Correlates of hepatitis C virus infection among incarcerated Ghanaians: a national multicentre study

Andrew A. Adjei,¹ Henry B. Armah,^{1,2} Foster Gbagbo,¹ William K. Ampofo,³ Isaac K. E. Quaye,⁴ Ian F. A. Hesse⁵ and George Mensah⁶

Correspondence

Andrew A. Adjei

andrewadjei50@hotmail.com

¹Department of Pathology, University of Ghana Medical School, College of Health Sciences, University of Ghana, Korle-Bu, Accra, Ghana

²Department of Pathology, University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, USA

³Virology Unit, Noguchi Memorial Institute for Medical Research, College of Health Sciences, University of Ghana, Legon, Accra, Ghana

⁴Department of Medical Biochemistry, University of Ghana Medical School, College of Health Sciences, University of Ghana, Korle-Bu, Accra, Ghana

⁵Department of Medicine and Therapeutics, University of Ghana Medical School, College of Health Sciences, University of Ghana, Korle-Bu, Accra, Ghana

⁶Department of Community Health, University of Ghana Medical School, College of Health Sciences, University of Ghana, Korle-Bu, Accra, Ghana

A national multicentre cross-sectional study was undertaken on the correlates of hepatitis C virus (HCV) infection in a sample of inmates from eight Ghanaian prisons. A total of 1366 inmates from eight of the ten regional central prisons in Ghana were enrolled between May 2004 and December 2005. Subjects voluntarily completed a risk-factor questionnaire and provided blood specimens for unlinked anonymous testing for the presence of antibodies to HCV. These data were analysed using both univariate and multivariate techniques. The median age of participants was 36.5 years (range 16–84 years). Of the 1366 inmates tested, HCV seroprevalence was 18.7%. On multivariate analysis, the independent determinants of HCV infection were being incarcerated for longer than the median time served of 36 months [odds ratio (OR) 5.8; 95% confidence interval (95% CI) 5.0–6.9], history of intravenous drug use (OR 4.5; 95% CI 3.8–5.4) and homosexuality (OR 3.1; 95% CI 2.5–3.9). Consistent with similar studies worldwide, the prevalence of HCV in prison inmates was higher than the general population in Ghana, suggesting probable transmission in prisons in Ghana through intravenous drug use and unsafe sexual behaviour.

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INTRODUCTION

Hepatitis C virus (HCV) is a blood-borne pathogen transmitted most efficiently by percutaneous exposure to infectious blood. Approximately 60% of hepatitis C cases are associated with injection drug use (IDU). HCV infection is increasingly recognized as a major healthcare problem throughout the world. The World Health Organization estimates 170 million people to be infected worldwide, and at risk of developing liver cirrhosis and liver cancer (World Health Organization, 1999). Sub-Saharan Africa is reported to have the highest HCV-seroprevalence rates, ranging from

0 to 40% (Madhava *et al.*, 2002). In this region, numerous studies of this have been reported since 1990 (Madhava *et al.*, 2002). The determined seroprevalence of HCV is 1.3–8.4% among blood donors in Ghana (Acquaye & Tettey-Donkor, 2000; Ampofo *et al.*, 2002; Candotti *et al.*, 2001; Sarkodie *et al.*, 2001; Wansbrough-Jones *et al.*, 1998), 5.4% among children in a rural district in Ghana (Martinson *et al.*, 1996) and 2.5% among pregnant women in Accra, Ghana (Lassey *et al.*, 2004). We recently reported a 19.2% seroprevalence rate of HCV infection among inmates at two regional central prisons in Ghana (Adjei *et al.*, 2006).

Prison populations are considered to be at high risk for HCV infection due to the high proportion of intravenous drug users, commercial sex workers and homeless people, as well

Abbreviations: 95% CI, 95% confidence interval; IDU, injection drug use; OR, odds ratio; STD, sexually transmitted disease.

as high-risk sexual behaviours before and during incarceration, and tattooing among inmates (Alizadeh *et al.*, 2005; Hammett *et al.*, 2002; Mertz *et al.*, 2002; Reindollar, 1999; Spaulding *et al.*, 1999; Veecken, 2000). Addressing these risk behaviours and the health needs of prisoners is important because the frequency and turnover of incarceration in Ghana is alarmingly high (unpublished data, Ghana Prisons Service). This has important implications for the monitoring and control of HCV infections in the general Ghanaian population as most people sent to jail remain there for relatively short periods then become part of the general population again and might be 'fertile reservoirs' for the spread of HCV infections. In Ghana prisoners do not currently undergo mandatory screening for HCV upon incarceration, nor are statistics on the HCV status of the prisoner population who are incidentally diagnosed collected. To our knowledge, data on the correlates of HCV infection among the incarcerated population in Ghana are unavailable, and therefore discussion(s) about blood-borne viral infections within the prisons often requires extrapolation from data obtained in other countries. Assessment of the sources of risk for prisoners will facilitate decision-making about how to screen for HCV, prevent further spread of the disease and provide appropriate care to infected inmates. The aim of this study was to determine the correlates of HCV infections among a sample of inmates at eight of the ten regional central prisons in Ghana.

METHODS

Study site. The study was designed as a national multicentre cross-sectional study and was conducted between the months of May 2004 and December 2005 among a convenient sample of male and female inmates of eight of the ten regional central prisons in Ghana. Ghana is divided into ten administrative regions, and the largest prison in each of these regions is the regional central prison in each regional capital. We enrolled inmates from eight of these ten prisons, but could not enrol from the other two prisons (Upper East Region and Upper West Region Central Prisons) as originally planned because of financial constraints. The policy of the Ghana Prison Service is to send prisoners to any prison in Ghana where there is a vacancy at the time of committal, and not necessarily to the prison nearest to the site of crime or the site of trial. Hence, the absence of these two regional central prisons is not likely to impact the representativeness of our sample, since all the prisons in Ghana are likely to have a comparable ethnic mix because of the above stated policy. The eight regional central prisons from which study participants were enrolled, the period of the study in the particular prison and the inmate population at the time of the study in the particular prison were as follows: Greater Accra Region James Fort & Camp (May 2004, 1497), Eastern Region Nsawam (August 2004, 1345), Ashanti Region Kumasi (January 2005, 1370), Central Region Cape Coast (March 2005, 918), Western Region Sekondi (June 2005, 780), Volta Region Ho (August 2005, 599), Brong Ahafo Region Sunyani (October 2005, 789) and Northern Region Tamale (December 2005, 354) (Ghana Prisons Service, 2004). The Ethical & Protocol Review Committee of the University of Ghana Medical School, Accra, Ghana, approved the study.

Study population. Subjects for this study were both male and female inmates incarcerated in these eight regional central prisons. The study was proposed to the entire population of each prison

after an explanation of the purpose of the study at a meeting organized for that purpose in each of these prisons. They were informed that the study was confidential and that the information provided would not affect their incarceration status. A total of 1366 inmates from the eight prisons consented and were enrolled in the study. Written informed consent was obtained from each participant, and the information regarding the protocol and informed consent was presented to each participant at an appropriate literacy level. No prison officer took part in the data collection. This was to allay fears of any possible punishment or security purpose of the study by ensuring that no one was coerced into taking part in any aspect of it. The study was conducted in a confidential manner and unique study-generated identifiers, not including the name of the inmates, were assigned to each participant to link questionnaires and serum samples; and this information was only accessible to the principal investigator. All participants were provided with pre- and post-test counselling.

Questionnaire. After an explanation of the study and following informed consent, all of the 1366 consenting participants were interviewed using an anonymous structured questionnaire assessing sociodemographic and sexual behavioural characteristics generally considered as risk factors for HCV infection. The questionnaire was pilot tested prior to the data collection. Physical examination was conducted to evaluate the general health condition of each participating inmate.

Sample collection and serological analysis. Blood samples (about 6 ml) were collected in plain tubes from each of the 1366 consenting participants. Samples were centrifuged and the serum kept at -20°C until analysed. Sera were ELISA tested at the Virology Unit, University of Ghana Medical School, for the presence of antibodies to HCV (anti-HCV; Abbot) in accordance with the manufacturer's instructions. Repeatedly reactive specimens by ELISA were assayed by Western blot at the Virology Unit, Noguchi Memorial Institute for Medical Research.

Statistical analysis. The Statistical Analysis System (SAS Institute, Cary, NC, USA) version 9.1 was used to complete all data analyses. For each generally accepted risk factor for HCV infection, the odds ratio (OR) and the 95% confidence interval (95% CI) were calculated to assess associations with sociodemographic and sexual behavioural variables in univariate analysis. A P value of <0.05 was considered significant. Independent associations were evaluated by calculating the adjusted OR by multivariate analysis for the sociodemographic and sexual behavioural variables found to be significant in the univariate analysis. The categories of characteristics were combined into only two or three categories to avoid large confidence intervals. The age categories were based on thirds of the age distribution of all the participating prisoners in the analysis. Marital status was categorized as married or not married (includes single, divorced or separated, and widowed), and educational level attained was classified as illiterate or at least primary education. Time served (from the beginning of their current period of incarceration to the day of the survey) was categorized as below the median of 36 months or above the median of 36 months, and sexual orientation was classified as heterosexual or homosexual (includes both gays and lesbians).

RESULTS

Between May 2004 and December 2005, a total of 1366 inmates participated in the study (17.9% of the total of 7652 eligible inmates in the eight prisons studied); 1247 (91.3%) were males, and the median age was 36.5 years (range 16–84). The participation for the study at the eight studied

Table 1. ORs for HCV seropositivity and corresponding 95% CIs among the 1366 study inmates in eight regional central prisons in Ghana

Regional central prison	No. of inmates		HCV seropositive	
	Eligible	Enrolled (%)	No. (%)	OR (95% CI)*
Volta region Ho	599	195 (32.6)	19 (9.7)	1
Northern region Tamale	354	204 (57.6)	28 (13.5)	1.7 (1.2–6.6)
Central region Cape Coast	918	173 (18.8)	25 (14.5)	1.9 (1.4–7.9)
Eastern region Nsawam	1345	72 (5.4)	13 (18.1)	2.7 (2.0–8.8)
Greater Accra region James Fort & Camp	1497	209 (14.0)	41 (19.6)	2.9 (2.1–9.3)
Western region Sekondi	780	222 (28.5)	47 (21.1)	3.3 (2.2–10.5)
Ashanti region Kumasi	1370	145 (10.6)	33 (22.8)	3.7 (2.5–12.0)
Brong Ahafo region Sunyani	789	146 (18.5)	49 (33.6)	5.9 (2.8–21.3)
Total	7652	1366	255	

*Adjusted for age.

prisons ranged from 5.4 % (Eastern Region Nsawam Prison) to 57.6 % (Northern Region Tamale Prison) (Table 1). All the 1366 consenting participants completed interviews and blood testing, and the results herein presented are from these 1366 inmates. Data from male and female inmates are combined because only 119 (8.7 %) out of the 1366 consenting participants were female. The most common sign by far on physical examination was pallor in 74.8 % of the participating inmates, followed by skin lesions (superficial fungal and bacterial infections, and scabies) in 16.7 % and hypertension (blood pressure $\geq 140/90$ mm Hg) in 18.3 %. The most common symptom was loss of appetite in 35.5 % of the participating inmates, followed by skin rashes in 24.1 %. The study inmates were in prison for various reasons, the most common being stealing (35.6 %), followed by murder (14.2 %); armed robbery (11.7 %), possession and sale of narcotics (10.7 %), assault (8.2 %), defilement (7.1 %), fraud (6.4 %) and rape (5.1 %). The median duration of time served (from the beginning of their current period of incarceration to the day of the survey) was 36 months (range 3–127 months). Of all the study inmates, 71.7 % reported marijuana use, 13.2 % used cocaine, 11.6 % used heroin and 3.5 % used phencyclidine (PCP) (data not shown). The above stated sex (male:female) ratio, the median age, the age range, the distribution of committal offence and the median duration of time served of the 1366 inmates participating in the study were similar to that of the total of 7652 eligible inmates in these eight prisons at the various periods of the study in each prison (Ghana Prisons Service, 2004) (data not shown).

A total of 255 of the 1366 study participants were HCV-positive (by both ELISA and Western blotting), giving an overall HCV seroprevalence of 18.7 % among the inmates. All the 255 repeatedly reactive sera samples by ELISA were confirmed by Western blotting. Among the eight regional central prison centres, inmates at Brong Ahafo Region Sunyani Central Prison had 5.9-fold (95 % CI 2.8–21.3) higher risk of HCV infection as compared with inmates at

Volta Region Ho Central Prison, which had the lowest HCV seroprevalence (Table 1). Table 2 shows the ORs for HCV seropositivity and corresponding 95 % CIs according to the sociodemographic characteristics of the study prisoners. Compared to the youngest age group (17–31 years), the greatest risk of HCV seropositivity was associated with those in the middle age group (32–46 years) and, to a lesser extent, those in the upper age group (above 47 years). Illiterate inmates, accounting for 17.8 % of study inmates, had a 1.7-fold (95 % CI 1.3–20.3) higher risk of HCV infection as compared with those who had attained a primary or higher level of formal education. Unmarried inmates, accounting for 24.6 % of study inmates, were at an increased risk (OR 1.9; 95 % CI 1.6–22.7) of HCV infection as compared with those who were married. Males, accounting for 91.3 % of study inmates, had a twofold (95 % CI 1.5–23.6) higher risk of HCV infection as compared with females (Table 2).

Table 3 shows the ORs for HCV seropositivity and corresponding 95 % CIs according to the behavioural characteristics of the study prisoners. Inmates incarcerated for longer than 36 months had 11.1-fold (95 % CI 4.2–29.3) higher risk of HCV infection as compared with inmates incarcerated for shorter than 36 months. Homosexual inmates, accounting for 29.5 % of study inmates, were at an increased risk (OR 3.6; 95 % CI 2.1–27.1) of HCV infection as compared with heterosexual inmates. Inmates reporting a previous history of IDU had 9.2-fold (95 % CI 3.1–24.9) higher risk of HCV infection as compared with inmates reporting no such previous history (Table 3). A previous history of blood transfusion, of assault or cuts, of paying or being paid for sex, or of sexually transmitted diseases (STD) were all associated with decreased HCV seropositivity, but only a previous history of assault or cuts reached statistical significance, in univariate analysis. A previous history of sharing needles or injection implements was not associated with HCV seropositivity (OR 1.0; 95 % CI, 0.5–1.7) (Table 3). However, being incarcerated for longer than 36 months, previous IDU and homosexuality

Table 2. ORs for HCV seropositivity and corresponding 95% CIs according to the sociodemographic characteristics among 1366 prisoners in Ghana

Sociodemographic characteristic*	No. of prisoners	HCV seropositive	
		No. (%)	OR (95 % CI)†
Age (years)			
17–31	455	73 (16.1)	1
32–46	458	101 (22.1)	1.9 (1.4–17.9)
> 47	453	81 (17.9)	1.5 (1.2–12.8)
Marital status			
Married	1030	170 (16.5)	1
Not married	336	85 (25.3)	1.9 (1.6–22.7)
Educational level attained			
Primary or better	1123	204 (18.2)	1
Illiterate or none	243	51 (21.0)	1.7 (1.3–20.3)
Gender			
Female	119	16 (13.4)	1
Male	1247	239 (19.2)	2.0 (1.5–23.6)

*Combined into only two or three categories to minimize the width of confidence intervals.

†Adjusted for age.

were the only independent determinants of HCV infection in the multivariate analysis (Table 4).

DISCUSSION

This is believed to be the first study to determine the correlates of HCV infection in Ghanaian prisons, and demonstrates the high prevalence of and the considerable potential for the transmission of HCV infection in prisons in Ghana. This study found very high overall rates (18.7%) of HCV antibody, known to correlate particularly well with HCV infection rates in high prevalence populations like that in sub-Saharan Africa, in the Ghanaian prison population. The HCV seroprevalence rate was particularly high in inmates incarcerated for longer than the median time served of 36 months, inmates reporting a previous history of IDU, and homosexual inmates. The finding of higher HCV-antibody prevalence in inmates with previous history of IDU and homosexuality relative to those without such previous history is consistent with the literature, and is widely attributable to sex- and drug-related behaviours practised outside the correctional setting, although transmission of HCV has also been documented inside prisons (Alizadeh *et al.*, 2005; Catalan-Soares *et al.*, 2000; Chetwynd *et al.*, 1995; Hammett *et al.*, 2002; Mertz *et al.*, 2002; Mutter *et al.*, 1994; Reindollar, 1999; Skoretz *et al.*, 2004; Solomon *et al.*, 2004; Spaulding *et al.*, 1999; Stratton *et al.*, 1997; Veeken, 2000; Weild *et al.*, 2000; Weinbaum *et al.*, 2005). The overall seroprevalence of HCV infection among Ghanaian prisoners (18.7%) is higher than the results of similar studies in incarcerated populations in England and Wales (7%) (Weild *et al.*, 2000), and Brazil (6.3%) (Catalan-Soares *et al.*, 2000). It is also higher than the reported seroprevalence of 1.3–8.4% in the general

Ghanaian population (of healthy blood donors, pregnant women and children) (Acquaye & Tettey-Donkor, 2000; Ampofo *et al.*, 2002; Candotti *et al.*, 2001; Lassey *et al.*, 2004; Martinson *et al.*, 1996; Sarkodie *et al.*, 2001; Wansbrough-Jones *et al.*, 1998), but comparable to our recently reported 19.2% seroprevalence rate of HCV infection among inmates at two of the eight herein studied regional central prisons in Ghana (Adjei *et al.*, 2006). However, the HCV seroprevalence rate of 18.7% herein reported is lower than the results of HCV seroprevalence studies in correctional populations in Iran (Alizadeh *et al.*, 2005), the United States of America (Hammett *et al.*, 2002; Solomon *et al.*, 2004; Spaulding *et al.*, 1999; Weinbaum *et al.*, 2005) and Canada (Skoretz *et al.*, 2004). The increased seroprevalence of HCV in inmates (18.7%) compared with that in the general population (1.3–8.4%) in Ghana supports previous reports that prisoners represent a high-risk group for the transmission of blood-borne diseases and sexually transmitted diseases (Adjei *et al.*, 2006; Alizadeh *et al.*, 2005; Catalan-Soares *et al.*, 2000; Chetwynd *et al.*, 1995; Hammett *et al.*, 2002; Mertz *et al.*, 2002; Mutter *et al.*, 1994; Reindollar, 1999; Skoretz *et al.*, 2004; Solomon *et al.*, 2004; Spaulding *et al.*, 1999; Stratton *et al.*, 1997; Veeken, 2000; Weild *et al.*, 2000; Weinbaum *et al.*, 2005). In fact their low socioeconomic and educational status, the overcrowding and poor sanitary conditions prevailing at the study prisons, and the flexibility of their moral values associated with the absence of motivation to improve self-destructive behaviours may have contributed and enhanced the risk of transmission of HCV. The observation of the increased prevalence of antibodies to HCV among the inmates is strong presumptive evidence of intra- and inter-prison transmission of HCV infection among the prisoners. This may have been due to a number of factors, including frequent movement of inmates

Table 3. ORs for HCV seropositivity and corresponding 95% CIs according to the behavioural characteristics among 1366 prisoners in Ghana

Sexual behavioural characteristic*	No. of prisoners	HCV seropositive	
		No. (%)	OR (95% CI)†
Time served (months)			
Below median (<36)	682	39 (5.7)	1
Above median (>36)	684	216 (31.6)	11.1 (4.2–29.3)
Sexual orientation			
Heterosexual	963	146 (15.2)	1
Homosexual	403	109 (27.0)	3.6 (2.1–27.1)
History of blood transfusion			
Yes	961	153 (15.9)	0.6 (0.3–1.2)
No	405	102 (25.3)	1
Ever injected drugs			
Yes	481	193 (40.1)	9.2 (3.1–24.9)
No	885	62 (7.1)	1
Ever snorted drugs			
Yes	598	134 (22.4)	2.1 (1.4–15.4)
No	768	121 (15.8)	1
Ever shared needles or injection implements			
Yes	977	182 (18.6)	1.0 (0.5–1.7)
No	389	73 (18.8)	1
Ever been tattooed or pierced			
Yes	219	42 (19.2)	1.2 (0.7–2.9)
No	1147	213 (18.6)	1
Ever been cut or assaulted			
Yes	423	27 (6.4)	0.3 (0.1–0.8)
No	943	228 (24.2)	1
Ever had sex with an injection drug user			
Yes	136	31 (22.8)	1.8 (1.3–13.5)
No	1230	224 (18.2)	1
Ever paid or been paid for sex			
Yes	73	8 (11.0)	0.6 (0.2–1.3)
No	1293	247 (19.1)	1
History of STD			
Yes	491	80 (16.3)	0.6 (0.4–1.2)
No	875	175 (20.0)	1

*Combined into only two or three categories to minimize the width of confidence intervals.

†Adjusted for age.

Table 4. Independent determinants of HCV seropositivity among 1366 inmates in eight regional central prisons in Ghana – multivariate analysis

Independent determinant	OR (95% CI)	P value
Time served (months)		
Below median (<36)	Reference category	
Above median (>36)	5.8 (5.0–6.9)	<0.001
History of intravenous drug use	4.5 (3.8–5.4)	<0.001
History of homosexuality	3.1 (2.5–3.9)	<0.001

between prisons (often with little notice), recidivism rate and the high rate at which prisoners return to prison after release. The latter rate is known to be particularly high among injecting drug users, indicating that this group of individuals may be the source of intra- and inter-prison transmission of HCV (Weinbaum *et al.*, 2005).

The explanations for the significantly higher seroprevalence of HCV among the inmates at the Brong Ahafo Region Sunyani Central Prison compared with the other regional central prisons in Ghana, and the variation in participation between the eight studied prisons are not obvious from this study. In this study, a significant number of the inmates used

illicit drugs, especially marijuana, and practised homosexuality. These high-risk behaviours place prisoners at increased risk of infection with blood-borne viruses in comparison to the rest of the population (Mutter *et al.*, 1994; Farell *et al.*, 1998). In this study, HCV infection was significantly associated with months of imprisonment. Though most of the HCV infections might have occurred before incarceration, it seems reasonable to suggest that being in prison in Ghana may be an independent risk factor for HCV transmission and infection. There was no association between HCV infection and a previous history of sharing needles or injection implements in the study inmates, and therefore the previously reported significant association of a history of needle-sharing and HCV infection in prisoners (Alizadeh *et al.*, 2005; Catalan-Soares *et al.*, 2000; Mutter *et al.*, 1994; Skoretz *et al.*, 2004; Solomon *et al.*, 2004; Weild *et al.*, 2000) could not be confirmed. Additionally, it should be noted that in some investigations, there were considerable numbers of HCV-infected cases with no apparent risk factors, depicting the complex nature of HCV transmission (Chetwynd *et al.*, 1995; Stratton *et al.*, 1997; Tsega *et al.*, 1995).

The religious beliefs and security concerns of the study inmates may be limitations of the study, despite all our assurances of confidentiality during the explanation of the purpose of the study. As a result, some inmates may not have responded correctly to the parts of the questionnaire relating to sexual orientation, drug use and history of STD. In spite of these limitations, the study results provide important data on the correlates of HCV infection among people sent to jail, and may contribute to efforts to respond to the important healthcare needs of these vulnerable individuals in Ghana. The results of the study reveal worrying trends for officials of the Ghana Prisons Service and the Ministries of Interior and Health, Accra, Ghana, who are charged with the management of HCV and other blood-borne viruses in the country. The results reported herein have significant implications for penal and public health officials, and suggest the urgent need for the introduction of policies to prevent the transmission of HCV during and following incarceration. These policy strategies must include increasing prisoner and correctional staff education about HCV prevention, testing for and treatment of infected inmates, education in tattoo application and the provision of professional tattooing services, the provision of bleach, and the provision of clean injecting equipment. The implementation of a HCV infection prevention programme in prisoners in Ghana should be seen as an opportunity to improve the health status of the infected prison inmates and to prevent further transmission of HCV, within and without the prisons. The cross-sectional scope of the current study did not allow us to determine whether the HCV-infected inmates acquired the infections while in prison or they carried them in. Further studies are under way to determine the modes of transmission, and to institute interventional measures.

In conclusion, IDU and unsafe sexual behaviours, among other factors, have resulted in the concentration of a

population infected with HCV in Ghanaian prisons. The high prevalence of HCV infection found in the Ghanaian prison population suggests the urgent need for the introduction of some of the range of effective preventive strategies employed in prisons elsewhere. Despite current financial and institutional constraints, collaborations have to be developed between the Ghana Prisons Service, local government authorities, academic institutions and community-based organizations to provide HCV prevention services within the prisons, because the rapid turnover of the prison population in Ghana has significant public health implications for the general population.

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