

M2910

ELISA for quantitative measurement of adalimumab drug levels

Ab	ADL	BUF	CAL	CONJ
Antibodies against	Adalimumab	Buffer	Calibrator	Conjugate

HRP	HUM	MOU	REK	TNF
HRP	Human	Mouse	Recombinant	TNF

WELL	≥ - ≤
Well	Range

General information

MabTrack level adalimumab is an enzyme linked immunoassay (ELISA) for fast, reproducible and specific quantitative determination of free adalimumab concentrations in human plasma and serum samples. Identification of drug levels can be important for patient adjusted treatment schedules, as low drug levels are frequently an indication for antibody formation against adalimumab. In addition, low drug levels may be a sign of ineffectiveness of adalimumab before rebound of clinical symptoms. Alternatively, it is proposed that in patients that respond well to adalimumab, the dosing of adalimumab can be reduced according to serum concentrations. Drug level tests can therefore help to adapt patient medication or to switch to an alternative TNF inhibitor.

By closely monitoring drug levels and antibody formation in combination with disease activity, it is possible for the physician to objectively determine the drug activity in an individual patient and to design patient specific treatment schedules. The therapeutic antibody adalimumab affects tumor necrosis factor (TNF) and is frequently administered to patients who suffer from rheumatic arthritis, intestinal disorders, dermatological diseases and cancer. TNF plays an important role in inflammation, it may cause pain, swollen joints and stiffness in rheumatoid arthritis patients and ulcers in patients with intestinal bowel disease. Inhibition of TNF is therefore believed to relieve some of these symptoms and thus to improve quality of life of patients. Plasma and serum levels of TNF inhibitors are highly variable between patients, and clearly correlate to the clinical symptoms in patients. In approximately 25 to 30% of the rheumatoid arthritis patients treated with adalimumab, antibodies are formed directed towards the idiotype of adalimumab. This can hamper the function of the TNF inhibitor and can cause a reduction in plasma concentration of the TNF inhibitor.

Clinical optimal ranges, e.g. therapeutic ranges, were determined with the adalimumab ELISA for rheumatoid arthritis: 5–8 µg/mL (Pouw et al.) and in dermatology (Psoriasis): 3.5–7 µg/mL (Menting et al.).

Principle of the test

The MabTrack level adalimumab ELISA is a "sandwich-type" of enzyme immunoassay. In the microtiter plates, TNF is captured by monoclonal antibodies coated to polystyrene microtiter wells. The adalimumab, present in the patient sample, the calibrator or the controls, binds to the TNF on the microtiter plate. Non-bound material is then removed by washing. Subsequently, a horseradish peroxidase-labeled monoclonal anti-drug antibody is added. This antibody binds to the adalimumab/TNF/anti-TNF complex present in the microtiter well. After removal of non-bound HRP conjugate by washing, substrate solution is added to the wells. A colored product is formed in proportion to the amount of adalimumab present in the sample, calibrator and controls. After the reaction has been terminated by the addition of a stop solution, absorbance is measured in a microtiter plate reader. From the absorbance of samples and those of the calibrator curve, the concentration of adalimumab can be determined by interpolation with the calibrator curve.

Package contents

Mouse-anti-TNF/recombinant TNF pre-coated microtiter plate	12 x 8 wells	-	M2911	ready for use
Calibrator 1-6	6 x 1 mL	black caps	M2912	ready for use
Control 1	1 x 1 mL	clear cap	M2913	ready for use; therapeutic range
Control 2	1 x 1 mL	clear cap	M2914	ready for use; sub-therapeutic range
Human anti-adalimumab HRP-conjugate	1 x 12.5 mL	brown bottle	M2915	ready for use
Wash buffer stock solution	1 x 50 mL	white bottle	M1805	dilute 1:20 in distilled water
HPE dilution buffer	1 x 50 mL	white bottle	M2940	ready for use
TMB substrate solution	1 x 12.5 mL	brown bottle	M1821	ready for use
Stop solution 0.18 M H ₂ SO ₄	1 x 13.0 mL	white bottle	M1823	ready for use
Plate seals	10 x	-	-	-



Package contents, continued

- The flat-bottom microtiter plate consists of 12 strips of 8 wells ready for use. All the wells are coated with TNF-specific mouse monoclonal antibody and recombinant TNF. The microtiter plate is vacuum sealed in a plastic pouch containing desiccant. The kit provides the flexibility to use the microtiter plate on separate occasions. Determine the number of strips required to test the desired number of samples plus 8 wells needed for running calibrators and controls. Remove strips that will not be used from the microtiter plate-frame and re-pack them in the plastic pouch containing the desiccant.
- After opening, all reagents and the microtiter plate strips may be used for ≤ 4 weeks if stored at 2–8 °C.
- Consult the enclosed information leaflet for the kit specific adalimumab concentrations in calibrator 1–6 and controls 1 and 2.

Additional materials and/or equipment

- Distilled or deionized water.
- Calibrated pipettes (5–1000 μ L).
- Multichannel pipette (30–300 μ L).
- Beakers, flasks, cylinders, and liquid containers necessary for preparation of reagents.
- Microtiter plate reader (for reading OD at 450 nm).

Precautions

For in vitro diagnostic use only. Reagents should be stored at 2–8 °C. Leaking or damaged vials must not be used. Reagents (unopened or opened) should not be used beyond the expiration date, which is printed on the label of the vial. The reagent cannot be assumed to be free from infectious agents. Care must be taken in the use and disposal of each container and its contents. Waste-disposal, after completion of the test, should be performed according to your laboratory regulations.

Test procedure

Specimen collection and preparation

1. Trough samples must be used to measure the concentration of adalimumab, thus samples must be taken within 24 hours BEFORE the drug is injected to make sure that the indicated expected levels reflect the trough level of the patient.
2. Only serum and EDTA plasma can be used in the assay.
3. Separate plasma or serum from the blood cells within 4 hours after collection and perform the analyses immediately. If testing of the samples is delayed, they can be stored at 2–8 °C for 72 hours. If samples are not analyzed within 72 hours, the samples must be stored frozen, they can be stored at ≤ -18 °C for 12 months.
4. Aliquot samples to avoid freeze-thaw cycles.
5. Prior to the assay, frozen samples must be thawed at room temperature. Do not use 37 °C or 56 °C water baths for thawing.
6. Mix the samples just before preparing the dilutions.

Dilution of the samples

- The patient samples are each incubated in one well. To improve the reliability of the ELISA test, it is recommended to perform duplicate determinations for each sample.
- A dilution of 1:1500 can be used in this assay to measure adalimumab levels in patients.
- If the concentration of the sample is too high to obtain an exact concentration, repeat the test with a sample dilution of 1:2000 to obtain a reliable result.
- If the concentration of the sample is too low to obtain an exact concentration, repeat the test with a sample dilution of 1:200 to obtain a reliable result.

Dilution	Sample type	HPE volume
1:50	5 μ L undiluted patient sample	245 μ L
1:200	50 μ L 1:50 pre-diluted patient sample	150 μ L
1:1500	10 μ L 1:50 pre-diluted patient sample	290 μ L
1:2000	5 μ L 1:50 pre-diluted patient sample	195 μ L

Preparation of the working-strength solution of the wash buffer

Prepare a working-strength solution by adding 50 mL of the wash buffer stock solution (this is the total volume of one bottle) to 950 mL of distilled water. The working-strength solution can be stored up to 2 months at 2–8 °C.

Preparation for the ELISA test procedure

1. Allow all reagents to reach room temperature (18–25 °C).
2. The complete assay must be performed at room temperature (18–25 °C) without shaking.
3. Do not allow wells to stand uncovered or dry for extended periods between incubation steps.
4. Carefully remove all air bubbles from the wells before incubation.
5. To avoid cross contamination use disposable pipette tips for each transfer and use new plate seals for each incubation/fixation step in the ELISA experiment.
6. Mix all reagents thoroughly but gently before use (without foaming).



Performance of the ELISA test procedure

1. Remove the microtiter plate with the required number of microtiter plate strips from the pouch. The unused strips can be stored in the plastic pouch with the desiccant.
2. Prepare the wash buffer and the samples according to protocol.
3. Add 100 µL per well of calibrators, controls or diluted patient samples according to the proposed microtiter plate lay-out or your own lay-out. Close the vials of the calibrators and controls after use, to prevent evaporation.
4. Cover the microtiter plate with adhesive seal and incubate for 1 hour.
5. Aspirate supernatants from wells and fill each well with 250 µL of diluted wash buffer. Leave the wash buffer in each well for 30 to 60 seconds per washing cycle, then empty the wells. After washing (manual and automated washing), thoroughly dispose of all liquid from the microtiter plate by tapping it on absorbent paper with the openings facing downwards to remove all residual wash buffer. Repeat this four times. After the final wash the wells must be dry!
6. Add 100 µL of the anti-adalimumab HRP-conjugate to each well.
7. Cover microtiter plate with adhesive seal and incubate for 1 hour.
8. Aspirate supernatants from wells and fill each well with 250 µL of diluted wash buffer. Leave the wash buffer in each well for 30 to 60 seconds per washing cycle, then empty the wells. After washing (manual and automated washing), thoroughly dispose of all liquid from the microtiter plate by tapping it on absorbent paper with the openings facing downwards to remove all residual wash buffer. Repeat this four times. After the final wash the wells must be dry!
9. Add 100 µL of TMB substrate solution to each well.
10. Incubate the microtiter plate in the dark and do not shake. Check the color formation every 5 minutes, when the blue color has developed in the positive wells and the blank is still colorless the reaction must be stopped. The average incubation time is 10 ± 1 minutes.
11. Stop the reaction by adding 100 µL of stop solution per well.
12. Measure the microtiter plate in an ELISA reader at 450 nm. Read the plate within 30 minutes after the stop solution is added. It is allowed to use a second, reference wavelength of 540–620 nm during measurement.

Proposed microtiter plate lay-out

The calibration curve and controls must be included for each quantitative analysis run, they can be performed in one single row. The reagents provided give the user the possibility to use the microtiter plate in one to maximally four runs. A proposed microtiter plate lay-out is given for use in one single run.

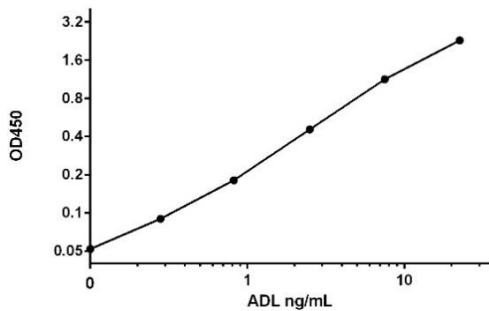
	1	2	3	4	5	6	7	8	9	10	11	12
A	CAL1	sample 1 DIL 1	sample 5 DIL 1	sample 9 DIL 1	sample 13 DIL 1	sample 17 DIL 1	sample 21 DIL 1	sample 25 DIL 1	sample 29 DIL 1	sample 33 DIL 1	sample 37 DIL 1	sample 41 DIL 1
B	CAL2	sample 1 DIL 1	sample 5 DIL 1	sample 9 DIL 1	sample 13 DIL 1	sample 17 DIL 1	sample 21 DIL 1	sample 25 DIL 1	sample 29 DIL 1	sample 33 DIL 1	sample 37 DIL 1	sample 41 DIL 1
C	CAL3	sample 2 DIL 1	sample 6 DIL 1	sample 10 DIL 1	sample 14 DIL 1	sample 18 DIL 1	sample 22 DIL 1	sample 26 DIL 1	sample 30 DIL 1	sample 34 DIL 1	sample 38 DIL 1	sample 42 DIL 1
D	CAL4	sample 2 DIL 1	sample 6 DIL 1	sample 10 DIL 1	sample 14 DIL 1	sample 18 DIL 1	sample 22 DIL 1	sample 26 DIL 1	sample 30 DIL 1	sample 34 DIL 1	sample 38 DIL 1	sample 42 DIL 1
E	CAL5	sample 3 DIL 1	sample 7 DIL 1	sample 11 DIL 1	sample 15 DIL 1	sample 19 DIL 1	sample 23 DIL 1	sample 27 DIL 1	sample 31 DIL 1	sample 35 DIL 1	sample 39 DIL 1	sample 43 DIL 1
F	CAL6 =blank	sample 3 DIL 1	sample 7 DIL 1	sample 11 DIL 1	sample 15 DIL 1	sample 19 DIL 1	sample 23 DIL 1	sample 27 DIL 1	sample 31 DIL 1	sample 35 DIL 1	sample 39 DIL 1	sample 43 DIL 1
G	CTRL 1	sample 4 DIL 1	sample 8 DIL 1	sample 12 DIL 1	sample 16 DIL 1	sample 20 DIL 1	sample 24 DIL 1	sample 28 DIL 1	sample 32 DIL 1	sample 36 DIL 1	sample 40 DIL 1	sample 44 DIL 1
H	CTRL 2	sample 4 DIL 1	sample 8 DIL 1	sample 12 DIL 1	sample 16 DIL 1	sample 20 DIL 1	sample 24 DIL 1	sample 28 DIL 1	sample 32 DIL 1	sample 36 DIL 1	sample 40 DIL 1	sample 44 DIL 1

Results

1. Every in-house or on-line available software method for calculation of concentrations may be used. Use non-linear regression analysis for curve fitting. Four-parameter (4PL) logistic regression analysis is recommended, but five-parameter (5PL) logistic regression or third order polynomial curve fitting can be used as well. A general method for calculation by hand is given.
2. Record the absorbance at 450 nm for each well containing calibrator.
3. Plot the absorbance on the Y-axis on a linear scale and plot the adalimumab concentration of the calibrator sample on the X-axis on a log scale and draw the best fitting curve.
4. Record the absorbance at 450 nm for each well containing a specific sample.
5. Locate the net average absorbance value found for each sample on the vertical axis and follow a horizontal line intersecting the calibrator curve.
6. Draw a vertical line from the intersection of the calibrator curve towards the X-axis.
7. At the intersection with the X-axis, read the adalimumab concentration from the horizontal axis.
8. Multiply the obtained adalimumab concentration with the dilution factor of the sample, this is the actual concentration of adalimumab in the sample. For control 1 and control 2 a dilution factor of 1:1500 must be used.
9. Calculate the average of the duplicate values for the sample.



Example of standard curve after 10 minutes of color formation:



Interpretation

The optimal therapeutic concentration of adalimumab depends on the disease in combination with patient specific characteristics. When performing the level test for diagnostic purposes and/or to determine the patient's treatment protocol, the concentration found can never provide a definite diagnosis, but must be considered as an indication of the clinical situation possibly requiring further diagnostic investigation. Clinical parameters must be used together with the adalimumab drug concentration in the process of decision making. Moreover, for patients with a low concentration of adalimumab, anti-adalimumab antibodies must be measured and added to the results of the immunogenicity test and the clinical parameters in the process of decision making.

Indication of therapeutic levels for rheumatoid arthritis patients treated with adalimumab*	
Healthy donors and patients not treated with adalimumab	negative
Sub-therapeutic levels of adalimumab	< 5 µg/mL
Normal therapeutic levels of adalimumab	5-8 µg/mL**
Elevated levels of adalimumab	> 8 µg/mL

*Only indications for therapeutic values are given, each laboratory must define its own cut-off values for diagnostic purposes.

**The normal therapeutic level is the concentration at which a patient has a higher probability of a good to moderate clinical response. The normal therapeutic level is not necessarily equal to the optimal therapeutic level. The optimal therapeutic level is related to the disease and the patient's individual parameters.

Specifications

The values cited for specific performance characteristics of the test represent typical results and are not to be viewed as specifications for this kit. Consult the enclosed information leaflet for the kit specific assay range and for the adalimumab concentration in the calibrators.

Recovery	: 99% at 2 µg/mL (1:1500)		
Limit of quantification	lower	: 0.06 µg/mL (1:200)	
	higher (antigen excess)	: no antigen excess observed (45 µg/mL at 1:2000)	
Precision	Total precision	between-run precision	
	0.23 µg/mL (1:200)	: 15.0%	15.4%
	2.00 µg/mL (1:1500)	: 10.0%	10.1%
	16.0 µg/mL (1:2000)	: 5.6%	5.1%
Linear range	: 1-30 µg/mL		
No cross reactivity with	: TNF inhibitors infliximab, etanercept and golimumab		
Interference factors	: interference < 20% with:		
	hemoglobin	-	1 and 50 mg/mL
	bilirubin conjugated	-	0.02 and 0.5 mg/mL
	bilirubin unconjugated	-	0.1 and 1.5 mg/mL
	triglycerides	-	15 and 50 mg/mL
	human serum albumin	-	80 mg/mL
	rheumatoid factor (RA)	-	1600 U/mL
Method comparison	assay	: 65 patient samples were compared to the in-house validated method	
	analysis	: Passing and Bablock: $y = 0.93x + 0.22$ Spearman correlation: 0.98	



Limitations

- The kit has been designed for professional use only, the user must be trained and familiar with ELISA test procedures.
- For optimal performance of ELISA make sure that all pipets and systems are checked and under full maintenance service according to described procedures of the manufacturers.
- Only manual testing of this kit, as described in this IFU, is validated. All claims in this IFU are validated with the manual testing procedure. When using the kit on an ELISA automate, the test must be validated by the user before use. The claims in this IFU are not valid for the performance of this kit on an ELISA machine.
- When the controls are not within the indicated range, the results are not valid and the test must be repeated.
- As the controls are pre-diluted, they cannot be used to check sample and reagent preparation by the user.
- Samples that have an OD450 nm outside the calibrator curve are not valid and cannot be used for calculations; extrapolation of the results is not acceptable. These samples must be measured in lower or higher dilutions.
- False positive or negative results can be obtained when samples are used with interference factors higher than indicated in the specifications.
- Only reagents supplied with the kit must be used, do not use reagents from different batches or from different kit lots, these are not interchangeable. However, the HPE, TMB, stop and wash buffer may be used from similar kits for biologics, provided that the materials are within their shelf life and the materials were stored in closed bottles at 2-8 °C.
- Reagents or remnants of reagents (e.g. dead volume) cannot be mixed with contents of freshly opened vials.
- Caps and vials are not interchangeable, caps must be replaced on the corresponding vials.
- NaN₃ cannot be added to the reagents, this affects the performance of the test.
- Do not use aluminum foil during the incubation steps.
- The concentrated buffer may contain salt crystals. Before preparing the working-strength buffer, warm the concentrated buffer BRIEFLY to 37°C to dissolve the crystals.

References

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