

## Response of Black African patients with hepatitis C virus genotype 4 to treatment with peg-interferon and ribavirin

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### Abstract

**Aim :** To compare responses to therapy of Black African (BA) and non-Black African (non-BA) patients with hepatitis C virus genotype 4 (HCV-4) residing in Belgium.

**Methods :** In this retrospective multicenter study, 473 patients with HCV-4 were selected from databases at 7 Belgian centers ; 209 treatment-naïve patients (154 BA) had received treatment with peg-interferon (peg-IFN) plus ribavirin (RBV) and were included in the study.

**Results :** There was a greater percentage of female patients in the BA group than in the non-BA group ; BA patients were also older, had a greater body mass index, and more frequently had abnormal glucose metabolism. The route of contamination was more frequently unknown in BA than in non-BA patients and BA patients had more HCV-4 subtypes. There were no differences in other demographic factors between the groups. Sustained viral response (SVR) and complete early viral response rates were significantly lower and relapse rates significantly higher in BA than in non-BA patients. There were no differences between groups in rates of dose modification or in drug tolerance.

**Conclusion :** In our cohort, treatment-naïve BA patients with HCV-4 who were treated with peg-IFN and ribavirin had a much lower SVR rate than treatment-naïve non-BA patients with HCV-4 who were treated with peg-IFN and ribavirin, and a higher relapse rate, possibly related to a weaker response to interferon-based therapy. Treatment may need to be adapted in this population. (*Acta gastroenterol. belg.*, 2013, 76, 291-299).

**Key words :** Black Africans, hepatitis C virus, antiviral therapy, genotype 4.

### Introduction

Hepatitis C virus (HCV) infection is frequent among the population of central Africa, with a prevalence of 6%. The predominant genotype in this region is genotype 4 (HCV-4) (1-3). However, response to therapy in patients with HCV-4 has been studied mainly in other population groups, for example, in patients from Egypt and the Middle East ; in these populations, sustained viral response (SVR) rates of 58 to 76% have been observed (4). There are few studies on therapeutic response in Black Africans (BA) with HCV-4. In a study conducted in France, which compared therapeutic responses in three ethnic groups infected with HCV-4, only 37 BA patients were included in the analysis of therapeutic data ; the SVR rate of the BA patients in this study was 32.4% (5).

It has been postulated that response to antiviral therapy in HCV-infected patients vary according to ethnic and/or racial group. Indeed, in the US, an ethnic/racial

difference in SVR rates (28% and 52%, respectively) was demonstrated in African Americans and non-African Americans infected with HCV genotype 1b (HCV-1b) (6) ; there was also a difference in SVR rates (34% vs. 49%) between Latin and non-Latin carriers of HCV-1 infection (7). It remains unclear whether these differences in viral response are related to host factors (ethnicity, human immunodeficiency virus [HIV] co-infection, overweight/obesity, insulin resistance, cirrhosis, and genetic polymorphism for IL28B) or to virus-related factors (HCV subtypes, viral load) (6,8-10).

Because of the cost of HCV therapy, it is unlikely that large-scale therapeutic trials will be conducted in sub-Saharan Africa to evaluate responses to therapy of BA patients infected with HCV-4. However, it is possible to study the therapeutic response in BA patients infected with this genotype who have immigrated to European countries.

Our aim, therefore, was to compare the response rate to peg-interferon (peg-IFN) plus ribavirin (RBV) therapy in treatment-naïve HCV-4 BA and non-BA patients living in Belgium.

### Patients and Methods

#### Patient selection

The study was conducted in conformity with the principles of the Declaration of Helsinki and local laws and regulations. The institutional review boards of the participating centers and the ethical Committee of the principal investigating center (CHU Saint-Pierre, Brussels, OM 007) approved the study protocol.

Patients with HCV-4 infection were identified from databases at 7 Belgian centers (CHU Saint-Pierre, CHU Brugmann, Hôpital Erasme, Hôpital Bracops and CH

The results of this study were presented in part at the AASLD meeting in Boston, 2006.

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Molière, Brussels ; CHU Sart Tilman, Liège ; University Hospital Antwerp). These centers are located in the 3 largest Belgian cities and most patients were from Brussels. Patients were selected for the study if they were aged 18 years, had HCV-4 infection, and were treatment-naïve before being treated with peg-IFN plus RBV with or without amantadine (AM) between 1999 and 2006.

### Study design

The criteria for starting antiviral therapy in Belgium follow international guidelines (11-14). IFN alpha-2a or-2b alone was given between 1992 and 2000, and IFN in association with RBV from 2001 to 2004. Since 2004, standard care consists of the association of peg-IFN alpha-2a or-2b plus RBV. Some patients received AM (200 mg daily) in addition to standard peg-IFN and RBV in the context of a Belgian clinical trial. Because it has been shown that AM has no effect on the SVR (15), we kept these cases in the study.

The duration of planned therapy was 48 weeks whatever the treatment. Criteria for stopping treatment were in accordance with international guidelines issued from 1999 to 2006, notably absence of a 2 log decrease in viral load at week 12 of antiviral treatment or a detectable viral RNA in the blood at week 24 of antiviral treatment.

Patients were divided into two groups according to their ethnic origin – BA and non-BA – and the two groups were compared in terms of epidemiological and demographic features, response and tolerance to therapy, and need for dose reduction. Factors predictive of viral response were also analyzed.

A patient was considered lost to follow-up when he/she no longer attended the viral and/or clinical check-up, and as a non-responder if he/she did not show a decrease in viral load  $> 2$  log at week 12 (= primary non-response), had detectable HCV RNA after 24 weeks of therapy, or had detectable HCV RNA at the end of treatment.

### Endpoints and assessments

Efficacy endpoints consisted of viral responses as follows :

- SVR, defined as undetectable HCV RNA levels 24 weeks after the end of the treatment period (week 72), and relapse (REL), assessed between the end of treatment and 24 weeks later ;
- early viral response (EVR) : negative qualitative PCR or a decrease in HCV RNA levels equal to more than  $2\text{-log}_{10}$  after 12 weeks ; complete EVR (cEVR) : undetectable HCV RNA levels at week 12 ;
- viral response at end of treatment : undetectable HCV RNA levels at week 48.

All enrolled patients who had been treated for at least 12 weeks were included in the efficacy evaluations. All patients who received one or more doses of IFN and un-

derwent one or more tolerance assessments were included in the drug tolerance analyses. Drug tolerance was assessed by the physician, who recorded adverse effects reported by each patient as well as clinical and laboratory results. Drug tolerance was classified as good (no need for dose reduction or treatment withdrawal) or poor (symptomatic adverse effects necessitating dose reduction or treatment withdrawal).

### Baseline parameters

The following baseline parameters were recorded : ethnic origin (a BA was defined as an individual from Central Africa whose parents were both BA ; the non-BA category included mainly Caucasian whites, North Africans and Turks) ; sex ; age at start of treatment ; body weight (kg) ; body mass index (BMI) (kg/m<sup>2</sup>) ; risk factors for infection ; co-morbidity, including arterial hypertension (treated or arterial pressure  $> 130/85$  mmHg), dyslipidemia (treated or above the upper limit of normal [ULN] for serum cholesterol and/or triglycerides), impaired glucose metabolism including intolerance (fasting glycemia  $> 100$ , but  $< 125$  mg/dL) and overt diabetes (treated or not), kidney failure (if serum creatinine was over the ULN) ; alcohol consumption (classified as never, occasional [less than or equal to 2 drinks per month], active/daily [more than 2 drinks per month or 1 drinks per day], past intake [no drink in the year preceding inclusion]) ; co-infection with hepatitis B virus (HBV, presence of HBs antigen) and/or HIV (positive antibodies and viremia) ; HCV-4 viral load ( $<$  or  $\geq 400,000$  IU/mL) and viral subtypes ; alanine transaminase (ALT) quotient (ALT level divided by the ULN)  $<$  or  $> 2$ , and persistently normal ALT (pNALT) over a 6- to 12-month period.

Liver biopsy specimens obtained before treatment, were evaluated using the METAVIR classification for activity grade (A), liver fibrosis stage (F), and degree of steatosis (16,17). A central review of biopsies was not performed. The following groups were distinguished : METAVIR grade (A)  $< 2$  and  $\geq 2$  ; METAVIR stage (F)  $< 2$  and  $\geq 2$  ; degree of steatosis  $< 10\%$ , 10 to 30%,  $> 30\%$ .

### Virology tests

Quantitative tests measuring HCV RNA levels (expressed in IU/ml) were performed using a Cobas AmpliCor HCV monitor, version 2.0 (Roche Systems), a Versant HCV RNA 3.0 assay (Bayer HealthCare) or the Cobas Taqman HCV test (Roche Systems) and Abbott Real Time (Abbott Diagnostic). Qualitative tests were performed using a Cobas AmpliCor HCV monitor, version 2.0 (Roche Systems) or an AmpliCor HCV monitor, version 2.0. The HCV limit of detection in qualitative assays was  $\leq 50$  IU/mL. Genotyping was performed using assays from INNO-LIPA HCV II (Innogenetics, Ghent, Belgium) and the Versant HCV genotyping assay (Bayer HealthCare).

### Statistical analysis

Baseline characteristics are presented as number of cases and percentages for categorical data, and as means and ranges for continuous data. Patient groups were compared using either Fisher's exact test or chi-square (for categorical variables with more than two levels). Continuous variables were compared using a Student's t test. Between-group differences are presented as the difference between means of each group, with a 95% CI for each comparison. A crude odds ratio (OR) is presented for each comparison. Each OR is presented with its 95% CI.

The primary efficacy endpoint was also assessed using multivariable logistic regression analysis to evaluate the effects of baseline prognostic factors on the probability of an SVR. To identify factors associated with rates of SVR, ORs adjusted for factors with a p value equal or less than 0.1 in crude (unadjusted) analysis were calculated.

Computerized procedures were performed using SPSS for Windows version 17.0 (SPSS Inc., Chicago, IL, USA).

## Results

### Types of treatment in the entire HCV-4 infected group

Among 473 patients identified with HCV-4 infection (331 BA and 142 non-BA), 273 (195 BA and 78 non-BA) had received treatment: 58 patients (37 BA and 21 non-BA) received IFN with or without RBV, 209 treatment-naïve patients (154 BA and 55 non-BA) and 6 treatment-experienced patients (4 BA and 2 non-BA) received Peg-IFN with or without AM. The BA patients were from Central Africa, including the Democratic Republic of Congo (two-thirds), Angola, Burundi, Cameroon, Gabon and Rwanda. Non-BA patients included white Caucasians, primarily from European countries (two-thirds), including Belgium, France, Greece, Italy, Portugal, Spain and Russia, or North Africa, including Morocco, Algeria, Egypt and Tunisia.

### Baseline characteristics of the treatment-naïve population (n = 209) treated with peg-IFN plus RBV with or without AM (Table 1)

Two hundred and nine treatment-naïve patients (154 BA and 55 non-BA) were treated with peg-IFN plus RBV (126 BA, 47 non-BA) or peg-IFN plus RBV plus AM (28 BA, 8 non-BA) and formed the study group. BA patients were more frequently female ( $p < 0.0001$ ), were significantly older than non-BA patients, and had a significantly higher BMI. The most frequent mode of transmission in BA patients was unknown (63%) compared to non-BA patients in whom intravenous drug use was the most frequent mode of transmission (45%). Glucose intolerance abnormalities and viral subtypes were significantly more frequent in BA than in non-BA patients.

There were no significant differences between the groups in frequency of co-infection with HBV and HIV, dyslipidemia, alcohol intake, transaminase levels, METAVIR score for activity or fibrosis, degree of liver steatosis or viral load.

### Treatment, doses and tolerance (Table 2)

Within the study population of treatment-naïve patients (Fig. 1):

- HCV RNA monitoring was not performed: at week 12 in 23 patients (16 BA and 7 non-BA) because of loss to follow-up (6 BA and 4 non-BA), or treatment withdrawal (10 BA and 3 non-BA);
- treatment was discontinued because of primary non-response in 37 BA and 11 non-BA patients at week 12, or non-response at week 24 in 15 BA and 2 non-BA patients. Other reasons for discontinuation of treatment included: thyroid dysfunction (1 BA), psychological complication (1 non-BA), lack of compliance (1 BA), travel to a foreign country (1 BA), asthenia (1 non-BA) or death (1 BA after liver transplantation and 1 non-BA from unknown cause).

There were no significant differences in type of treatment and dose reduction because of adverse events between the groups, and drug tolerance was similar. No tolerance details were available for 53 patients (37 BA and 16 non-BA).

### Viral responses (Table 3)

The SVR rate was lower in BA patients than in non-BA patients ( $p = 0.002$ ) because of the higher rate of relapse in BA compared to non-BA patients ( $p = 0.03$ ). There was a lower response rate at the end of treatment in BA than in non-BA patients ( $p = 0.08$ ). More non-BA patients had a complete EVR than did BA patients ( $p = 0.02$ ), but the overall EVR was not significantly different in non-BA and BA patients [37/48 (77.1%) vs. 101/138 (73.2%), OR and 95%CI 0.81 (0.37-1.75),  $p = 0.5$ ]. In both groups, SVR rates were similar in patients treated with peg-IFN+RBV without AM compared to those treated with peg-IFN+RBV plus AM: in BA, 30/112 (26.5%) vs. 9/25 (36%); and in non-BA, 21/41 (53.6%) vs. 2/5 (40%).

### Viral outcome according to METAVIR fibrosis stage (Fig. 2)

In patients with bridging fibrosis (stage F3) or cirrhosis (stage F4), the SVR rate was 3/29 (10.3%) in BA patients compared to 5/10 (50%) in non-BA patients [OR 0.11 (0.02-0.64),  $p = 0.007$ ]. In patients with mild to moderate fibrosis (stage F0 to stage F2), the SVR was also lower in BA than in non-BA patients [34/102 (33.3%) vs. 18/32 (56.2%), OR 0.38 (0.17-0.87),  $p = 0.02$ ].

Factors predictive of viral response in univariate and multivariate analyses (Table 4).

Table 1. — Baseline characteristics of 209 treatment-naïve patients treated with peg-IFN plus RBV with or without amantadine, stratified according to ethnicity: non-Black African (non-BA) versus Black African (BA)

Patient characteristics	non-BA <sup>a</sup> (n = 55)	BA <sup>a</sup> (n = 154)	Odds ratio (95%CI) <sup>b</sup>	p-Value <sup>c</sup>
Male gender n (%)	37 (67.3%)	58 (37.7%)		0.0002
Age at treatment (years)				
Mean (SD)	42.9 (9.7)	50.4 (12.3)		< 0.0001
Range	24 to 71	20 to 75		
Weight (kg)				
Mean (SD)	73.5 (16.9)	77.1 (12.8)		0.02
Range	46 to 136	45 to 118		
Patients with weight of ≥ 70 kg (n* = 48/138)	30 (62.5%)	138 (100%)	5.6 (4.04 to 7.75)	< 0.0001
Body mass index (kg/m <sup>2</sup> )				
Mean (SD)	25.3 (4.2)	27.7 (4.6)		0.0007
Range	19.7 to 40.2	14.8 to 42.8		
Contamination risk factor (n* = 49/152)				
Transfusion	7 (14.2%)	35 (23%)		< 0.001
I.v. drug use	22 (44.9%)	3 (2%)		
Unknown	17 (34.69%)	97 (63.8%)		
Iatrogenic/other	1 (1.8)/2 (4.1%)	12 (7.9%)/5 (3.3%)		
HBs antigen + ve	13 (23.6%)	40 (26%)	1.13 (0.55 to 2.32)	0.85
HIV + ve (n*=51/152) (%)	9 (17.65%)	19 (12.5%)	0.66 (0.28 to 1.58)	0.35
Glucose intolerance or diabetes (n* = 45/134) (%)	6 (13.3%)	38 (28.4%)	2.57 (1.00 to 6.50)	0.04
Dyslipidemia (n* = 43/121) (%)	8 (18.6%)	27 (22.3%)	1.25 (0.52 to 3.02)	0.61
Alcohol Intake (n* = 46/116) (%)				
No	32 (69.6%)	92 (79.3%)	}	0.27
Active	8 (17.4%)	10 (8.6%)		
Past	4 (8.7%)	6 (5.2%)		
Occasional	2 (4.3%)	8 (6.9%)		
ALT (n* = 52/147) (%)				
Persistently normal ALT	3 (5.8%)	19 (12.9%)		0.22
quotient <2N/ >2N	32 (61.5%)/17 (32.7%)	93(63.2%)/35 (23.8%)		
METAVIR score (n* = 52/145) (%)				
≥ A2	15 (29.4%)	52 (34.7%)	1.41 (0.71 to 2.83)	0.32
> F2**	25 (50%)	89 (61.8%)	0.16 (0.84 to 3.1)	0.14
Degree of liver steatosis (n*=45/108) (%)				
< 10%	32 (71.1%)	88 (81.5%)	}	0.25
10% to 30%	8 (17.8%)	15 (13.9%)		
> 30%	5 (11.1%)	5 (4.6%)		
Subtype (n = 55/153)				
4a; 4c/4d	0; 26 (47.2%)	8 (3.85%); 15 (9.8%)	}	< 0.001
4e; other	1 (1.8%); 27 (49%)	26 (17%); 102 (66.6%)		
Viral load (× 10 <sup>3</sup> IU/mL) (n* = 51/141)				
Mean (SD)	1414 (1845)	1017 (1142)		0.55
Range	6 to 8260	11 to 7000		
Viral load > 400,000 IU/ml (n = 51/141) (%)	35 (68.6%)	101 (71.6%)		0.90

<sup>a</sup> In each group, data are presented as number of cases (percentages); bCI, confidence interval; cP value comparing non-BA group versus BA group; n\*: number of cases for which data were available in each group, non-BA/BA; SD: standard deviation; +ve-positive; \*\* Number of patients with a METAVIR fibrosis stage of 3 or 4 was 29/145 (20%) in BA and 10/45 (22.2%) in non-BA respectively.

In univariate analysis, baseline factors studied were ethnicity, gender, age, weight, HIV status, METAVIR fibrosis stage, HCV-4 subtypes, pretreatment viral load, drug tolerance, and complete EVR. BA ethnicity, age > 40, HIV-positive status, viral load > 400000, subtypes other than 4c/4d, METAVIR fibrosis stage > 2, and partial EVR were associated with a lower SVR rate.

In multivariate analysis, BA ethnicity, HIV infection, viral load > 400000, and partial EVR were independent predictors of poor response.

## Discussion

This retrospective study comprises the largest series to date of BA patients treated for HCV-4 infection. Our study indicates that treatment-naïve HCV-4 infected BA patients living in Belgium have a significantly lower SVR rate following treatment with peg-IFN plus RBV than do treatment-naïve non-BA patients: 28% vs. 52%, respectively. This lower SVR rate in BA patients was the result of a slower viral response (with a less complete



Table 2. — Treatment type, dose, and adverse effects in 209 treatment-naïve patients treated with peg-IFN plus RBV with or without AM, stratified according to ethnicity: non-Black African (non-BA) versus Black African (BA)

Patient characteristics	non-BA	BA	OR (95%CI)	p-Value
Type of treatment -n (%)				
PEG + RBV	47/55 (85.45%)	126/154 (81.8%)	0.76 (0.32 to 1.79)	0.53
PEG + RBV + AM	8/55 (14.5%)	28/154 (18.8%)	1.30 (0.55 to 3.06)	0.53
Dose reduction because of adverse events				
Peg-IFN - n (%)	10/55 (18.2%)	44/154 (28.6%)	1.8 (0.83 to 3.88)	0.15
RBV -n (%)	10/55 (18.2%)	41/154 (26.6%)	1.63 (0.75 to 3.53)	0.27
Tolerance to treatment -n (%) (good vs. poor)	28/38 (73.6%)	77/117 (65.8%)	0.68 (0.30 to 1.55)	0.412

EVR) leading to a higher rate of relapse (43% vs 19%) ; the rate of non-response was similar in the two groups. Importantly, in univariate and multivariate analyses, BA ethnicity and partial EVR were good predictors of a poor SVR.

Similar observations have been reported in the US, where a trend toward a higher relapse rate was found in African Americans compared to Caucasian Americans (6). Because many African Americans are descendants of BA individuals, it is presumed that their genetic background is likely to be similar. The reason for hyporesponsiveness in African Americans and BA patients residing in Europe is not known, but may be related to different interactions between viral and host factors (non-modifiable and modifiable) (18,19).

HCV genetic diversity within isolates may modulate sensitivity to IFN (20). Non-modifiable host factors, including IFN-stimulated gene transcription (higher in Caucasian Americans than in African Americans) and genetic polymorphism in the IL28B gene encoding IFN- $\lambda$ -3 (associated with a twofold greater response to therapy in Caucasians versus African Americans), may also be involved (10,21). Recently, in France, an association between the IL28B polymorphism and treatment response was demonstrated in patients with HCV4 infection. It would have been interesting to perform this test for polymorphism in the IL28B gene in our study ; however, our study was carried out before Ge *et al.* published their results. Moreover, patient DNA, mandatory for sequencing genes, was not available, because our study was retrospective and multicenter. Additional immunogenetic factors may also be involved, including human leukocyte antigen class II, nucleotide polymorphism for immune genes and T lymphocyte natural killer receptors (21-25).

In multivariate analysis, we found that, in addition to ethnicity, concomitant HIV infection was an independent predictor of a poor SVR. HIV infection significantly impaired the SVR rate of our patients, similar to observations in other studies (26-28). Nevertheless, even after exclusion of HIV infection as a confounding factor, ethnicity was a predictor of SVR [OR 0.33 (0.10 to 1.04),  $p = 0.05$ ].

Age and viral load were also independent predictors of response. The fact that our BA patients were older than our non-BA patients may thus, in part, explain our observation of hyporesponsiveness among BA patients. Concerning the viral load, we observed that a viral load equal to or greater than 400000 IU/mL was associated with a worse response ; other trials have shown similar results (4,6,8,18).

Liver fibrosis is another factor that has been consistently shown to affect SVR (6,8,29). In our study, we observed only a trend because of the limited sample size. The stage of bridging fibrosis and cirrhosis was similar in BA and non-BA patients, but the SVR rate was significantly lower in BA patients with bridging fibrosis/cirrhosis than in non-BA patients with bridging fibrosis/cirrhosis. Similarly, in patients with mild liver disease, BA patients were more often hyporesponsive than were non-BA patients. We also demonstrated that infected patients with cirrhosis can achieve an SVR, in line with a recent study by Bruno *et al.* (30).

In our study, BA patients were more commonly female, weighed more, and had more viral subtypes than did the non-BA patients, but these factors did not explain the difference in response between the two groups after adjustment for multiple factors. However, male gender, obesity, and non-4a viral subtype have been associated with a lower SVR in other studies. Other factors related to treatment, such as drug tolerance or therapeutic dose, cannot explain the difference in SVR we observed, because these factors were similar in our two groups of patients. Nevertheless, it is well established that a maximum therapeutic dose taken for a maximum time period is essential to achieve an SVR (5,6,8,29,31).

BA and non-BA patients were similarly co-infected with HBV. Moreover, the SVR rates were 8/24 (33%) in co-infected BA and 3/6 (50%) in co-infected non-BA patients, which were not significantly different from each other ( $p = 0.09$ ). This response rate in co-infected patients is close to the average response rate in each HCV mono-infected group. Although our results are limited because of the small number of HBV-HCV co-infected patients, Chuang *et al.* showed that HBV-HCV-1-co-infected patients treated with IFN plus RBV had a

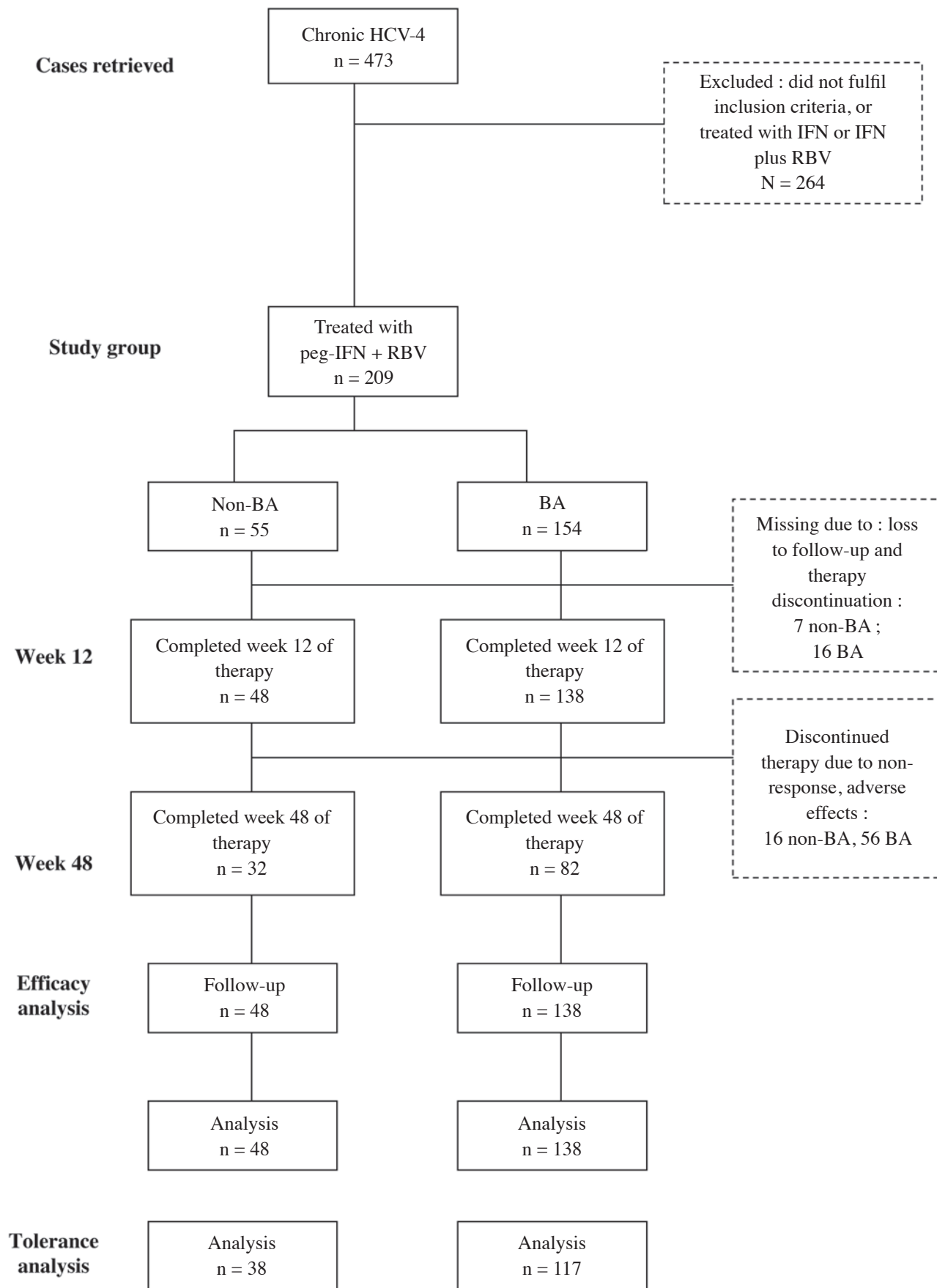


Fig. 1. — Study design : Among 473 patients with HCV-4, 273 received treatment. We studied the subgroup of 209 treatment-naïve patients who had been treated with peg-IFN + RBV.

Table 3

Response (type)	Overall	Ethnicity		OR	95% CI	p-Value
		non-BA	BA			
EVR	138/186 (74.2%)	37/48 (77.1%)	101/138(72.8%)	0.81	0.37-1.75	0.53
cEVR	62/186 (33.3%)	22/48 (45.8%)	40/138 (29.0%)	0.48	0.24 – 0.94	0.02
EOT VR	98/186 (52.7%)	31/48 (64.6%)	67/138 (48.6%)	0.51	0.26 – 1.02	0.05
Relapse	34/98 (34.7%)	6/31 (19.3%)	28/67 (42.6%)	0.33	0.12 – 0.92	0.03
SVR	64/186 (34.4%)	25/48 (52.0%)	39/138 (28.3%)	0.36	0.18 – 0.72	0.002

complete; EVR: early viral response; EOT VR: end of treatment viral response; SVR: sustained viral response; OR and 95% CI: odds ratio and 95% confidence interval.

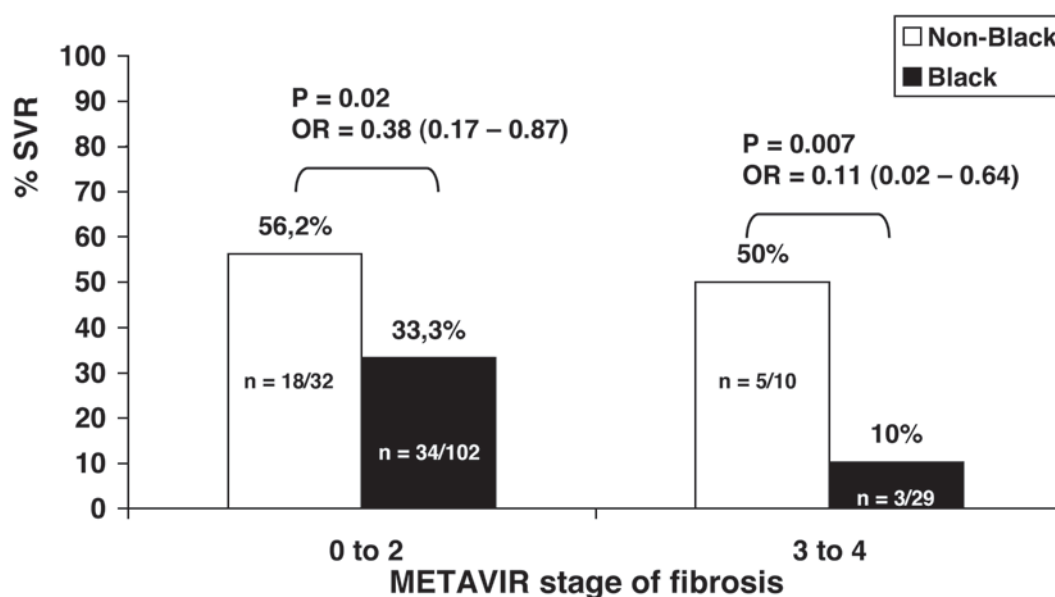


Fig. 2. — Viral outcome according to the METAVIR stage of fibrosis

response comparable to that of HCV-1 mono-infected patients (32).

The SVR rate among BA patients was lower than that observed in Egyptian and Middle Eastern patients treated with peg-IFN and RBV (from 54% to 80%). The reason for this difference is unclear. Some possible explanations were presented earlier in the discussion section. Another potential reason may be related to the HCV-4 subtype. Indeed, although no subtype was predictive of response in our study, in Egyptian studies subtype 4a was most prevalent and was associated with a more favorable viral response (4,5). Additional factors, such as the number of patients with cirrhosis, along with environmental factors, may play a role in this difference in response rate between our BA patients residing in Belgium and patients from Egypt and the Middle East.

The results of our study indicate that the need for better anti-HCV therapy is greater than ever in populations infected with HCV-4, particularly those of BA origin. Pre-

liminary data from next-generation agents currently under development against HCV-4 (e.g., TMC 435) are encouraging (33). Other strategies, including better management of host-modifiable factors or treatment prolongation in case of slow response, as suggested for genotype 1, could be proposed. Therapy with nitazoxanide (a new activator of IFN-induced mediators that has demonstrated efficacy against HCV-4) and with newer molecules targeting viral machinery or based on host genes should be studied in the BA population (34-36).

In conclusion, this study demonstrates that treatment-naïve BA patients with HCV-4 who were treated with peg-IFN and RBV had a much lower SVR rate than did treatment-naïve non-BA patients with HCV-4. This lower SVR rate was associated with a higher relapse rate, probably related to a slower viral response to IFN-based therapy. The mechanism behind this observation has not been clearly elucidated, but may be related to

Table 4

Predictor	Categories		SVR yes n (%)	Univariate analysis			Multivariate analysis		
				OR	95% CI	p value	OR	95% CI	p value
Ethnicity	BA (n = 138)	vs. Non-BA (n = 48)	39 (28.3%) vs. 25 (52.1%)	0.36	0.18-0.71	0.002	0.15	0.04-0.55	0.004
Gender	Female (n = 103)	vs. Male (n = 85)	30 (29.1%) vs. 35 (41.2%)	0.58	0.32 – 1.07	0.08	–	–	–
Age <sup>a</sup>	40 (n = 132)	vs. < 40 (n = 51)	41 (31.1%) vs. 23 (45.1%)	0.54	0.28-1.06	0.05	0.18	0.05-0.63	0.007
Body weight	70 kg (n = 121)	vs. < 70 kg (n = 47)	45 (37.2%) vs. 18 (38.3%)	0.97	0.47-1.9	0.89	–	–	–
HIV	Positive (n = 25)	vs. Negative (n = 158)	4 (16.0%) vs. 60 (38.0%)	0.31	0.10-0.95	0.03	0.04	0.004-0.39	0.005
Viral load*	400000 (n = 119)	vs. < 400000 (n = 53)	32 (26.9%) vs. 31 (58.5%)	0.26	0.13-0.51	< 0.0001	0.22	0.07-0.66	0.006
Subtype	4c/d (n = 40)	vs. Other (n = 147)	23 (57.5%) vs. 41 (27.9%)	3.49	1.69-7.21	0.0005	2.23	0.49-10.14	0.29
Fibrosis stage**	> 2 (n = 42)	vs. ≤ 2 (n = 133)	8 (19.0%) vs. 53 (39.8%)	0.41	0.18-0.92	0.029	0.22	0.04-1.20	0.08
Drug tolerance	Good (n = 87)	vs. Poor (n = 52)	40 (46.0%) vs. 15 (28.8%)	2.09	1.00-4.37	0.04	2.57	0.76-8.60	0.12
Complete EVR	Yes (n = 62)	vs. No (n = 126)	33 (53.2%) vs. 30 (19.8%)	3.72	1.95-7.08	< 0.0001	3.88	1.32-11.33	0.01

BA = Black Africans, n number, SVR sustained viral response, OR and 95% CI odds ratio and 95% confidence interval,  $\mu$  years, \*IU/mL, \*\*METAVIR classification, EVR early viral response.

genetic or purely ethnic differences between the two groups, suggesting that the therapeutic regimen may need to be adapted in BA populations.

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