Supporting Information

Substantial increase of capillary electrophoretic throughput by separation-interrupted sequential injection

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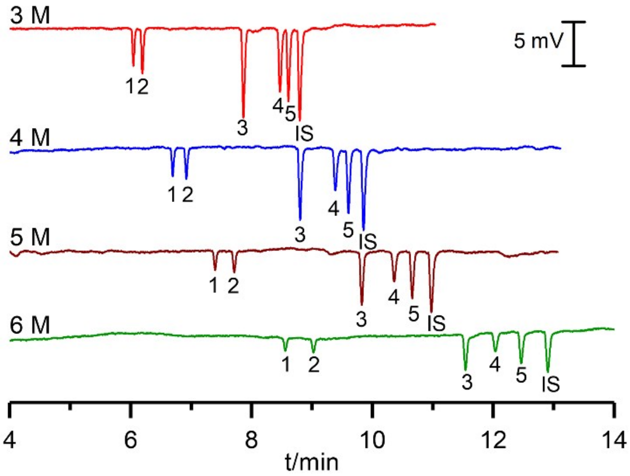

Figure S1 Influence of acetic acid buffer concentration on CE resolution of standard cation solutions (NH_4^+, K^+, Ca^{2+}, Na^+, Mg^{2+} at 100 μM each) measured at room temperature and 18 kV applied across a capillary of 50 μm i.d. × 60 cm / 70 cm (effective/total). Injection was achieved by siphon at a height of 10 cm for 15 s, and peaks were detected by contactless capacitively-coupled conductivity detector (C^4D).

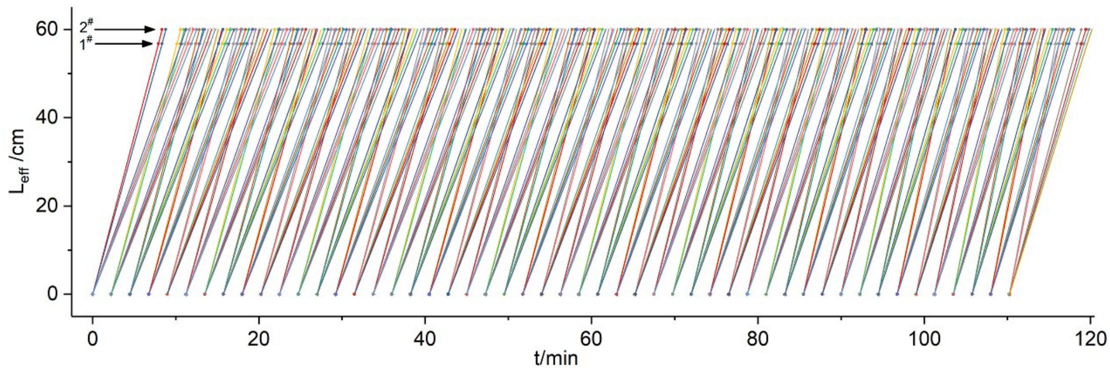

Figure S2 Plots of effective length against peak time in Sisi-CE-C^4D/C^4D of 50 injections of the standard cation solutions in only a single run using a capillary of 50 μm i.d. × 60/70 cm (effective/total) applied with +18 kV via siphon-injection at 10 cm height for 15 s plus 147 s t_{non}.

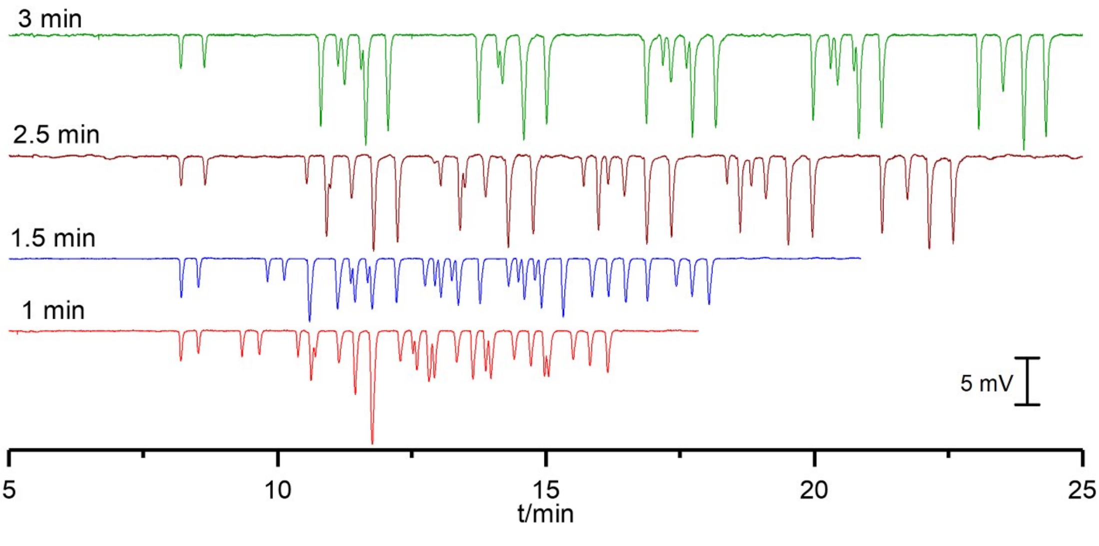

Figure S3 Influence of injection frequency (f^{-1} = 1 min, 1.5 min, 2.5 min and 3 min) on the resolution of Sisi-CE-C^{4}D tested with a standard sample composed of NH_4^+, K^+, Ca^{2+}, Na^+, Mg^{2+} and Mn^{2+} at 100 μM each. Five injections at each frequency and CE conditions were the same as in Figure S1.

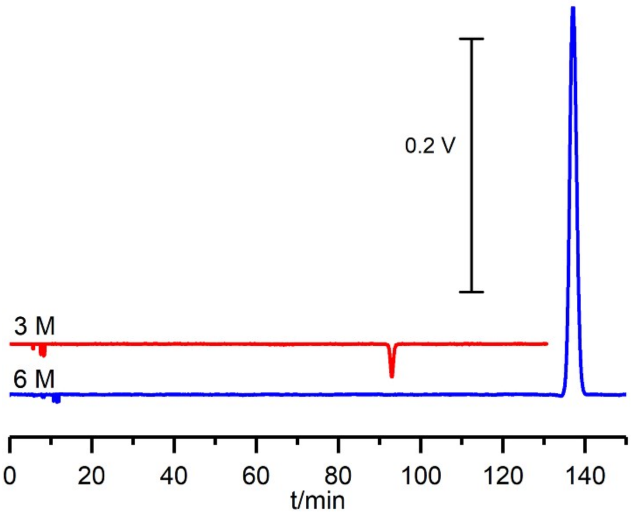

Figure S4 Impact of electroosmotic peak on the baselines in Sisi-CE-C^{4}D measured by one injection of a standard solution composed of NH_4^+, K^+, Ca^{2+}, Na^+, and Mg^{2+} at 100 μM each. The running buffer was 3 M (upper) and 6 M (lower) acetic acid and CE conditions were the same as in Figure S1.

Table S1 List of the migration velocity of the standard cations injections 50 times in Sisi-CE-C^{4}D/C^{4}D (cm/min)

Injection times	NH_4^+	K^+	Ca^{2+}	Na^+	Mg^{2+}	Mn^{2+}
1	7.165	6.798	5.337	5.123	4.956	4.783
2	7.169	6.801	5.337	5.123	4.954	4.781
3	7.169	6.802	5.342	5.128	4.960	4.789
4	7.165	6.801	5.347	5.135	4.969	4.797
5	7.160	6.793	5.349	5.135	4.967	4.791
6	7.165	6.797	5.330	5.114	4.946	4.776
7	7.134	6.762	5.308	5.092	4.927	4.760
8	7.112	6.754	5.308	5.092	4.927	4.762
9	7.104	6.746	5.312	5.099	4.935	4.770
10	7.099	6.746	5.317	5.108	4.950	4.783
11	7.099	6.742	5.332	5.114	4.960	4.787
12	7.117	6.766	5.337	5.117	4.954	4.785
13	7.152	6.794	5.334	5.117	4.952	4.785
14	7.134	6.774	5.322	5.103	4.939	4.774
15	7.160	6.802	5.347	5.126	4.962	4.801
16	7.152	6.793	5.354	5.132	4.973	4.809
17	7.152	6.797	5.359	5.141	4.981	4.819
18	7.196	6.845	5.396	5.169	5.007	4.841

19	7.227	6.865	5.411	5.187	5.024	4.859
20	7.281	6.927	5.441	5.215	5.048	4.879
21	7.318	6.943	5.457	5.222	5.053	4.883
22	7.336	6.968	5.459	5.224	5.055	4.888
23	7.359	6.980	5.474	5.238	5.072	4.904
24	7.368	6.997	5.485	5.252	5.090	4.923
25	7.410	7.048	5.526	5.288	5.121	4.952
26	7.463	7.086	5.553	5.312	5.144	4.973
27	7.525	7.156	5.601	5.351	5.180	5.007
28	7.584	7.205	5.636	5.391	5.222	5.046
29	7.634	7.254	5.671	5.416	5.248	5.070
30	7.714	7.322	5.719	5.461	5.288	5.110
31	7.781	7.392	5.758	5.495	5.320	5.142
32	7.886	7.472	5.816	5.550	5.371	5.187
33	7.973	7.564	5.859	5.587	5.409	5.225
34	8.038	7.629	5.901	5.625	5.444	5.255
35	8.134	7.709	5.964	5.674	5.485	5.296
36	8.203	7.792	5.989	5.705	5.516	5.325
37	8.337	7.903	6.063	5.775	5.585	5.389
38	8.446	7.989	6.124	5.824	5.630	5.434
39	8.545	8.089	6.172	5.877	5.691	5.490
40	8.627	8.163	6.249	5.937	5.744	5.540
41	8.777	8.302	6.309	5.989	5.787	5.579
42	8.965	8.477	6.406	6.079	5.880	5.666
43	9.105	8.595	6.492	6.146	5.931	5.716
44	9.258	8.731	6.543	6.199	5.983	5.764
45	9.369	8.830	6.613	6.259	6.039	5.819
46	9.506	8.959	6.682	6.313	6.083	5.857
47	9.736	9.163	6.775	6.399	6.163	5.928
48	9.852	9.258	6.830	6.442	6.202	5.965
49	10.012	9.376	6.895	6.496	6.252	6.014
50	10.134	9.498	6.953	6.554	6.303	6.058
RSD of the first 30 times	2.4%	2.4%	2.2%	2.0%	2.0%	2.1%
RSD of the first 40 times	6.1%	6.0%	5.1%	4.8%	4.7%	4.7%
RSD of the first 50 times	11.6%	11.3%	8.9%	8.3%	8.1%	8.0%

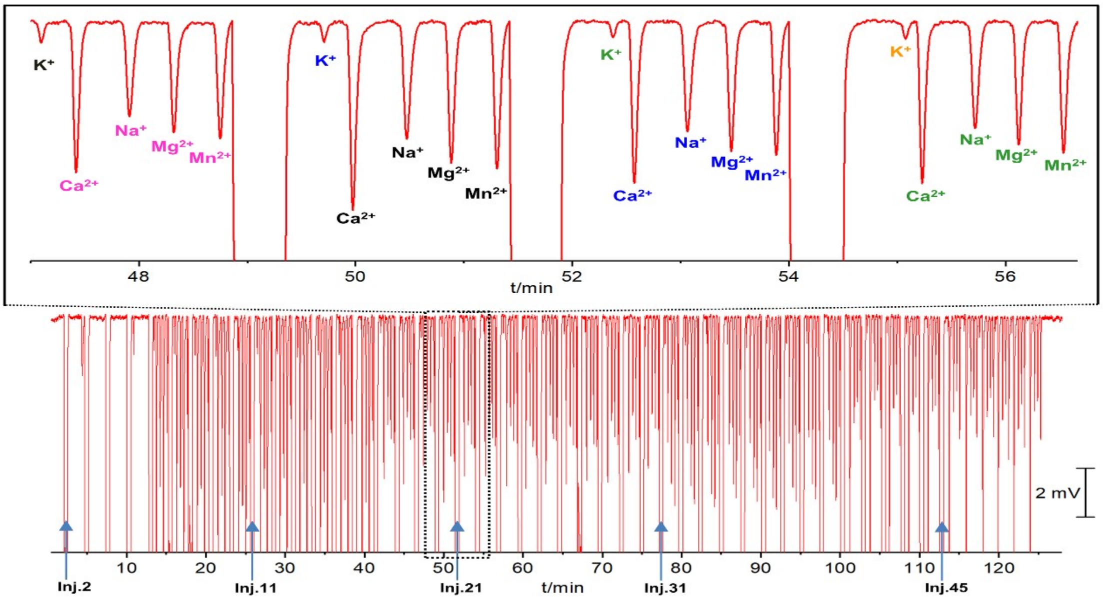

Figure S5 Electropherogram obtained by Sisi-CE-C^{4}D of 45 mineral water samples. The CE conditions were the same as in Figure S2.

Table S2 List of the analyzed mineral water samples (mg/L) [a]

Samples	Production date	NH_4^+	K^+	Ca^{2+}	Na^+	Mg^{2+}
Alkaqua						
A1	June 8, 2018	nd [b]	1.9±0.2	4.9±0.5	6.9±0.7	4.2±0.3
A2	July 8, 2018	nd	2.2±0.2	4.8±0.5	7.0±0.6	3.9±0.3
A3	July 13, 2018	nd	1.81±0.01	4.7±0.3	6.8±0.1	4.0±0.2
A4	July 11, 2018	nd	1.8±0.3	4.9±0.1	7.0±0.1	4.0±0.2
A5	August 20, 2018	nd	2.2±0.4	5.3±0.7	6.9±0.6	3.9±0.2
A6	July 9, 2018	nd	1.9±0.5	5.3±0.3	7.3±0.6	4.1±0.4
A7	August 19, 2019	nd	2.4±0.4	5.1±0.1	7.3±0.3	4.2±0.1
A8	September 5, 2019	nd	2.1±0.2	5.0±0.4	7.3±0.5	4.2±0.3
A9	September 23, 2019	nd	2.0±0.2	4.9±0.3	7.0±0.6	3.9±0.3
Mean±SD			2.0±0.2	5.0±0.2	7.0±0.2	4.0±0.1
Ganten						
G1	May 7, 2019	nd	1.0±0.3	13.5±1.4	4.0±0.4	1.9±0.1
G2	July 7, 2019	nd	0.7±0.2	11.1±1.3	3.6±0.3	1.9±0.1
G3	July 24, 2019	nd	0.9±0.5	13.1±1.4	3.7±0.4	1.8±0.1
G4	August 9, 2019	nd	0.98±0.03	12.5±0.7	3.7±0.2	1.9±0.1
G5	August 21, 2019	nd	0.6±0.2	12.3±1.3	3.9±0.2	1.9±0.1
G6	August 11, 2019	nd	0.6±0.5	11.4±1.1	3.9±0.2	1.82±0.01
G7	May 15, 2019	nd	0.7±0.3	13.1±0.6	3.9±0.3	1.9±0.1
G8	May 26, 2019	nd	0.8±0.3	12.1±0.6	3.8±0.1	1.9±0.1
G9	August 13, 2019	nd	0.7±0.4	11.7±0.4	3.7±0.3	1.8±0.1
G10	May 24, 2019	nd	0.7±0.1	12.2±0.6	3.8±0.1	1.85±0.04
G11	July 2, 2019	nd	0.64±0.03	11.2±0.8	3.7±0.2	1.8±0.1

Mean±SD			0.8±0.1	12.2±0.8	3.8±0.1	1.85±0.02
Kangshifu						
K1	May 3, 2018	nd	2.8±0.1	10.9±0.4	7.3±0.4	8.1±0.4
K2	May 5, 2018	nd	2.4±0.2	10.9±0.6	7.5±0.5	8.1±0.8
K3	May 6, 2018	nd	3.0±0.3	11.4±0.6	8.0±0.4	8.3±0.3
K4	May 13, 2018	nd	2.5±1.7	11.5±0.6	7.8±0.3	8.3±0.4
K5	June 8, 2019	nd	2.9±0.4	10.7±0.6	7.7±0.3	8.0±0.5
K6	July 18, 2019	nd	2.6±0.4	11.4±1.0	7.3±0.4	8.0±0.5
K7	August 15, 2019	nd	3.1±0.5	11.1±1.2	7.3±0.3	8.2±0.8
K8	May 15, 2018	nd	2.8±0.6	10.5±0.6	7.4±0.7	8.0±0.5
K9	July 23, 2019	nd	2.9±0.7	11.5±1.0	7.5±0.8	8.1±0.5
K10	June 1, 2019	nd	2.7±0.5	10.6±0.9	7.4±0.7	7.9±0.5
K11	March 21, 2019	nd	2.7±0.2	10.6±0.1	7.3±0.3	7.9±0.2
Mean±SD			2.8±0.2	11.0±0.4	7.5±0.2	8.1±0.2
Nongfu Spring						
N1	July 26, 2019	nd	0.6±0.3	6.0±0.2	4.0±0.1	2.6±0.1
N2	July 27, 2019	nd	0.7±0.1	5.9±0.6	3.9±0.4	2.6±0.3
N3	July 28, 2019	nd	0.8±0.3	6.2±0.6	4.1±0.2	2.5±0.1
N4	July 10, 2019	nd	0.9±0.3	6.0±0.6	3.9±0.2	2.4±0.2
N5	July 29, 2019	nd	1.0±0.3	6.0±0.5	3.9±0.1	2.5±0.1
N6	September 1, 2019	nd	0.8±0.4	5.8±0.5	4.0±0.4	2.5±0.2
N7	July 30, 2019	nd	0.8±0.3	5.8±0.5	4.0±0.4	2.5±0.1
N8	August 31, 2019	nd	0.7±0.3	5.8±0.3	4.0±0.3	2.6±0.1
N9	August 13, 2019	nd	0.6±0.1	6.0±0.4	3.8±0.1	2.5±0.1
N10	July 31, 2019	nd	0.7±0.1	6.0±0.4	3.9±0.3	2.5±0.1
N11	September 4, 2019	nd	0.7±0.1	6.0±0.4	3.79±0.04	2.4±0.1
N12	May 23, 2019	nd	0.6±0.1	6.0±0.1	3.8±0.1	2.5±0.1
N13	August 28, 2019	nd	0.7±0.2	6.0±0.2	3.9±0.2	2.5±0.1
N14	August 29, 2019	nd	0.7±0.1	6.0±0.5	4.0±0.3	2.5±0.1
Mean±SD			0.7±0.1	5.9±0.1	3.9±0.1	2.5±0.1

[a] The detailed information of the 45 mineral water samples shown in Table S1, all concentrations were calculated as mean ±SD (n = 3).

[b] nd = not detected

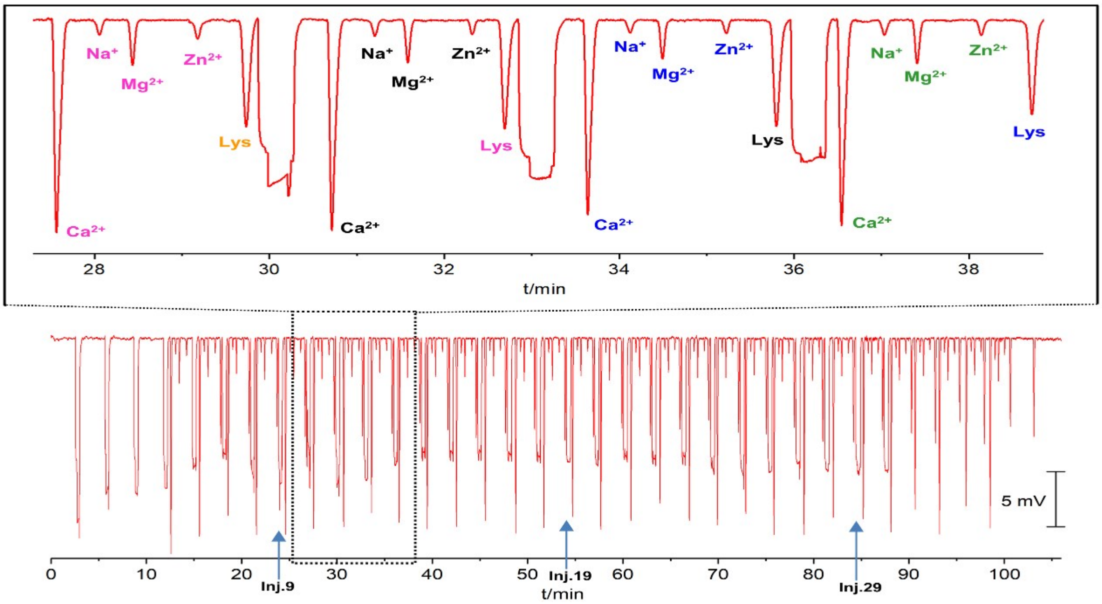

Figure S6 Electropherogram obtained by Sisi-CE-C^{4}D of 30 injections of CZG oral solution samples. The siphon-injection at 10 cm height for 15 s plus 171 s t_{non} and other CE conditions were the same as in Figure S2.

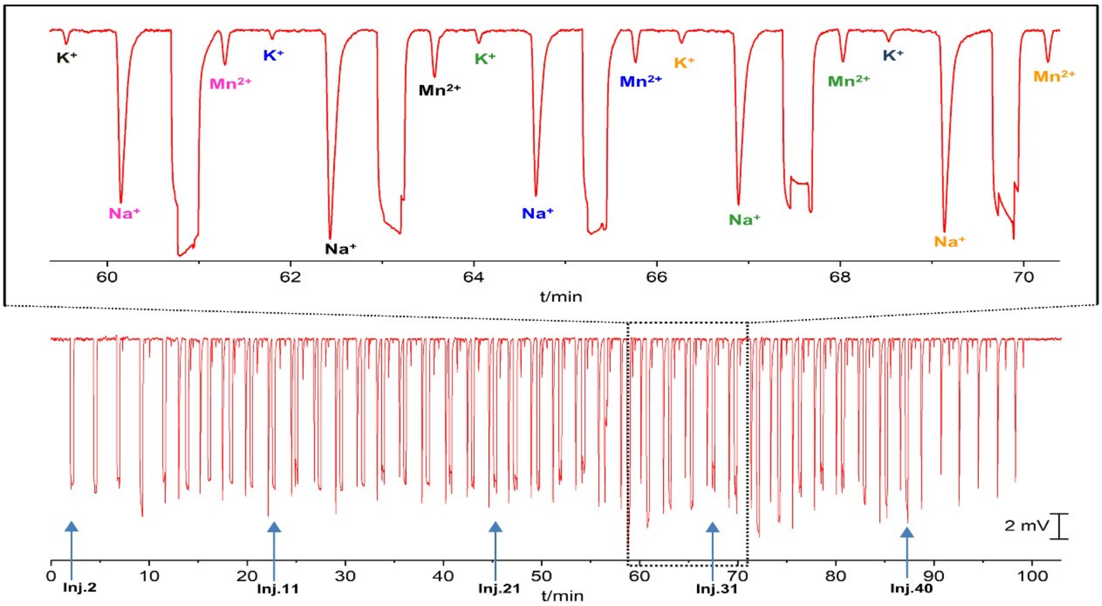

Figure S7 Electropherogram obtained by Sisi-CE-C^{4}D of 40 human blood serum samples. The CE conditions were the same as in Figure S2.

Table S3 List of the analyzed human blood serum samples (mM) [a]

Samples	Type of disease	K^+	Na^+
S1	Hyperkalemia	6.8±0.3	125.8±12.5
S2	Renal failure	5.4±0.7	125.4±8.3
S3	Renal failure	3.6±0.8	128.0±14.6
S4	Renal failure	4.2±1.0	132.8±4.1
S5	Renal failure	5.2±1.0	139.6±21.1

S6	Renal failure	4.7±1.8	128.5±10.7
S7	Renal failure	4.5±0.5	136.9±13.0
S8	Renal failure	3.5±0.5	126.4±12.2
S9	Renal failure	4.8±2.0	134.7±13.2
S10	Renal failure	5.3±1.3	124.8±19.7
S11	Renal failure	3.7±1.1	126.0±14.1
S12	Hypokalemia	3.3±0.9	123.0±12.6
S13	Renal failure	3.8±0.6	131.6±13.7
S14	Renal failure	4.4±1.0	125.4±18.8
S15	Hyperkalemia	6.7±0.4	123.9±8.6
S16	Hypokalemia	3.1±0.4	123.8±10.3
S17	Renal failure	4.2±1.4	135.1±11.3
S18	Renal failure	4.5±1.0	128.9±19.3
S19	Renal failure	4.8±1.4	133.0±18.3
S20	Hypokalemia	3.2±0.5	144.8±14.5
S21	Renal failure	5.1±1.2	132.3±9.6
S22	Hyperkalemia	7.7±0.5	128.1±15.7
S23	Hyperkalemia	6.5±1.0	130.4±9.3
S24	Renal failure	4.5±0.8	133.0±11.4
S25	Hyperkalemia	6.7±0.8	123.0±11.1
S26	Hyperkalemia	6.6±0.7	123.1±16.9
S27	Hyperkalemia	6.1±1.0	129.3±20.7
S28	Renal failure	4.5±1.2	138.2±11.0
S29	Renal failure	3.6±1.0	123.6±14.1
S30	Hyperkalemia	6.6±1.5	142.0±22.2
S31	Hyperkalemia	6.2±1.4	132.1±22.0
S32	Renal failure	5.4±1.4	131.9±18.8
S33	Renal failure	5.2±1.7	127.7±18.3
S34	Renal failure	5.1±1.7	135.1±8.5
S35	Hyperkalemia	7.4±0.9	130.1±16.6
S36	Hyperkalemia	6.3±1.0	126.6±11.0
S37	Renal failure	4.4±0.9	130.6±22.7
S38	Renal failure	5.0±1.3	122.9±10.7
S39	Renal failure	5.3±1.0	139.4±20.3
S40	Renal failure	4.8±0.8	128.3±15.9
Mean±SD		5.1±1.2	130.2±5.6

[a] The detailed information of the 40 human blood serum samples shown in Table S2, all concentrations were calculated as mean ±SD (n = 3).