISE, diluted	596	1.8	1.9	1.7	603	1.5	1.8	1.8	619	1.8	1.8	1.4	619	1.4	1.7	1.7
ISE, undiluted	482	2.1	2.4	2.0	486	1.5	2.1	2.1	498	2.2	2.0	2.2	500	2.2	2.1	2.1
Other method	17	0.0	4.0	2.4	16	3.0	2.2	3.5	9	2.7	0.0	3.6	7	4.3	2.5	4.0
Protein, total	1,571	3.3	3.7	3.3	1,579	3.9	3.2	3.2	1,592	3.5	3.2	3.5	1,595	3.5	3.2	3.5
Biuret method	1,556	3.3	3.7	3.3	1,565	3.9	3.2	3.2	1,575	3.5	3.2	3.5	1,577	3.5	3.2	2.3
Other method	15	6.1	6.7	6.0	14	5.2	4.1	6.1	17	2.3	5.5	5.2	18	5.1	4.1	5.3
Sodium	1,095	1.4	1.3	1.6	1,105	1.3	1.3	1.5	1,126	1.4	1.4	1.3	1,126	1.3	1.5	1.3
ISE, diluted	574	1.1	1.1	1.2	584	1.2	1.0	1.1	600	1.2	1.2	1.2	600	1.2	1.1	1.1
ISE, undiluted	504	1.5	1.7	1.6	505	1.5	1.3	1.4	517	1.5	1.4	1.6	519	1.4	1.5	1.4
Other method	17	1.4	1.4	2.2	16	1.7	1.2	1.5	9	1.4	1.7	2.2	7	0.9	2.1	1.1
Total CO ₂	231	7.0	6.0	7.0	230	6.0	6.6	6.7	234	6.2	7.1	6.0	234	5.8	7.2	6.1
Phosphoenolpyruvate carboxylase	228	6.9	6.0	6.7	228	6.0	6.6	6.6	232	6.2	7.1	5.9	232	5.8	7.2	6.0
Total iron-binding capacity	392	3.2	3.1	3.4	394	3.0	3.5	3.4	396	3.3	3.4	3.3	397	3.7	3.4	3.0
Bathophenanthroline	114	2.0	2.5	1.9	114	2.2	1.7	1.3	114	2.6	1.8	2.5	114	2.6	1.6	2.4
Chromazural B	26	4.8	3.7	4.3	25	2.9	5.7	5.6	23	2.6	3.5	2.9	23	3.6	3.0	3.3
Ferrozine	122	2.8	3.6	2.5	121	3.0	2.4	2.6	122	3.8	2.5	3.8	122	4.0	2.5	3.1
Nitroso-PSAP	128	2.9	2.7	3.1	132	3.1	3.3	3.3	135	2.6	3.3	2.6	136	2.5	3.2	2.7
Triglyceride	1,657	3.7	5.3	3.8	1,668	5.0	3.7	3.5	1,679	5.6	3.3	5.1	1,686	5.0	3.5	5.3
Enzymatic with free glycerol elimination	556	3.0	3.2	3.1	562	2.7	2.8	2.9	561	2.7	2.8	2.5	563	2.8	2.8	3.2
Enzymatic without free glycerol elimination	1,085	4.4	6.1	4.0	1,090	5.6	4.2	3.9	1,100	6.4	4.0	5.9	1,104	6.0	4.0	6.0
Other method	16	6.3	7.5	6.2	16	6.4	4.2	5.0	18	5.2	5.1	4.9	18	6.6	5.8	6.5

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Table 7. Continued

Test/method	Trials															
	1st				2nd				3rd				4th			
	Lab*	CC- 20-01	CC- 20-02	CC- 20-03	Lab	CC- 20-04	CC- 20-05	CC- 20-06	Lab	CC- 20-07	CC- 20-08	CC- 20-09	Lab	CC- 20-10	CC- 20-11	CC- 20-12
Urea nitrogen	1,647	4.9	4.1	4.8	1,659	4.0	4.8	4.6	1,673	4.3	5.2	4.4	1,678	4.2	5.0	4.1
Other method	17	5.0	6.4	6.2	17	8.1	8.7	5.6	19	6.5	6.9	6.4	20	8.3	9.3	8.2
Urease with colorimetry	16	3.9	7.2	3.4	16	7.0	4.0	3.4	17	6.3	4.3	6.6	17	6.9	4.6	4.4
Urease with GLDH	1,612	4.9	4.0	4.9	1,625	4.0	4.7	4.6	1,636	4.1	5.0	4.2	1,640	4.2	5.0	3.9
Uric acid	1,284	3.4	3.5	3.3	1,293	3.5	3.5	3.4	1,303	3.1	3.3	3.1	1,307	4.0	3.3	3.2
Other method	9	7.0	1.8	2.5	10	5.3	5.1	1.1	11	6.2	6.6	7.1	11	8.2	6.3	9.0
Uricase	1,269	3.3	3.5	3.3	1,277	3.4	3.4	3.4	1,286	3.1	3.2	3.1	1,290	3.9	3.3	3.1
Uricase (dry chemistry)	6	2.0	2.1	2.3	6	2.5	1.9	2.3	6	0.7	2.7	1.0	6	0.6	0.0	0.0

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-sulfopropylamino)-phenol; GLDH, glutamate dehydrogenase.

*Number of laboratories participated in Korean External Quality Assessment Service 2020.

Table 8. Distribution of analytical methods (principle) used and coefficients of variation (%) according to the principle of urine chemistry programs in 2020

Test/method	Trials							
	1st				2nd			
Lab*	CUC-20-01	CUC-20-02	CUC-20-03	Lab	CUC-20-04	CUC-20-05	CUC-20-06	
Albumin	193	12.9	12.1	27.6	192	22.2	13.9	21.6
Dye binding-BCG	3	20.3	17.7	51.3	2	13.7	5.9	10.1
Immunoturbidimetry	183	12.5	11.6	26.5	187	22.0	13.8	19.5
Calcium	165	2.6	2.9	4.4	165	5.0	2.6	3.6
Colorimetry_arsenazo III	29	4.0	4.3	4.4	24	3.1	2.7	1.5
Colorimetry_methylxlenol blue	13	0.6	1.6	2.5	18	6.1	2.4	3.8
Colorimetry_OCPC	64	3.3	3.4	5.6	62	4.8	2.5	3.7
NM-BAPTA	57	1.8	1.8	2.1	61	2.7	2.0	2.5
Chloride	192	2.2	2.5	7.6	195	7.4	2.4	6.4
ISE, diluted	188	2.2	2.5	7.5	190	7.4	2.4	6.3
ISE, undiluted	2	8.7	12.2	20.8	3	9.4	11.4	1.3
Creatinine	228	5.8	5.5	6.3	229	4.3	4.3	4.7
Enzymatic method	11	5.9	5.7	5.1	15	3.6	3.9	3.2
Kinetic Jaffe with compensation	4	5.0	4.5	3.7	4	3.2	2.6	3.7
Kinetic Jaffe without compensation	188	5.4	5.2	5.8	188	4.1	3.9	4.5
Rate blanked compensated kinetic Jaffe method	24	5.6	4.7	5.3	21	2.4	2.3	2.7
Glucose	143	2.8	2.8	2.8	143	3.2	2.0	2.6
Hexokinase	143	2.8	2.8	2.8	143	3.2	2.0	2.6
Magnesium	112	3.1	3.2	3.6	111	3.5	3.1	3.6
Colorimetry_Xylidyl blue	112	3.1	3.2	3.6	111	3.5	3.1	3.6
Phosphorus	144	1.9	2.6	2.8	144	2.4	2.4	2.3
Molybden blue colorimetry	15	2.2	2.5	2.3	18	1.4	1.0	1.4
Phosphomolybdate	129	2.0	2.6	2.9	126	2.6	2.3	2.6
Potassium	194	2.7	2.8	1.7	197	1.6	3.0	1.5
ISE, diluted	190	2.7	2.8	1.7	192	1.6	3.0	1.5
ISE, undiluted	2	8.5	10.4	2.4	3	7.0	3.1	4.6

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Table 8. Continued

Test/method	Trials									
	1st					2nd				
	Lab*	CUC-20-01	CUC-20-02	CUC-20-03	Lab	CUC-20-04	CUC-20-05	CUC-20-06		
Protein	196	8.2	7.9	6.8	197	6.6	7.5	6.6		
Biuret method	5	3.8	7.6	5.5	7	3.4	1.2	2.3		
Dye binding using pyrogallol red	114	7.4	7.6	7.1	112	6.0	6.1	7.6		
Turbidimetry using benzethonium chloride	76	3.0	3.6	5.9	78	4.8	2.9	4.5		
Sodium	197	1.3	1.3	2.6	199	3.5	1.2	3.0		
ISE, diluted	192	1.3	1.3	2.5	194	3.5	1.2	2.9		
ISE, undiluted	3	4.1	4.6	13.0	3	5.2	2.3	4.4		
Urea nitrogen	166	3.6	3.3	3.9	166	2.9	2.9	2.7		
Urease with GLDH	166	3.6	3.3	3.9	166	2.9	2.9	2.7		
Uric acid	153	3.7	3.9	4.9	152	4.7	3.2	4.8		
Uricase	153	3.7	3.9	4.9	152	4.7	3.2	4.8		

Abbreviations: BCG, bromocresol green; 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 2020.