ElisaRSR™ AQP4 Ab Version 2
Aquaporin-4 (AQP4) Autoantibody
ELISA Version 2 Kit – Instructions for use

RSR Limited
Parc Ty Glas, Llanishen, Cardiff
CF14 5DU United Kingdom
Tel.: + 44 29 2068 9299 Fax: + 44 29 2075 7770
Email: info@rsrltd.com Website: www.rsrltd.com

INTENDED USE
The RSR AQP4 Autoantibody ELISA Version 2 kit is intended for use by professional persons only, for the quantitative determination of AQP4 autoantibodies (AQP4 Ab) in human serum. Neuromyelitis optica (NMO), also known as Devic’s syndrome, is an immune-mediated neurolologic disease that involves the spinal cord and optic nerves. It can be considered to be a disorder distinct from multiple sclerosis (MS). A serum immunoglobulin G autoantibody (NMO-IgG) has been shown to be a specific marker for NMO and the water channel aquaporin 4 (AQP4) has been identified as the antigen for NMO IgG. Measurement of AQP4 Ab can be of considerable value in distinguishing NMO from MS when full clinical features may not be apparent and early intervention may prevent or delay disability.

REFERENCES
V. A. Lennon et al.
V. A. Lennon et al.
B. G. Weinshenker et al.
Neuromyelitis optica IgG predicts relapse after longitudinally extensive transverse myelitis. Annals of Neurology 2006 59: 566 - 569
N. Isebo et al.
Quantitative assays for anti-aquaporin-4 antibody with subclass analysis in neuromyelitis optica. Multiple Sclerosis Journal 2012 18: 1541 – 155
S. Jarius et al.

PATENTS
The following patents apply:

ASSAY PRINCIPLE
In RSR’s AQP4 Ab ELISA Version 2 kit, AQP4 Ab in patients’ sera, calibrators and controls are allowed to interact with AQP4 coated onto ELISA plate wells and liquid phase biotinylated AQP4 (AQP4-Biotin). After incubation at room temperature for 2 hours with shaking, the well contents are discarded. AQP4 Ab bound to the AQP4 coated on the well will also interact with AQP4-Biotin through the ability of AQP4 Ab in the samples to act divalently leaving AQP4-Biotin bound to the well via an AQP4 Ab bridge. The amount of AQP4-Biotin bound is then determined in a second incubation step involving addition of streptavidin peroxidase (SA-POD), which binds specifically to biotin. Excess, unbound streptavidin peroxidase is then washed away and addition of the peroxidase substrate, 3,3’,5,5’-tetramethylbenzidine (TMB), results in formation of a blue colour. This reaction is stopped by the addition of a stop solution, causing the well contents to turn yellow. The absorbance of the yellow reaction mixture at 450nm and 405nm is then read using an ELISA plate reader. A higher absorbance indicates the presence of AQP4 autoantibody in the test sample. Reading at 405nm allows quantitation of high absorbances. It is recommended that values below 10 u/mL should be measured at 450nm. If it is possible to read at only one wavelength 405nm may be used. The measuring interval is 3.0 – 80 u/mL (arbitrary RSR units).

STORAGE AND PREPARATION OF SERUM SAMPLES
Sera to be analysed should be assayed soon after separation or stored, preferably in aliquots, at or below –20°C. 100 µL is sufficient for one assay (duplicate 50 µL determinations). Repeated freeze thawing or increases in storage temperature should be avoided. Do not use lipaemic or haemolysed samples. Studies in which EDTA, citrate and heparin plasma samples were spiked with AQP4 Ab positive sera showed minor changes in signal compared with spiked serum from the same donor. In particular OD450 values with spiked EDTA, citrate and heparin plasmas were 79% - 128% of spiked serum (15 samples with serum concentrations ranging from 2.6 u/mL – 30 u/mL) or 87% - 130% in terms of u/mL. When required, thaw test sera at room temperature and mix gently to ensure homogeneity. Centrifuge serum prior to assay (preferably for 5 min at 10-15,000 rpm in a microfuge) to remove particulate matter. Please do not omit this centrifugation step if sera are cloudy or contain particulates.

SYMBOLS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE</td>
<td>EC Declaration of Conformity</td>
</tr>
<tr>
<td>IVD</td>
<td>In Vitro Diagnostic Device</td>
</tr>
</tbody>
</table>
MATERIALS REQUIRED AND NOT SUPPLIED

Pipettes capable of dispensing 25 μL, 50 μL and 100 μL.
Means of measuring various volumes to reconstitute or dilute reagents supplied.
Pure water.
ELISA Plate reader suitable for 96 well formats and capable of measuring at 450nm and 405nm.
ELISA Plate shaker, capable of 500 shakes/min (not an orbital shaker).
ELISA Plate cover.

PREPARATION OF REAGENTS SUPPLIED

Store unopened kit and all kit components at 2-8°C.

A

AQP4 Coated Wells
12 breakapart strips of 8 wells (96 in total) in a frame and sealed in foil bag. Allow foil bag to stand at room temperature (20-25°C) for 30 minutes before opening.

Ensure wells are firmly fitted in the frame provided. After opening return any unused wells to the original foil bag and seal with adhesive tape. Then place foil bag in the self-seal plastic bag with desiccant provided and store at 2-8°C for up to 4 months.

B1-5

Calibrators
1.5, 5, 20, 40, 80 u/mL (arbitrary RSR units)
5 x 0.7 mL
Ready for use

C1-2

Positive Controls I & II (see label for concentration range)
2 x 0.7 mL
Ready for use

D

Negative Control
0.7 mL
Ready for use

E

AQP4–Biotin
3 vials
Lyophilised

Immediately before use, reconstitute with reconstitution buffer for AQP4-Biotin (F), 1.5 mL per vial. When more than one vial is to be used, pool the contents of the vials and mix gently.

F

Reconstitution Buffer for AQP4-Biotin
10 mL
Ready for use

Streptavidin Peroxidase (SA-POD)
0.8 mL
Concentrated

Dilute 1 in 20 with diluent for diluting SA-POD (H). For example, 0.5 mL (G) + 9.5 mL (H). Store for up to 16 weeks at 2-8°C after dilution.

G

Diluent for SA-POD
15 mL
Ready for use

H

Peroxidase Substrate (TMB)
15 mL
Ready for use

Concentrated Wash Solution
120 mL
Concentrated

Dilute 1 in 10 with pure water before use. Store at 2-8°C up to kit expiry date.

J

Stop Solution
14 mL
Ready for use

ASSAY PROCEDURE

Allow all reagents to stand at room temperature (20-25°C) for at least 30 minutes prior to use. Do not reconstitute AQP4-Biotin until step 2 below. An Eppendorf type repeating pipette is recommended for steps 2, 5, 8, and 9.

1. Pipette 50 μL (in duplicate) of patient sera, calibrators (B1-5) and controls (C1-2 and D) into respective wells. Leave one well empty for blank.
2. Reconstitute AQP4-Biotin and pipette 25 μL into each well (except blank).
3. Cover the frame and shake the wells for 2 hours at room temperature on an ELISA plate shaker (500 shakes per min).
4. Use an ELISA plate washer to aspirate and wash the wells three times with diluted wash solution (J). If a plate washer is not available, discard the well contents by briskly inverting the frame of wells over a suitable receptacle, wash three times manually and tap the inverted wells gently on a clean dry absorbent surface to remove excess wash.
5. Pipette 100 μL of diluted SA-POD (G) into each well (except blank).

6. Cover the plate and incubate for 20 minutes at room temperature on an ELISA plate shaker (500 shakes per min).

7. Repeat wash step 4. If manual washing is being carried out, use pure water for the final wash step (to remove any foam) before tapping the wells dry.

8. Pipette 100 μL of TMB (I) into each well (including blank) and incubate for 20 minutes in the dark at room temperature without shaking.

9. Pipette 100 μL of stop solution (K) into each well (including blank) and shake the plate for approximately 5 seconds on a plate shaker. Ensure substrate incubations are the same for each well.

10. Within 10 minutes, read the absorbance of each well at 450nm and 405nm using an ELISA plate reader, blanked against a well containing 100 μL of TMB (I) and 100 μL stop solution (K) only.

RESULT ANALYSIS

A calibration curve can be established by plotting calibrator concentration on the x-axis (log scale) against the absorbance of the calibrators on the y-axis (linear scale). The AQP4 Ab concentrations in patient sera can then be read off the calibration curve [plotted at RSR as a spline log/lin curve (smoothing factor = 0)]. Other data reduction systems can be used. The negative control can be assigned a value of 0.15 u/mL to assist in computer processing of assay results. Samples with AQP4 Ab concentrations above 80 u/mL can be diluted (e.g. 10 x and/or 100 x) in AQP4 Ab negative serum. Some sera will not dilute in a linear way.

TYPICAL RESULTS (Example only; not for calculation of actual results)

<table>
<thead>
<tr>
<th></th>
<th>A450 nm</th>
<th>Concentration (u/mL)</th>
<th>A405 nm</th>
<th>Concentration (u/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(D)</td>
<td>0.021</td>
<td></td>
<td>0.006</td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>0.085</td>
<td>1.5</td>
<td>0.024</td>
<td>1.5</td>
</tr>
<tr>
<td>B2</td>
<td>0.354</td>
<td>5</td>
<td>0.108</td>
<td>5</td>
</tr>
<tr>
<td>B3</td>
<td>1.577</td>
<td>20</td>
<td>0.468</td>
<td>20</td>
</tr>
<tr>
<td>B4</td>
<td>3.802</td>
<td>40</td>
<td>1.118</td>
<td>40</td>
</tr>
<tr>
<td>B5</td>
<td>6.588</td>
<td>80</td>
<td>1.938</td>
<td>80</td>
</tr>
<tr>
<td>Positive Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(CI)</td>
<td>0.755</td>
<td>12.1</td>
<td>0.224</td>
<td>12.0</td>
</tr>
<tr>
<td>Positive Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(CII)</td>
<td>2.506</td>
<td>28</td>
<td>0.745</td>
<td>28</td>
</tr>
</tbody>
</table>

Absorbance readings at 405nm can be converted to 450nm absorbances by multiplying by the appropriate factor (3.4 in the case of equipment used at RSR).

ASSAY CUT OFF

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Negative</strong></td>
<td>&lt; 3.0 u/mL</td>
</tr>
<tr>
<td><strong>Positive</strong></td>
<td>≥ 3.0 u/mL</td>
</tr>
</tbody>
</table>

This cut off has been validated at RSR. However each laboratory should establish its own normal and pathological reference ranges for AQP4 Ab levels. Also it is recommended that each laboratory include its own panel of control samples in the assay.

CLINICAL EVALUATION

(The information below is derived from 450nm data)

Clinical Specificity

Sera from 358 individual healthy blood donors were tested in the AQP4 Ab ELISA Version 2 kit. 356 (99%) sera were identified as being negative for AQP4 Ab.

Clinical Sensitivity

Of 62 sera from patients with NMO or NMO spectrum disorder (NMOSD) 48 (77%) were positive for AQP4 Ab.

Lower Detection Limit

The negative control was assayed 20 times and the mean and standard deviation calculated. The lower detection limit at 2 standard deviations was 0.17 u/mL.

<table>
<thead>
<tr>
<th></th>
<th>Mean u/mL (n = 25)</th>
<th>CV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>3.9</td>
<td>7.7</td>
</tr>
<tr>
<td>Sample 2</td>
<td>7.0</td>
<td>8.6</td>
</tr>
<tr>
<td>Sample 3</td>
<td>28</td>
<td>3.2</td>
</tr>
<tr>
<td>Sample 4</td>
<td>58</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Intra Assay Precision

<table>
<thead>
<tr>
<th></th>
<th>Mean u/mL (n = 20)</th>
<th>CV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample A</td>
<td>5.0</td>
<td>15.6</td>
</tr>
<tr>
<td>Sample B</td>
<td>13.3</td>
<td>10.5</td>
</tr>
<tr>
<td>Sample C</td>
<td>35</td>
<td>7.9</td>
</tr>
<tr>
<td>Sample D</td>
<td>59</td>
<td>7.5</td>
</tr>
</tbody>
</table>

Inter Assay Precision
Clinical Accuracy
Analysis of 205 sera from patients with autoimmune diseases other than neuromyelitis optica spectrum disorders (NMOSD) indicated no interference from autoantibodies to the TSH receptor (n=110), glutamic acid decarboxylase (n=26), 21-hydroxylase (n=12), the acetylcholine receptor (n=10), thyroid peroxidase (n=15), thyroglobulin (n=10), IA-2 (n=7) or from rheumatoid factor (n=15) in the RSR AQP4 Ab ELISA Version 2.

Interference
No interference was observed when samples were spiked with the following materials; bilirubin at 20 mg/dL or intralipid up to 3000 mg/dL. Interference was seen from haemoglobin at 500 mg/dL.

SAFETY CONSIDERATIONS

Streptavidin Peroxidase (SA-POD)
Signal word: Warning
Hazard statement(s)
H317: May cause an allergic skin reaction
Precautionary statement(s)
P280: Wear protective gloves/protective clothing/eye protection
P302 + P352: IF ON SKIN: Wash with plenty of soap and water
P333 + P313: If skin irritation or rash occurs: Get medical advice/attention
P362 + P364: Take off contaminated clothing and wash it before reuse

Peroxidase Substrate (TMB)
Signal word: Danger
Hazard statement(s)
H360: May damage fertility or the unborn child

ASSAY PLAN

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipette:</td>
<td>50 μL Calibrators, controls and patient sera</td>
</tr>
<tr>
<td>Pipette:</td>
<td>25 μL AQP4-Biotin (reconstituted) into each well (except blank)</td>
</tr>
<tr>
<td>Incubate:</td>
<td>2 Hours at room temperature on an ELISA plate shaker at 500 shakes/min</td>
</tr>
<tr>
<td>Aspirate/Decant:</td>
<td>Plate</td>
</tr>
<tr>
<td>Wash:</td>
<td>Plate three times and tap dry on absorbent material¹</td>
</tr>
<tr>
<td>Pipette:</td>
<td>100 μL SA-POD (diluted 1:20) into each well (except blank)</td>
</tr>
<tr>
<td>Incubate:</td>
<td>20 Minutes at room temperature on a ELISA plate shaker at 500 shakes/min</td>
</tr>
<tr>
<td>Aspirate/Decant:</td>
<td>Plate</td>
</tr>
<tr>
<td>Wash:</td>
<td>Plate three times and tap dry on absorbent material¹,²</td>
</tr>
<tr>
<td>Pipette:</td>
<td>100 μL TMB into each well (including blank)</td>
</tr>
<tr>
<td>Incubate:</td>
<td>20 Minutes at room temperature in the dark without shaking</td>
</tr>
<tr>
<td>Pipette:</td>
<td>100 μL Stop solution into each well (including blank) and shake for 5 seconds</td>
</tr>
<tr>
<td>Read absorbance at 450nm and 405nm within 10 minutes of adding stop solution³</td>
<td></td>
</tr>
</tbody>
</table>

¹It is not necessary to tap the plates dry after washing when an automatic plate washer is used
²Use pure water for the final wash when washing manually
³If it is possible to read at only one wavelength, 405nm may be used