| **Calcium on Abbott** |
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| **Purpose** | This procedure provides instructions for CALCIUM ON ABBOTT INSTRUMENTATION. The calcium method is an *in vitro* diagnostic test for the quantitative measurement of calcium in human serum and plasma on the Abbott Architect c4000 or Abbott Alinity c automated chemistry analyzers. |
| **Policy Statements** | This procedure applies to all personnel responsible for operating the Abbott Architect c4000 or Abbott Alinity c at Children’s Minnesota Laboratory.  |
| **Principle** | Arsenazo-III dye reacts with calcium in an acid solution to form a blue-purple complex. The color developed is measured at 660 nm and is proportional to the calcium concentration in the sample.Methodology: Arsenazo III |
| **Clinical Significance** | The majority of calcium in the body is present in bones. The remainder of the calcium is in serum and has various functions. For example, calcium ions decrease neuromuscular excitability, participate in blood coagulation, and activate some enzymes.Hypercalcemia can result from hyperparathyroidism, hypervitaminosis D, multiple myeloma, and some neoplastic diseases of bone. Long-term lithium therapy has been reported to cause hyperparathyroidism in some individuals, with resulting hypercalcemia.Hypocalcemia can result from hypoparathyroidism, hypoalbuminemia, renal insufficiency, and pancreatitis.Calcium has traditionally been difficult to measure accurately and precisely, and a large variety of methods have been developed. Among these are flame photometry, oxalate precipitation with titration, atomic absorption spectrophotometry, EDTA chelation, and more recently calcium dye complexes which are measured spectrophotometrically. Examples of calcium dyes are o-cresolphthalein complexone and Arsenazo III, the latter being the dye used for calcium determination in this method. |
| **Analyzer** | **Minneapolis: Abbott Alinity c (Sunquest method code: MALIC), Abbott Alinity ci (Sunquest test code: MACC)****St. Paul: Abbott Architect c4000 (Sunquest method code: ARCH4), Abbott Alinity c (Sunquest method code: SALIC)** |
| **Sunquest Test Codes** |

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| **CA**  |  Calcium in plasma or serum in mg/dL  |   |
|  **UCAL**  |  Calcium in urine in mg/dL  |   |
|  **UCAQ/UCA**  |  Quantitative urine calcium, timed collection in mg/collection  |   |
|  **CCRA**  |  Calcium Creatinine Ratio  |   |

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| **Specimen** | Sample: Plasma (lithium heparin with or without gel) preferred. Sodium heparin plasma or serum (with or without gel) also acceptable. Refer to specimen collection procedures.**Minimum sample volume:** 200 µL preferred, 150 µL minimum**Stability when separated from cells/gel:** RT / 7 days, 2-8 °C / 3 weeks, < -20°C / 8 months**Rejection criteria:** Unlabeled tube, sample type other than serum or heparinized plasma**Preparation:** 1. Whole blood specimens should be centrifuged following complete clot formation, according to Specimen Processing procedures prior to analysis.
2. Serum or plasma should be physically separated from cells as soon as possible with a maximum limit of two hours from the time of collection.
3. Specimens should be free of particulate matter.
4. Transfer serum or plasma to a properly labeled sendout tube. Short samples should be pipetted into an Abbott sample cup and nested on a sendout tube; any amount remaining after sampling should be pipetted into the sendout tube and tightly capped.
5. Architect and Alinity systems utilize a specimen level detect mechanism, so special racks specific to tube-type are not required.
6. Minimum labeling includes sample accession ID, and/ or patient name, medical record number, collection date and time.

Urine (on Alinity ci only): Timed (24 hour) or Random collection, no preservatives **Minimum volume:** 0.2 mL**Stability:** 20-25 C 48 hours, 2-8C 4 Days , < -20C / 3 weeks**Rejection criteria:** Unlabeled specimens.**Preparation:**1. Timed urine collections are measured for total volume, and the collection date and time recorded for the start and end of the collection. Enter this information into Sunquest in CVIS by ordering the test PV on the same accession number.2. Centrifuge all urine calcium specimens prior to testing. Complete testing as soon as possible after collection. |
| **Reagents** | **Alinity c and Architect c4000:****Reagent Handling** Upon receipt, place reagent cartridges in an upright position for 8 hours before use to allow bubbles that may have formed to dissipate. If a reagent cartridge is dropped, place in an upright position for 8 hours before use to allow bubbles that may have formed to dissipate. Reagents are susceptible to the formation of foam and bubbles. Bubbles may interfere with the detection of the reagent level in the cartridge and cause insufficient reagent aspiration that may adversely affect results. Use a pipette to remove all bubbles prior to loading on the Alinity or Architect system.* Do not use reagents beyond the expiration date.
* Do not pool reagents within a kit or between kits.
* Do not use components from one lot with components from another lot.

**Alinity c:**Reagents may be stored on or off the system. If removed from the system, store reagents with new replacement caps in an upright position at 15 - 30 °C. For reagents stored off the system, it is recommended that they be stored in their original trays or boxes to ensure they remain upright.**Alinity c:**

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| ***Product Description*** | ***Product Code*** | ***Stability*** |
| Abbott Alinity c Calcium ReagentCHC# 32622 | 07P57-20 | **Store at:** 15 - 30 °C**Unopened:** Manufacturer’s printed expiration date**On-board: 30 days****Opened, off the analyzer (with clean caps):** Manufacturer’s printed expiration date. (Reagents may be stored on or off the system. The system tracks time onboard.) |
| Abbott Alinity c Multiconstituent CalibratorCHC# 32633 | 08P60-01 | **Store at:** 2 – 8 °C**Unopened:** Manufacturer’s printed expiration date**On board expiration: 5 days when stored onboard.** The Alinity c tracks time on the system.**Opened expiration: 7 days** when opened and stored off the system. |

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|  | **Architect c4000:**

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| ***Product Description*** | ***Product Code*** | ***Stability*** |
| Abbott Architect Calcium ReagentCHC# 32542 | 03L79-21 | **Store at:** 15 - 30°C**Unopened:** Manufacturer’s printed expiration date.**On-board:** 30 Days |
| Abbott Architect Multiconstituent CalibratorCHC# 32557 | 01E65-05 | **Store at:** 2 – 8°C**Unopened:** Manufacturer’s printed expiration date**Opened:** 7 Days |

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| **Risk and Safety** |

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| **CAUTION:** For in vitro diagnostic use. This product requires the handling of human specimens. It is recommended that all human sourced materials be considered potentially infectious and be handled in accordance with the OSHA Standard on Bloodborne Pathogens. Appropriate Personal Protective Equipment (PPE) must be worn according to Children’s Minnesota Laboratory policies. Current SDSs are kept on the [Children’s StarNet](https://msdsmanagement.msdsonline.com/a07dc954-23d8-42a9-b591-ef5763cdfd33/ebinder/?nas=True) pageR1 Reagent: Contains methylisothiazolone. Causes skin irritation. May cause an allergic skin reaction. Causes serious eye irritation.Dispose of used reagent in normal trash. Unused (expired) reagents and Multiconstituent Calibrator should be disposed of in Regulated Medical Waste (red trash). |

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| **Calibration** | **Alinity c** and **Architect c4000:**

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| Assay Range: | 2.0 – 24.0 mg/dL |
| Reference Material: | Abbott Alinity Multiconstituent Calibrator |
| Suggested Calibration Levels: |  See lot-specific assay set point documentation |
| Calibration Scheme: | 2 levels, Linear data reduction method |
| Calibration Frequency: | 30 Days |
| AMR | AMR is verified twice annually using the Maine Standards GC1 Product # 1100ab and UC4 Product # 704ri by running all applicable levels in triplicate. Assay results are submitted to Maine Standards for compilation and comparison to peers. Results are reviewed and approved by the Technical Specialist. Any questionable results are investigated and corrective actions documented.  |

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| **Quality Control** | **Alinity c and Architect c4000:** **Bio-Rad Liquichek™ Unassayed Multiqual Chemistry Control (Human) Levels 1 & 3****Frequency:** Two levels each day of use**Stability:** Once thawed, opened, and stored tightly capped at 2 to 8°C, this product will be labeled with an expiration date equal to the shortest stability of the included analytes, which is **7 days.****Preparation**: This product should be treated the same as patient specimens and run in accordance with the instructions accompanying the instrument, kit, or reagent being used. * To thaw the product, allow it to stand at room temperature (18° to 25°C) until completely thawed but no longer than one (1) hour.
* After thawing, the product **MUST** be gently swirled and inverted several times to ensure homogeneity.
* For optimal analyte stability in the thawed state, promptly return to 2 to 8°C storage after each use and minimize the time at room temperature to no more than 20 minutes daily.
* **Before each use**, gently swirl the contents until homogeneous with no visible signs of precipitate.

**Bio-Rad Liquichek™ Urine Chemistry Levels 1 & 2****Frequency:** Two levels each day of use**Stability:** Once opened store tightly capped at 2 to 8°C, this product has a stability of 30 days once open unless vial expiration date comes first**Preparation**: This product should be treated the same as patient specimens and run in accordance with the instructions accompanying the instrument, kit, or reagent being used. * The product **MUST** be gently swirled and inverted several times to ensure homogeneity.
* For optimal analyte stability promptly return to 2 to 8°C storage after each use and minimize the time at room temperature to no more than 20 minutes daily.
* **Before each use**, gently swirl the contents until homogeneous with no visible signs of precipitate.

**Acceptable ranges:** * Non-Bio-Rad controls will utilize manufacturer ranges and 2 SD Westgard rules.
* New lots of Bio-Rad controls should be run for 20 days in parallel with the current lot whenever possible prior to switching to the new lot.
* Refer to the Westgard Rules in Chemistry procedure (insert hyperlink) for current Westgard rules in place for each analyte.
* **Acceptable ranges are current in Unity Real Time only.** Quality Control results must be rejected in Sunquest when the results cross the interface.
* In the event of a QC failure, refer to the [Unity Real Time QC Review, General User](https://starnet.childrenshc.org/References/labsop/chem/quality/ch-2.17-unity-real-time-qc-review-general-user.pdf) and navigate to the QC Troubleshooting section.
* Do not load or release patients until QC is acceptable in Unity Real Time.
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| **Interferences** | **Alinity c and Architect c4000:** **Hemolysis, Icterus & Lipemia (HIL) Index Values:**

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At HIL levels at or above the specified cutoff value, append the appropriate comment AFTER visually confirming presence of interferent: -HP for “Hemolysis present, may affect results.” -BIN for “Bilirubin Interference”-LINT for “Lipid Interference”Interference studies were conducted by Abbott Diagnostics Division and effects were assessed by Dose Response and Paired Difference methods at the medical decision levels of the analyte. Interference is less than 10% at calcium concentration levels of 7.6 mg/dL and 11.3 mg/dLfor:* Hemoglobin: up to 2000 mg/dL
* Bilirubin: up to 60 mg/dL
* Lipemia (Intralipid®): up to 750 mg/dL

Interferences from medication or endogenous substances may affect results.Samples with moderate lipemia should be clarified by ultracentrifugation and repeated. The appropriate comment should be appended, -LINT. For accurate results, serum and plasma specimens should be free of fibrin, red blood cells, and other particulate matter. Serum specimens from patients receiving anticoagulant or thrombolytic therapy may contain fibrin due to incomplete clot formation.  |
|  | **Alinity c and Architect c4000: Serum/ Plasma** |
| **Reference Intervals** |

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| Age | Calcium |
| Premature newborns | 6.2 – 11.0 mg/dL |
| 0 to 10 days | 7.6 – 10.4 mg/dL |
| 10 days to 24 months | 9.0 – 11.0 mg/dL |
| 2 - 12 years | 8.8 – 10.8 mg/dL |
| 12 – 60 years | 8.4 – 10.2 mg/dL |
| >60 years | 8.8 – 10.0 mg/dL |
| Urine:25-150 mg/24 hrsDIET DEPENDENTLow Calcium intake <5 mg/24 hrsAvg calcium Intake 50-150 mg/24 hrsHigh calcium intake 10-300 mg/24 hrsThe reference values are for a 24-hour collection. Random specimens and timed specimens collected for other than a 24-hour time period are reported in units of mg/dL, for which reference values are not established.Calcium/Creatinine Ratio

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| Up to age 16 | < 0.20 |
| Adult | < 0.11 |

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| **Critical Values** | Plasma/Serum: <6.0 or >14.0 mg/dL.Critical values must be called according to the Critical Limit Test Value Policy. |
| **Limitations** | The instrument reporting system contains flags and comments to provide the user with information regarding instrument processing errors, instrument status information and potential errors in calcium results. Refer to the [Abbott Architect](https://starnet.childrenshc.org/References/labsop/chem/operator/abbott-architect-operations-manual.pdf) or [Alinity](https://starnet.childrenshc.org/References/labsop/chem/operator/alinity-ci-series-operations-manual.pdf) Operator’s Guides for the meaning of report flags and comments, and instructions for addressing them. Do not report results until a report containing flags and/or comments is resolved.For accurate results, serum and plasma specimens should be free of fibrin, red blood cells, and other particulate matter. Serum specimens from patients receiving anticoagulant or thrombolytic therapy may contain fibrin due to incomplete clot formation.  |
| **Dilutions** |

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| **Alinity c and Architect c4000:**  |
| Auto Dilution: | None |
| Maximum Manual Dilution: | 1:2 |
| Diluent: | Saline |
| Manual Dilution: | Follow Abbott [Architect Operator’s Manual](https://starnet.childrenshc.org/References/labsop/chem/operator/abbott-architect-operations-manual.pdf) or [Alinity Operator’s Manual](https://starnet.childrenshc.org/References/labsop/chem/operator/alinity-ci-series-operations-manual.pdf) instructions for programming manual dilutions. The operator must enter the dilution factor when ordering the manual dilution. The system will use this dilution factor to automatically calculate the concentration of the sample and report the result. If a diluted sample result is less than the lower value of the measuring interval of 2.0 mg/dL, do not report the result. Rerun using an appropriate (lower) dilution or investigate for other possible causes. |

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| **Result Reporting** | **Alinity c and Architect c4000:** **Serum/ Plasma*** Results between 2.0 – 24.0 mg/dL without error messages are released
* Results below 2.0 mg/dL: report as < 2.0 mg/dL instead of the numerical value.
* Results > 24.0 mg/dL without error messages should be manually diluted with a maximum dilution of 1:2 as noted above.
* Results > 48.0 mg/dL after manual dilution are reported as > 48.0 mg/dL rather than the numerical value.

Samples with moderate lipemia should be clarified by ultracentrifugation and repeated. The appropriate comment should be appended, -LINT. Refer to CH 5.301.f1 Assay Flowchart. Urine:* Results between 2.0 – 24.0 mg/dL without error messages are released
* Results below 2.0 mg/dL: report as < 2.0 mg/dL instead of the numerical value.
* Results > 24.0 mg/dL without error messages should be manually diluted with a maximum dilution of 1:2 as noted above.

Results > 48.0 mg/dL after manual dilution are reported as > 48.0 mg/dL rather than the numerical value |
| **Specimen Storage** | Promptly stopper tested specimen and store upright in a specimen rack. Every 8 hours remove specimens to refrigerator/freezer storage. Samples are retained 7 days in specimen storage freezer. |
| **References** | 1. Jacobs & DeMott Laboratory Test Handbook, Lexi-Comp, Inc., Hudson, OH, 5th Edition, 2001
2. Architect Calcium Package Insert, Abbott Laboratories Diagnostics Division, Abbott Park, IL 60064, January 2016.
3. Alinity Calcium Package Insert, Abbott Laboratories Diagnostics Division, Abbott Park, IL 60064, February 2018.
4. CALIPER pediatric reference range database. (2019). Retrieved October 3, 2019, from https://caliper.research.sickkids.ca/#/
5. Alinity c Multiconstituent Calibrator Package Insert, Abbott Laboratories Diagnostics Division, Abbott Park, IL 60064, December 2017.
6. Architect Multiconstiuent Calibrator Package Insert, Abbott Laboratories Diagnostics Division, Abbott Park, IL 60064, August 2017.
7. Bio-Rad Liquichek Unassayed Multiqual Chemistry Control Product Insert, Bio-Rad Laboratories, Irvine, CA 92618
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| **Historical Record** | **Version** | **Written/Revised by:** | **Effective Date:** | **Summary of Revisions** |
| 1 | Erin Bartos | 10/15/2019 | New Procedure for Abbott analyzers |
| 2 | Erin Bartos, Elauteria Earnhardt | October 28,2020 | Added St Paul Alinity c as an analyzer; added mpls Alinity ci, changed QC material, other minor changes |