Infectious Uveitis in Immunocompromised Patients and the Diagnostic Value of Polymerase Chain Reaction and Goldmann-Witmer Coefficient in Aqueous Analysis

ARNAUD C. WESTENENG, ANIKI ROTHOVA, JOKE H. DE BOER, AND JOLANDA D. F. DE GROOT-MIJNES

• PURPOSE: To establish the causes of uveitis in immunocompromised patients and to determine the contribution of polymerase chain reaction (PCR) and Goldmann-Witmer coefficient (GWC) analysis of aqueous humor in patients with an infectious etiology.

• DESIGN: Retrospective case series of 56 consecutive immunocompromised patients with uveitis.

• METHODS: All patients underwent full ophthalmologic examination and laboratory blood analysis for uveitis. Aqueous humor analyses were performed using PCR and GWC for cytomegalovirus (CMV), herpes simplex virus (HSV), varicella zoster virus (VZV), and *Toxoplasma gondii*.

• RESULTS: Of 56 immunocompromised patients, 43 (77%), all posterior and panuveitis, had intraocular infections. Twenty-one (49%) had CMV, three (7%) had VZV, 11 (26%) had *T. gondii*, six (14%) had *Treponema pallidum*, and one (2%) each had *Aspergillus* and *Candida*. In AIDS patients, CMV was the most common cause. A strong correlation between AIDS and ocular syphilis was also observed ($P = .007$). In non-AIDS immunocompromised patients, *T. gondii* was most frequently detected. Twenty-seven patients were examined by both PCR and GWC; five (18.5%) were positive by both assays, 15 (55.5%) were positive by PCR alone and seven (26%) by GWC alone. Viral infections were detected by PCR in 16 of 17 (94%) cases; *T. gondii* in four of 10 (40%) patients. Using GWC, a viral infection was diagnosed in three of 17 (18%) and *T. gondii* in nine of 10 (90%) cases.

• CONCLUSIONS: In immunocompromised patients, PCR is superior in diagnosing viral infections. Analysis of intraocular antibody production played a decisive role in the diagnosis of ocular toxoplasmosis. (Am J Ophthalmol 2007;144:781–785. © 2007 by Elsevier Inc. All rights reserved.)

Accepted for publication Jun 26, 2007.

From the F. C. Donders Institute of Ophthalmology (A.C.W., A.R., J.H.d.B., J.D.F.d.G.-M.); and the Department of Medical Microbiology, University Medical Center Utrecht (J.D.F.d.G.-M.), Utrecht, The Netherlands.

Inquiries to Jolanda D. F. de Groot-Mijnes, Department Medical Microbiology, Room G04.614, University Medical Center Utrecht, Heidelberglaan 100, 3584 CX Utrecht, The Netherlands; e-mail: J.D.F.deGroot@umcutrecht.nl

INFECTIOUS UVEITIS IN IMMUNOCOMPROMISED PATIENTS is a rapidly progressive and blinding disorder that can be halted by prompt administration of specific antimicrobial therapy.[1–5] The long-term antimicrobial treatment is essential for the prevention of further attacks or activity in the not yet affected eye.[6] Therefore a rapid identification of the causative agent is indispensable.

In immunodeficient patients with uveitis, the ophthalmoclinical features are not discriminatory for a specific diagnosis.[6] In addition, the correct diagnosis of the intraocular infection cannot be based on systemic findings only, because the patients might suffer from multiple infections.[7–10] Consequently, the analysis of intraocular fluids constitutes an important tool for a correct and quick diagnosis.[3,11,12]

Polymerase chain reaction (PCR) and Goldmann-Witmer coefficient (GWC) analysis of aqueous humor play a prominent role in the diagnosis of viral and *Toxoplasma* infections in immunocompetent patients.[11,13–17] In immunocompromised patients, PCR analysis is preferred because the production of antibodies is unpredictable.[3,7] However, immunodeficient patients with a positive GWC were reported previously.[11,12] The diagnostic value of both techniques in immunocompromised patients is not known. In this report, the specific diagnoses of 56 immunocompromised patients with intraocular inflammation were assessed and the diagnostic value of PCR and GWC analysis performed on aqueous humor was determined.

METHODS

THIS STUDY INCLUDED 56 CONSECUTIVE IMMUNOCOMPROMISED patients with uveitis who underwent aqueous humor analysis between February 1994 and October 2005. The clinical data had been collected for all patients. None of the patients developed adverse effects during or after aqueous sampling.

Serum and cerebrospinal fluid (CSF) samples were analyzed using the *T. Pallidum* particle agglutination [TPPA] (Serodia) assay and Veneral Disease Research Laboratory [VDRL] (Abbott) assay according to the instructions of the manufacturer.

All aqueous humor samples were taken at the uveitis clinic of the University Medical Center Utrecht (UMCU)

0002-9394/07/$32.00
doi:10.1016/j.ajo.2007.06.034

and were stored at −80 C in sterile screw-cap tubes within five hours of collection before processing for laboratory analysis. Until October 2001, the samples were analyzed at the Netherlands Ophthalmic Research Institute (NORI) in Amsterdam. From then on, the analyses were performed at the UMCU. The PCR and GWC assays for cytomegalovirus (CMV), herpes simplex virus (HSV), varicella zoster virus (VZV), and *Toxoplasma gondii* at the NORI and the UMCU were described previously.[3,17] The GWC was considered positive when its value exceeded 3.[11,18] None of the samples was inhibited during PCR analysis or were unable to be analyzed for the presence of antibody. Of the 56 samples, 27 were analyzed at the NORI and 29 at the UMCU. In 31 of 56 patients a positive result was obtained. Statistical analysis did not reveal significant differences in positive results for PCR (viral $P = .625$; toxoplasmosis $P = .348$) or GWC (viral $P = .272$; toxoplasmosis $P = .600$) analysis between the NORI and the UMCU. For further analysis of the diagnostic contribution of PCR and GWC, only patients that were analyzed by both assays were included. In cases of multiple sample analysis, the first positive aqueous humor sample was used.

For statistical analysis the Fisher exact test was applied. A value of $P < .05$ was considered significant.

RESULTS

IN THIS SERIES OF 56 IMMUNOCOMPROMISED PATIENTS, THE cause of immune insufficiency was AIDS in 27 cases. The remainder (nonAIDS; n = 29) consisted of 18 patients with immunosuppressive therapy because of organ transplantation, bone marrow (BMT) or hematopoietic stem cell transplantation and 11 patients with immunosuppressive therapy because of rheumatoid arthritis (n = 6), malignancy (n = 1), or other diseases (Wegener granulomatosis in two, systemic lupus erythematosus in one, and midline lethal granuloma in one case). Posterior uveitis and panuveitis (n = 51) were more common than anterior uveitis (n = 5; Table 1). In the five immunocompromised patients with anterior uveitis, no infectious agent was detected. After completion of the diagnostic assays in patients with posterior and panuveitis, 43 (84%) were considered of infectious and eight (16%) of noninfectious origin (Table 1).

Of the 43 patients with infectious uveitis, a CMV, VZV or *T. gondii* infection was detected by aqueous humor analysis in 31 (72%) patients (Table 1). No intraocular HSV infections were found. Furthermore, one patient was positive for *Aspergillus* antigen in the vitreous fluid. Six patients had ocular syphilis. All six had a positive serum TPPA and four a positive serum VDRL. Five of six patients also had a positive TPPA on cerebrospinal fluid. Of the two VDRL-negative patients, one previously had insufficiently treated syphilis and presented with active neurosyphilis at the time of ocular involvement; the other was an HIV-positive patient, who had never been treated for syphilis and possibly had late syphilis with ocular involvement. In the five remaining patients with infectious uveitis, the definitive diagnosis was based on other diagnostic tools in combination with clinical features (Table 1).

TABLE 1. Etiology of Uveitis in 56 Immunocompromised Patients

	n	%
Posterior and panuveitis	51	
Infectious	43	
Cytomegalovirus	21	37
Varicella zoster virus	3	5
Toxoplasma gondii	11	20
*Treponema pallidum**	6	11
Aspergillus†	1	2
Candida spp.‡	1	2
Noninfectious	8	
HLA-B27 associated	1	2
Behçet's disease	1	2
Associated with graft-versus-host disease	1	2
Systemic lupus erythematosus	1	2
Lymphoma	1	2
Immune recovery uveitis#	2	3
Undetermined	1	2
Anterior uveitis	5	
Associated with graft-versus-host disease	2	3
Undetermined	3	5
Total	56	100

*All six patients had positive serology for *Treponema pallidum*, five of which had positive cerebrospinal fluid titers as well. One patient also had a borderline toxoplasma Goldmann-Witmer coefficient (GWC) value and may have had a double infection.

†Positive for *Aspergillus* antigen in vitreous biopsy.

‡Diagnosis was based on clinical presentation and positive reaction to treatment.

#Both patients had suffered from cytomegalovirus retinitis before highly active antiretroviral therapy. At the time of sampling, the cytomegalovirus GWCs were negative.

Cytomegalovirus (n = 21) was the most common agent, followed by *T. gondii* (n = 11) and *Treponema pallidum* (n = 6) (Table 1). Statistical analysis revealed a strong correlation between having AIDS and ocular syphilis (6/21 in AIDS patients vs 0/22 in nonAIDS patients, $P = .009$; Table 2). No significant correlation between AIDS and CMV retinitis was observed (13/21 in AIDS patients and 8/22 in nonAIDS patients, $P = .09$). However, the 95% confidence interval of the difference is –3.4% to 54.4%, suggesting borderline significance. All patients with AIDS-related CMV retinitis were diagnosed before 1997. In nonAIDS patients, ocular toxoplasmosis was the most frequently occurring infection (10/22 vs 1/21 in patients with AIDS, $P = .002$).

Of the 31 patients with a positive laboratory result on aqueous humor, 27 were examined by both PCR and

TABLE 2. Distribution of Pathogens Causing Infectious Uveitis in 43 Immunocompromised Patients

	AIDS		NonAIDS		
	n	%	n	%	*P*
Cytomegalovirus	13	62	8	38	.09*
Varicella zoster virus	1	33	2	67	ND†
Toxoplasma gondii	1	9	10	91	.002
Treponema pallidum	6	100	0	0	.007
Aspergillus	0	0	1	100	ND
Candida	0	0	1	100	ND
Total	21	100	22	100	

ND = not determined because of insufficient number of patients.

*95% confidence interval of the difference: −3.4% to 54.4%.

TABLE 3. Simultaneous PCR and Goldmann-Witmer Coefficient Analyses in Aqueous Humor from 27 Immunocompromised Patients with Infectious Uveitis

	PCR+/ GWC−		PCR+/ GWC+		PCR−/ GWC+		Total
	n	%	n	%	n	%	n
Pathogen							
Cytomegalovirus	11	*79*	2	*14*	1	*7*	14
Varicella zoster virus	3	*100*	0	*0*	0	*0*	3
Toxoplasma gondii	1	*10*	3	*30*	6	*60*	10
Total	15	*55.5*	5	*18.5*	7	*26*	27

GWC = Goldmann-Witmer coefficient.

GWC. Of these, the diagnosis was established by PCR solely in 15 (55.5%), by both PCR and GWC in five (18.5%) and by GWC only in seven (26%) cases (Table 3).

When the results were analyzed for each pathogen, positive PCR results were obtained in 13 of 14 (93%) CMV and all three VZV infections (Table 3). Only three of 14 (21%) patients with CMV and none with VZV had positive GWC results. In contrast, in *T. gondii* infections, nine of 10 (90%) patients were diagnosed by GWC and four of 10 (40%) by PCR (Table 3). Statistical analyses confirmed a strong association between positive PCR results in patients with viral uveitis and between positive GWC results in ocular toxoplasmosis ($P = .004$ and $P = .000$, respectively). In patients with AIDS, PCR was positive in 10/11 (91%) and GWC in 1/11 (9%) cases, whereas in patients with immunosuppressive medications, 10/16 (63%) were positive by PCR and 11/16 (69%) by GWC (Table 4).

No association was found between positive laboratory results and uni- or bilateral disease, or intraocular inflammation, defined as the presence of cells in the eye ($P = .243$ and $P = .167$, respectively). Furthermore, no association was found between positive PCR results and the time of sampling being less or more than two weeks after the onset of symptoms ($P = .092$ for all, $P = .767$ for viral and $P = .203$ for *Toxoplasma* infections).

DISCUSSION

OUR STUDY DEMONSTRATES THAT IN A MAJORITY OF IMmunosuppressed patients the uveitis is of infectious origin, with CMV being the overall most common causative agent. In patients with AIDS, the two most common causes of infectious uveitis were CMV (13 of 21; 62%) and *T. pallidum* (six of 21; 29%), whereas in nonAIDS immunocompromised patients, infections with *T. gondii* (10 of 22; 45%) and CMV (eight of 22; 36%) were most frequent.

An interesting finding is the association between AIDS and ocular syphilis and the absence of ocular syphilis in transplant patients. This is most likely because the risk factors for infection with HIV and *T. pallidum* are similar.[19] Ocular syphilis is commonly diagnosed by both clinical manifestations and positive serologic assays.[5,19–21] Attempts by us to determine GWC in ocular fluids of patients suspected of ocular syphilis by applying the TPPA have not yielded positive results yet. *Treponema*-specific enzyme-linked immunosorbent assays have been developed, but it has to be determined whether these assays can be used for GWC analysis.[19] Recently, positive PCR results on ocular fluid were reported and may prove valuable for the diagnosis of ocular syphilis.[22] So far no studies using PCR and GWC determination have been conducted and the contribution of either assay in the diagnosis of ocular syphilis, in both immunocompromised and immunocompetent patients, remains to be determined yet.

The results on causes of uveitis in patients with AIDS are consistent with earlier findings.[3–5,23,24] However, little is known about the etiology of uveitis in patients immunocompromised other than by AIDS.[25] Overall, we found no significant difference in the frequency of CMV retinitis between patients with AIDS and nonAIDS patients (Table 2). However, since the introduction of highly active antiretroviral therapy (HAART), which has been reported to result in a considerable decline of disseminated and ocular CMV infections in patients with AIDS,[24,26,27] no new cases of CMV retinitis were observed in our patients with AIDS. Indeed, comparison of the incidence of CMV retinitis in patients with AIDS and nonAIDS patients before and after the introduction of HAART in The Netherlands in 1997 revealed a significant difference after the introduction of HAART ($P = .002$). In the posttransplant patients, three of four (75%) bone marrow transplantation/hematopoietic stem cell transplantation patients suffered from CMV retinitis, whereas only three of 11 (27%) patients with organ transplants had uveitis caused by CMV. Although the numbers of patients are very small and the data are not significantly different ($P = .143$), it is possible that a more severe and prolonged immunosuppres-

TABLE 4. Overview of Clinical Data and Laboratory Results of 27 Patients with Aqueous Examination by Both PCR and Goldmann-Witmer Coefficient

	Gender	Cause of Immunosuppression	Pathogen	Laboratory Results	Intraocular Inflammation
1	M	AIDS	Cytomegalovirus	PCR+	Yes
2	F	AIDS	Cytomegalovirus	PCR+	No
3	M	AIDS	Cytomegalovirus	PCR+	No
4	M	AIDS	Cytomegalovirus	PCR+	Yes
5	M	AIDS	Cytomegalovirus	PCR+	No
6	M	AIDS	Cytomegalovirus	PCR+	Unknown
7	M	AIDS	Cytomegalovirus	PCR+	Yes
8	M	AIDS	Cytomegalovirus	PCR+	Yes
9	M	AIDS	Cytomegalovirus	PCR+	Yes
10	M	AIDS	Varicella zoster virus	PCR+	Yes
11	M	AIDS	*Toxoplasma gondii*	GWC+	Yes
12	F	Renal transplant	Cytomegalovirus	PCR+/GWC+	Yes
13	M	Renal transplant	Cytomegalovirus	PCR+	Yes
14	M	Renal transplant	*Toxoplasma gondii*	GWC+	Yes
15	F	Renal transplant	*Toxoplasma gondii*	GWC+	Yes
16	M	Renal transplant	*Toxoplasma gondii*	GWC+	Yes
17	M	Heart transplant	Cytomegalovirus	GWC+	Yes
18	M	Heart transplant	*Toxoplasma gondii*	PCR+	Yes
19	M	Heart transplant	*Toxoplasma gondii*	PCR+/GWC+	Yes
20	F	Liver transplant	*Toxoplasma gondii*	PCR+/GWC+	Yes
21	F	Liver transplant	*Toxoplasma gondii*	GWC+	Yes
22	F	HSCT	Cytomegalovirus	PCR+	Yes
23	F	BMT	Varicella zoster virus	PCR+	No
24	F	Wegener granulomatosis	Cytomegalovirus	PCR+/GWC+	Yes
25	M	Wegener granulomatosis	Varicella zoster virus	PCR+	Yes
26	F	Rheumatoid arthritis	*Toxoplasma gondii*	GWC+	Yes
27	F	Rheumatoid arthritis	*Toxoplasma gondii*	PCR+/GWC+	Yes

GWC = Goldmann-Witmer coefficient; HSCT = hematopoietic stem cell transplantation; BMT = bone marrow transplantation.

sion may contribute to the incidence of CMV retinitis in hematologic transplant patients.

No differences in positive results were found for patients with uni- or bilateral disease or the presence or absence of intraocular inflammation. In immunocompetent patients, a clear association was noted between the type of positive assay (PCR or GWC) and the time to sampling after onset of inflammation.[3,17] This correlation was not observed in this study of immunocompromised patients. However, the limited number of patients precludes definitive conclusions.

It is noteworthy that, despite the fact that our patients had an infectious inflammation located in the posterior segment of the eye, most exhibited positive results on aqueous humor analysis. Indeed, in a recent study it was demonstrated that in 29% of patients with posterior uveitis aqueous analysis revealed an infectious cause and change of treatment was required in 24%.[28] Although vitreous biopsies are recommended for these cases, this study suggests that aqueous humor analysis might be a valuable and less invasive additional diagnostic procedure also in immunocompromised patients. The comparison of positive results from aqueous and vitreous analysis in different types of uveitis would be required to determine which diagnostic approach is most valuable in a given clinical situation.

The results presented here demonstrate that PCR analysis is the mainstay in the laboratory investigations of aqueous humor from immunosuppressed patients with viral uveitis. However, the yield of positive results can be improved by the determination of GWC. Although GWC seems to contribute modestly to the diagnosis of viral infections, for identifying ocular toxoplasmosis in immunosuppressed patients this assay is of considerable value. Of the 10 cases with ocular toxoplasmosis, PCR results were negative in six and these patients were diagnosed by GWC solely. In essence, the data for immunocompromised patients are similar to those reported for immunocompetent patients.[17]

Immunocompromised patients with infectious uveitis frequently have atypical clinical manifestations and require a quick and adequate antimicrobial treatment. Aqueous humor analysis by PCR and GWC of our immunosuppressed patients with intraocular inflammation provided information on the infectious etiology and allowed early therapeutic intervention in the majority of cases.

THIS STUDY WAS SUPPORTED BY THE DR. F. P. FISCHER FOUNDATION, AMERSFOORT, THE NETHERLANDS (DR DE GROOT-Mijnes). The authors indicate no financial conflict of interest. Involved in design and conduct of study (A.C.W., A.R., J.D.F.d.G.-M.); collection, management, analysis, and interpretation of the data, and preparation, review, or approval of the manuscript (A.C.W., A.R., J.H.d.B., J.D.F.d.G.-M.). This study was performed according to the tenets of the Declaration of Helsinki and according to institutional regulations.

We thank David A. M. van de Vijver, Department of Medical Microbiology, University Medical Center Utrecht, The Netherlands for statistical consultation and assistance.

REFERENCES

1. Pepose JS, Hilborne LH, Cancilla PA, Foos RY. Concurrent herpes simplex and cytomegalovirus retinitis and encephalitis in the acquired immune deficiency syndrome (AIDS). Ophthalmology 1984;91:1669–1677.
2. Forster DJ, Dugel PU, Frangieh GT, et al. Rapidly progressive outer retinal necrosis in the acquired immunodeficiency syndrome. Am J Ophthalmol 1990;110:341–348.
3. de Boer JH, Verhagen C, Bruinenberg M, et al. Serologic and polymerase chain reaction analysis of intraocular fluids in the diagnosis of infectious uveitis. Am J Ophthalmol 1996;121: 650–658.
4. Ritterband DC, Friedberg DN. Virus infections of the eye. Rev Med Virol 1998;8:187–201.
5. Balba GP, Kumar PN, James AN, et al. Ocular syphilis in HIV-positive patients receiving highly active anti-retroviral therapy. Am J Med 2006;119:448 e21–25.
6. Holland GN. Ocular toxoplasmosis in the immunocompromised host. Int Ophthalmol 1989;13:399–402.
7. Doornenbal P, Seerp Baarsma G, Quint WG, et al. Diagnostic assays in cytomegalovirus retinitis: detection of herpes virus by simultaneous application of the polymerase chain reaction and local antibody analysis on ocular fluid. Br J Ophthalmol 1996;80:235–240.
8. Levinson RD, Hooks JJ, Wang Y, et al. Triple viral retinitis diagnosed by polymerase chain reaction of the vitreous biopsy in a patient with Richter syndrome. Am J Ophthalmol 1998;126:732–733.
9. Rathinam SR, Cunningham ET, Jr. Infectious causes of uveitis in the developing world. Int Ophthalmol Clin 2000; 40:137–152.
10. Lai LJ, Chen SN, Kuo YH, et al. Presumed choroidal atypical tuberculosis superinfected with cytomegalovirus retinitis in an acquired immunodeficiency syndrome patient: a case report. Jpn J Ophthalmol 2002;46:463–468.
11. Kijlstra A, Luyendijk L, Baarsma GS, et al. Aqueous humor analysis as a diagnostic tool in toxoplasma uveitis. Int Ophthalmol 1989;13:383–386.
12. Kijlstra A, van den Horn GJ, Luyendijk L, et al. Laboratory tests in uveitis. New developments in the analysis of local antibody production. Doc Ophthalmol 1990;75:225–231.
13. Witmer R. Clinical implications of aqueous humor studies in uveitis. Am J Ophthalmol 1978;86:39–44.
14. Fox GM, Crouse CA, Chuang EL, et al. Detection of herpes virus DNA in vitreous and aqueous specimens by the polymerase chain reaction. Arch Ophthalmol 1991;109: 266–271.
15. Aouizerate F, Cazenave J, Poirier L, et al. Detection of *Toxoplasma gondii* in aqueous humour by the polymerase chain reaction. Br J Ophthalmol 1993;77:107–109.
16. Robert-Gangneux F, Binisti P, Antonetti D, et al. Usefulness of immunoblotting and Goldmann-Witmer coefficient for biological diagnosis of toxoplasmic retinochoroiditis. Eur J Clin Microbiol Infect Dis 2004;23:34–38.
17. De Groot-Mijnes JDF, Rothova A, van Loon AM, et al. Polymerase chain reaction and Goldmann-Witmer coefficient analysis are complimentary for the diagnosis of infectious uveitis. Am J Ophthalmol 2006;141:313–318.
18. de Boer JH, Luyendijk L, Rothova A, et al. Detection of intraocular antibody production to herpes viruses in acute retinal necrosis syndrome. Am J Ophthalmol 1994;117:201–210.
19. Aldave AJ, King JA, Cunningham ET, Jr. Ocular syphilis. Curr Opin Ophthalmol 2001;12:433–441.
20. Samson C, Foster C. Syphilis. In: Foster C, Vitale A, eds. Diagnosis and treatment of uveitis. Philadelphia, Pennsylvania: W. B. Saunders Company, 2002:237–244.
21. Whitcup S. Bacterial and fungal diseases, 3rd edn. In: Nussenblatt R, Whitcup S, eds. Uveitis. Fundamentals and clinical practice. Philadelphia, Pennsylvania: Mosby, 2004: 157–184.
22. Müller M, Ewert I, Hansmann F, et al. Detection of Treponema pallidum in the vitreous by PCR. Br J Ophthalmol 2007;91:592–595.
23. Ausayakhun S, Watananikorn S, Ittipunkul N, et al. Epidemiology of the ocular complications of HIV infection in Chiang Mai. J Med Assoc Thai 2003;86:399–406.
24. Ng WT, Versace P. Ocular association of HIV infection in the era of highly active anti-retroviral therapy and the global perspective. Clin Experiment Ophthalmol 2005;33:317–329.
25. Holland GN. Ocular toxoplasmosis: a global reassessment. Part II: disease manifestations and management. Am J Ophthalmol 2004;137:1–17.
26. Cassoux N, Bodaghi B, Katlama C, LeHoang P. CMV retinitis in the era of HAART. Ocul Immunol Inflamm 1999;7:231–235.
27. Hogg RS, Yip B, Chan KJ, et al. Rates of disease progression by baseline CD4 cell count and viral load after initiating triple-drug therapy. JAMA 2001;286:2568–2577.
28. Rothova A, de Boer JH, ten Dam-van Loon NH, et al. Usefulness of aqueous humor analysis for the diagnosis of posterior uveitis. Ophthalmology 2007. Forthcoming.