**Urine Biomarkers, Acute Kidney Injury, and Fluid Overload in Neonatal Cardiac Surgery**

**SUPPLEMENTARY MATERIALS**

**Supplementary Table 1.** Unadjusted urine biomarkers for all neonates at different perioperative time points (presented as medians [25th–75th percentile]).

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| --- | --- | --- | --- |
| **Urine biomarker** | **Preoperative**  N=6 | **Early postoperative**  N=11 | **Late postoperative**  N=6 |
| **αGST** (pg/mL) | 740.1 (513.7- 2906.6) | 8179.9 (4283.3-56947.5) | 960.9 (875.2-1441.4) |
| **Alb** (µg/mL) | 38.6 (9.1-58.2) | 171 (87.1-249) | 23.5 (20.0-33.6) |
| **β2M** (ng/mL) | 727.5 (585.0-1903.4) | 5384.7 (2925.7-11000) | 629.3 (125.6- 1732.4) |
| **Cal** (ng/mL) | 33.9 (13.3-52.4) | 16.4 (10.5-23.6) | 17.3 (6.5-27.1) |
| **Clust** (ng/mL) | 69.5 (46.9-137.2) | 105.1 (75.5-320.0) | 54.2 (22.6-82.1) |
| **CysC** (ng/mL) | 55.0 (18.3-75.7) | 176.1 (81.6-1328.4) | 19.6 (10.6-30.7) |
| **EGF** (ng/mL) | 2.9 (2.4- 5.7) | 2.7 (1.4-3.8) | 3.5 (1.4-8.2) |
| **KIM1** (pg/mL) | 637.1 (326.5-1144.7) | 775.2 (570.3-1880.6) | 2751.3 (754.6-6183.0) |
| **NGAL** (ng/mL) | 13.1 (6.6-17.6) | 110.2 (92.7-602) | 10 (8.5-32.1) |
| **Osteo** (ng/mL) | 6.3 (5.9-10.8) | 14.6 (9.8-21.8) | 11.8 (6.1-22.2) |
| **OPN** (ng/mL) | 447.4 (219.4-758.7) | 753.7 (495.5-1793.2) | 264.6 (136.6- 534.6) |
| **TFF3** (pg/mL) | 745.9 (46.5-1995.1) | 373.5 (193.9-1385.1) | 81.0 (52.8-150.3) |
| **UMOD** (ng/mL) | 1546.6 (1412.2-2271.5) | 2141.9 (979.7-2513.9) | 1144.1 (719.3-1719.4) |
| **VEGF** (pg/mL) | 460.0 (347.8-534.6) | 1295.9 (532.1-2634.1) | 281.0 (234.1-452.3) |

αGST = α-glutathione S-transferase; Alb = albumin; β2M = β-2 microglobulin; Cal = calbindin; Clust = clusterin; CysC = cystatin C; EGF = epidermal growth factor; KIM1 = kidney injury molecule-1; NGAL = neutrophil gelatinase associated lipocalin; Osteo = osteoactivin; OPN = osteopontin; TFF3 = trefoil factor-3; UMOD = uromodulin; VEGF = vascular endothelial growth factor.

**Supplementary Table 2.** Exploratory Unadjusted Biomarkers by CS-AKI Phenotype at different perioperative time points (presented as medians [25th–75th percentile]).

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| **Biomarker** | **CS-AKI-/FO-**  N=3 | **CS-AKI+/FO-**  N=5 | **CS-AKI-/FO+**  N=1 | **CS-AKI+/FO+**  N=4 |
| **αGST** (pg/mL) | | | | |
| Preoperative | 2906.6 (513.7-8484.1) | 617.0 | None | 575.3 (287.3-863.2) |
| Early postoperative | 9789.5 (4283.3-35722.1) | 4658.9 (2881.3-6433.7) | 1408.7 | 141441.8 (56947.5-924073.6) |
| Late postoperative | 943.5 (792.8- 1901.0) | 926.8 (875.2-978.4) | None | 1441.4 |
| **Alb** (µg/mL) | | | | |
| Preoperative | 58.2 (27.5-60.6) | 4.7 | None | 29.4 (9.1- 49.6) |
| Early postoperative | 239 (135-249) | 78.6 (50.9-129) | 386 | 224 (150-398) |
| Late postoperative | 22.2 (20.0-33.6) | 14.8 (4.9-24.7) | None | 49.8 |
| **β2M** (ng/mL) | | | | |
| Preoperative | 945.0 (510.1-1903.4) | 58.5 | None | 2596.9 (47.3-5146.6) |
| Early postoperative | 5384.7 (761.2-11000) | 4091.7 (3165.2-5454.5) | 500.3 | 15400 (5928.7 15800 |
| Late postoperative | 984.2 (52.9-1732.4) | 200.1 (125.6-274.5) | None | 2288.7 |
| **Cal** (ng/mL) | | | | |
| Preoperative | 47.7 (13.3- 69.1) | 5.7 | None | 36.3 (20.2-52.4) |
| Early postoperative | 10.5 (6.3- 11.4) | 24.7 (14.4-57.2) | 23.6 | 16.4 (15.0-16.5) |
| Late postoperative | 6.5 (4.5-30.1) | 21.4 (15.6-27.1) | None | 19.0 |
| **Clust** (ng/mL) | | | | |
| Preoperative | 54.8 (46.9- 137.2) | 32.0 | None | 193.2 (84.3-302.2) |
| Early postoperative | 81.5 (75.7-113.0) | 75.2 (32.6-250.6) | 1065.4 | 240.3 (75.5-320.0) |
| Late postoperative | 57.3 (13.2-480.6) | 36.8 (22.6-51.1) | None | 82.1 |
| **CysC** (ng/mL) | | | | |
| Preoperative | 75.7 (18.3-98.7) | 0.1 | None | 55.0 (48.8-61.2) |
| Early postoperative | 116.2 (50.3-311.5) | 134.1 (79.1-217.5) | 81.6 | 2089.6 (1328.4-2551.2) |
| Late postoperative | 30.7 (14.9-37.4) | 5.3 (0.1-10.6) | None | 24.3 |
| **EGF** (ng/mL) | | | | |
| Preoperative | 2.6 (2.4-5.7) | 1.1 | None | 6.0 (3.3-8.7) |
| Early postoperative | 2.7 (2.4-3.3) | 2.2 (1.4-5.3) | 6.2 | 2.2 (0.7-3.8) |
| Late postoperative | 4.1 (1.1-12.1) | 2.1 (1.4-2.9) | None | 8.2 |
| **KIM1** (pg/mL) | | | | |
| Preoperative | 703.3 (266.2-1144.7) | 570.9 | None | 1410.6 (326.5-2494.7) |
| Early postoperative | 777.2 (642.4-2450.4) | 602.2 (451.1-839.6) | 3367.2 | 775.2 (481.2-1880.6) |
| Late postoperative | 3337.0 (754.6-14681.6) | 1400.1 (634.7-2165.5) | None | 6183.0 |
| **NGAL** (ng/mL) | | | | |
| Preoperative | 13.5 (6.6-18.0) | 4.9 | None | 15.1 (12.6-17.6) |
| Early postoperative | 286.1 (25.3-602.4) | 93.2 (74.7-101.3) | 110.2 | 1887.3 (316.6-2921.1) |
| Late postoperative | 11.5 (8.5- 32.1) | 7.4 (6.3-8.5) | None | 53.3 |
| **Osteo** (ng/mL) | | | | |
| Preoperative | 5.9 (5.0-11.9) | 6.2 | None | 8.6 (6.5-10.8) |
| Early postoperative | 15.7 (13.8-15.9) | 10.3 (6.3-24.5) | 3.9 | 14.6 (9.8-21.8) |
| Late postoperative | 16.6 (6.1-28.6) | 12.8 (3.5-22.2) | None | 7.1 |
| **OPN** (ng/mL) | | | | |
| Preoperative | 230.3 (200.5-664.6) | 219.4 | None | 1021.7 (758.7-1284.7) |
| Early postoperative | 511.6 (303.3-1182.8) | 632.8 (503.8-809.2) | 435.2 | 3447.0 (1793.2-5795.1) |
| Late postoperative | 296.6 (136.6-735.6) | 383.6 (232.5-534.6) | None | 86.4 |
| **TFF3** (pg/mL) | | | | |
| Preoperative | 1159.6 (332.2-1995.1) | 46.5 | None | 2072.3 (23.7-4120.9) |
| Early postoperative | 342.6 (298.2-693.1) | 283.7 (159.6-1051.1) | 1385.14 | 815.4 (47.4-2379.5) |
| Late postoperative | 101.0 (52.8- 150.3) | 33.5 (5.9-61.0) | None | 381.5 |
| **UMOD** (ng/mL) | | | | |
| Preoperative | 1520.7 (1412.2-2896.5) | 411.7 | None | 1922.1 (1572.6-2271.5) |
| Early postoperative | 1140.7 (893.4-2141.9) | 2333.6 (1412.1-3314.4) | 4581.0 | 1554.3 (979.7-2513.9) |
| Late postoperative | 1719.4 (455.3-1988.1) | 1009.7 (719.3-1300.0) | None | 988.3 |
| **VEGF** (pg/mL) | | | | |
| Preoperative | 410.3 (347.8-534.6) | 240.3 | None | 650.8 (509.8-791.8) |
| Early postoperative | 671.0 (345.8-1604.9) | 1047.2 (502.3-2098.2) | 779.9 | 3124.5 (1295.9-4330.3) |
| Late postoperative | 291.6 (234.1-941.6) | 361.3 (270.4-452.3) | None | 218.1 |

αGST = α-glutathione S-transferase; Alb = albumin; β2M = β-2 microglobulin; Cal = calbindin; Clust = clusterin; CysC = cystatin C; EGF = epidermal growth factor; KIM1 = kidney injury molecule-1; NGAL = neutrophil gelatinase associated lipocalin; Osteo = osteoactivin; OPN = osteopontin; TFF3 = trefoil factor-3; UMOD = uromodulin; VEGF = vascular endothelial growth factor.

**Supplementary Item 1.** Urine Biomarker PDF