Electronic Supplementary Material (ESI) for Analyst.

ELECTRONIC SUPPLEMENTARY INFORMATION

Simultaneous Quantitation of Urinary Albumin and Creatinine for Rapid Clinical Albuminuria Diagnostics using High-Throughput Paper Spray Mass Spectrometry

Igor Pereira[1], Jason L. Robinson[2], and Chris G. Gill[1, 3, 4, 5]

[1] Applied Environmental Research Laboratories (AERL), Chemistry Department, Vancouver Island University, Nanaimo, BC, Canada, V9R 5S5
[2] Health PEI, Charlottetown, PEI, Canada, C1A 7N8
[3] Chemistry Department, University of Victoria, Victoria, BC, Canada, V8P 5C2
[4] Chemistry Department, Simon Fraser University, Burnaby, BC, Canada, V5A 1S6
[5] Department of Occupational and Environmental Health Sciences, University of Washington, Seattle, WA, United States, 98195-1618

***Address correspondence to:**

Professor Chris G. Gill, Ph.D., P. Chem.
Co-Director, Applied Environmental Research Laboratories (AERL)
Department of Chemistry
Vancouver Island University
900 Fifth Street, Nanaimo, BC, Canada, V9R 5S5

Ph: 250-753-3245
chris.gill@viu.ca

Table S1 Parameters for application of rewet and spray solvents using the VeriSpray™ PS-MS ion source. Each rewetting and solvent dispense is 10 µL

Sample Rewetting Dispense Delay	
Dispense	Delay (s)
1	1
2	1
3	1
Spray Solvent Dispense Delay	
Dispense	Delay (s)
1	1
2	1
3	1
4	3
5	3
6	3
7	3
8	3
9	3
10	3

Table S2 Albumin concentrations (mg L^{-1}) in 56 anonymous human patient urine samples obtained with PS-MS and a validated clinical method (immunoturbidimetry)

Sample	PS-MS (mg L^{-1})	Validated Clinical Method (mg L^{-1})
1	0.0	5.6
2	9.2	7.9
3	10.3	12.9
4	13.7	18.3
5	21.0	24.6
6	89.2	74.2
7	118.1	94.8
8	197.4	107.8
9	171.0	139.8
10	191.4	184.2
11	293.2	212.1
12	821.2	340.2
13	431.0	412.8
14	462.0	496.1
15	658.5	649.7
16	984.9	787.2
17	884.6	964.0
18	872.3	1003.3
19	51.6	45.2
20	63.5	53.3
21	28.7	32.4
22	12.2	16.8
23	24.8	29.5
24	14.0	28.1
25	10.9	25.7
26	8.6	18.3
27	64.8	54.0
28	34.7	56.0
29	13.4	5.4
30	66.5	100.6
31	34.7	39.9
32	16.5	14.1
33	63.6	62.1
34	624.0	412.3
35	207.3	227.3

36	12.2	5.5
37	390.4	385.2
38	14.0	11.2
39	115.8	152.7
40	86.7	99.4
41	68.3	91.5
42	50.3	84.3
43	21.6	15.1
44	145.7	189.4
45	433.1	374.0
46	62.7	69.0
47	27.6	27.2
48	212.0*	207.2
49	1350.4	1462.6
50	821.5	756.2
51	1026.6	1000.3
52	1452.3	1478.3
53	3580.8*	2938.8
54	1052.2	965.6
55	2392.9*	2605.6
56	1832.3	2700.6

* Results obtained using 10-fold diluted urine samples in water.

Table S3 Creatinine concentrations (mmol L^{-1}) in 56 anonymous human patient urine samples obtained using PS-MS and a validated clinical method (Jaffe's method)

Sample	PS-MS (mmol L^{-1})	Validated Clinical Method (mmol L^{-1})
1	11.9	10.9
2	5.2	5.0
3	9.2	8.5
4	16.9	15.5
5	18.8	18.4
6	3.8	3.1
7	3.0	3.0
8	4.7	4.2
9	10.4	9.1
10	5.8	5.4
11	8.0	7.0
12	19.8	12.4
13	2.6	2.4
14	12.6	11.7
15	8.3	8.1
16	16.0	14.0
17	3.7	3.7
18	15.8	15.1
19	12.5	11.2
20	19.2	16.9
21	7.9	7.0
22	6.1	5.7
23	7.9	7.1
24	11.8	10.3
25	7.5	6.9
26	9.9	8.6
27	7.3	6.8
28	3.7	3.0
29	9.8	7.7
30	3.5	2.9
31	11.5	10.9
32	7.1	6.0
33	3.0	2.5
34	16.9	12.9
35	17.6	14.6

36	5.8	4.5
37	5.0	3.9
38	12.8	9.9
39	13.3	11.1
40	9.7	8.0
41	15.4	12.2
42	6.0	4.8
43	16.4	12.6
44	9.7	7.9
45	16.9	12.3
46	8.1	6.7
47	10.7	8.3
48	39.1*	35.0
49	4.5	3.9
50	8.8	7.0
51	18.1	14.5
52	7.5	6.6
53	12.4*	9.2
54	7.8	6.3
55	23.5*	20.6
56	11.2	10.0

* Results obtained using 10-fold diluted urine samples in water.

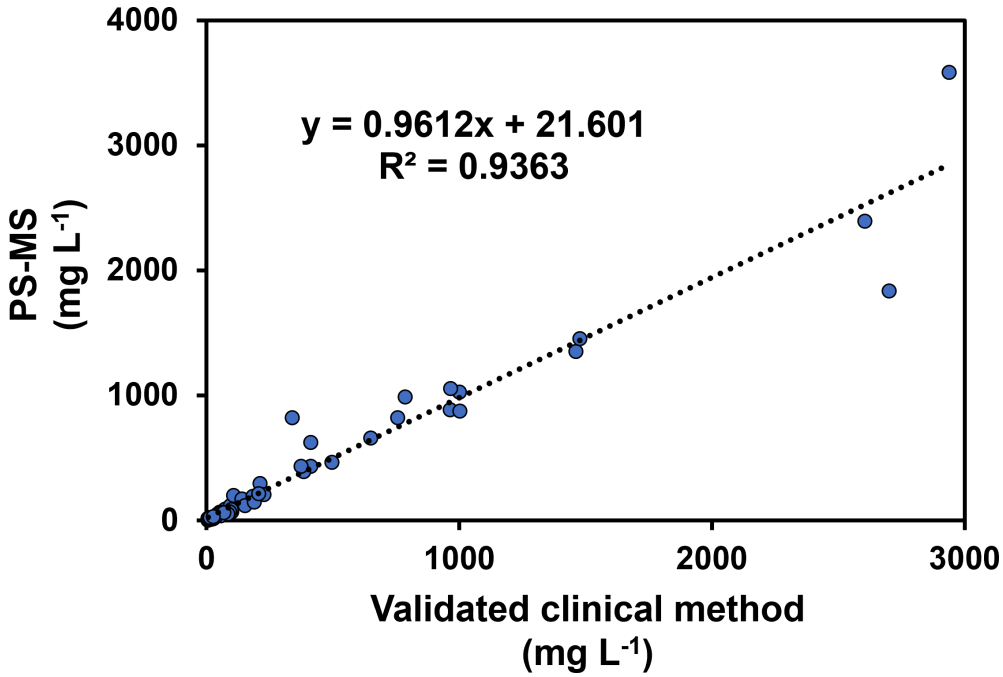

Fig. S1 Correlation between PS-MS and a validated clinical method (immunoturbidimetry) in the analyses of albumin in 56 anonymous human patient urine samples.

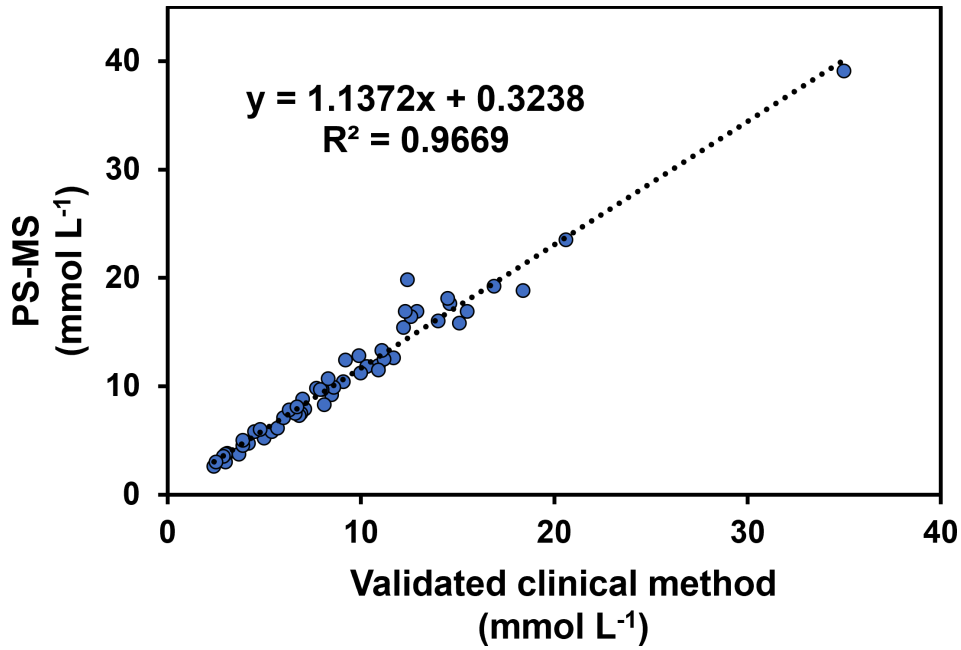

Fig. S2 Correlation between PS-MS and a validated clinical method (Jaffe's method) in the analyses of creatinine in 56 anonymous human patient urine samples.

Table S4 Albumin-to-creatinine ratio concentrations (mg $mmol^{-1}$) in 56 anonymous human patient urine samples obtained by PS-MS and a validated clinical method. PS-MS results were obtained by simultaneously measuring albumin and creatinine. Clinical results were obtained using immunoturbidimetry for albumin and the Jaffe's method for creatinine

Sample	PS-MS Albumin/Creatinine (mg $mmol^{-1}$)	Clinical Method Albumin/Creatinine (mg $mmol^{-1}$)
1	0.0	0.5
2	1.8	1.6
3	1.1	1.5
4	0.8	1.2
5	1.1	1.3
6	23.5	23.9
7	39.4	31.6
8	42.0	25.7
9	16.4	15.4
10	33.0	34.1
11	36.7	30.3
12	41.5	27.4
13	165.8	172.0
14	36.7	42.4
15	79.3	80.2
16	61.6	56.2
17	239.1	260.5
18	55.2	66.4
19	4.1	4.0
20	3.3	3.2
21	3.6	4.6
22	2.0	2.9
23	3.1	4.2
24	1.2	2.7
25	1.5	3.7
26	0.9	2.1
27	8.9	7.9
28	9.4	18.7
29	1.4	0.7
30	19.0	34.7
31	3.0	3.7
32	2.3	2.4
33	21.2	24.8

34	36.9	32.0
35	11.8	15.6
36	2.1	1.2
37	78.1	98.8
38	1.1	1.1
39	8.7	13.8
40	8.9	12.4
41	4.4	7.5
42	8.4	17.6
43	1.3	1.2
44	15.0	24.0
45	25.6	30.4
46	7.7	10.3
47	2.6	3.3
48	5.4	5.9
49	300.1	375.0
50	93.4	108.0
51	56.7	69.0
52	193.6	224.0
53	288.8	319.4
54	134.9	153.3
55	101.8	126.5
56	163.6	270.1

Table S5 Albumin-to-creatinine concentrations (mg $mmol^{-1}$) and clinical outcomes for 6 outlier samples in the comparison between PS-MS and clinical method. The albuminuria classification is based on the KDIGO[S1] (Kidney Disease: Improving Global Outcomes) criteria

Sample	PS-MS Concentration (mg $mmol^{-1}$) and clinical outcome	Clinical Method Concentration (mg $mmol^{-1}$) and clinical outcome
8	42.0 (macroalbuminuria)	25.7 (microalbuminuria)
12	41.5 (macroalbuminuria)	27.4 (microalbuminuria)
25	1.5 (normoalbuminuria)	3.7 (microalbuminuria)
30	19.0 (microalbuminuria)	34.7 (macroalbuminuria)
45	25.6 (microalbuminuria)	30.4 (macroalbuminuria)
47	2.6 (normoalbuminuria)	3.3 (microalbuminuria)

Table S6 Sensitivity, specificity, and bias obtained from the PS-MS clinical outcomes in comparison with clinical decision limits established by the Canadian Diabetes Association (CDA)[S2]

	Clinical decision limits (mg $mmol^{-1}$)	PS-MS sensitivity (%)	PS-MS specificity (%)	PS-MS bias (%)
Normoalbuminuria	<2	89	94	-0.04
Microalbuminuria	2-20	94	89	-2.0
Overt nephropathy	>20	92	100	-13.7

References

S1 KDIGO, *Kidney Int*., 2022, **102**, 1–127.

S2 P. McFarlane, D. Cherney, R. E. Gilbert and P. Senior, *Can. J. Diabetes*, 2018, **42**, 201–209.