

HEMATOLOGICAL STUDIES ON MALARIA IN PUERTO RICO*

REPORT OF 100 CASES

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Malaria constitutes a serious medical and public health problem in this Island, particularly on the coastal plain where it is most severe and where in certain localities it is not unusual to find between 25 and 35 per cent¹ of the population with parasites in the blood. In 1934 the death rate from malaria for Puerto Rico was 152.8 per 100,000 inhabitants², and though this rate was 23.9 per cent lower than that for 1933, malaria in 1934 was still the third cause of death on the Island. A search in the local medical literature has revealed but one previous hematological study³ in this widespread and important malady, even though the laboratory diagnosis of this condition requires an examination of the blood smear. It seemed, therefore, that a study of the blood picture in uncomplicated cases of malaria would not only be of interest, but would possess value as a contribution to the clinical aspect of the disease as found in Puerto Rico.

MATERIAL AND METHOD

The present study was carried out in the town of Loíza, located on the northeastern coast of the Island about 20 miles east of San Juan, and in the rural districts adjacent to this town where malaria is endemic and the Department of Health maintains a control center. Studies were made during the months of September, October, November, December, January and March when there is an annual excess of malaria (loc. cit.) in this district. The work consisted of an examination of the blood picture in one hundred malarial individuals of both sexes, all harboring parasites at the time when the study was made. All the cases examined were colored and the majority were negroes. Pregnancy, pulmonary tuberculosis, sprue and dysentery were excluded, but serologic data was

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not available to rule out syphilis. There were forty-nine females and fifty-one males. The oldest was a woman of fifty years of age, and the youngest a girl ten years old.

Spleen examinations were made on the recumbent posture and the temperature of each individual was recorded. The spleens were classified as nonpalpable and palpable, no attempt being made to divide them according to size.

Thick blood films for diagnosis were examined by Mr. M. Pérez-Torres one to seven days before the hematological studies were made. In many instances parasite counts were made also, but will not be considered in this paper. An approximately equal distribution of *P. vivax*, *P. falciparum* and *P. malariae* was found. A few individuals having mixed infections were included.

Examination of feces for intestinal parasites was made in twenty random cases and only slight infestations of hookworm, *Ascaris* and *Trichuris trichiura* were found as evidenced by Stoll's egg count technique.

Specimens of blood were taken between 2 and 4 P. M. in the patients' homes or in the office of the officer in charge of the anti-malarial campaign. Temperatures were recorded at the time the blood was removed. All but a few cases were ambulatory. Individuals classified as acute cases were those suffering from the first attack of chills and fever, while chronic cases were those which gave a history of repeated attacks of the disease.

Hematologic studies were made from venous blood within three hours after drawing, without stasis and rendered incoagulable by the addition of six milligrams of dry potassium oxalate. Smears for differential counts were prepared from capillary blood taken from finger. Schilling hemograms were determined in ninety-six individuals. The mean of two corpuscular counts and of two hemoglobin determinations was recorded for each case. A single Newcomer-Klett hemoglobinometer with a solid standard was employed, so calibrated that 14.5 gms. of hemoglobin per 100 cc. of blood was equivalent to 100 per cent hemoglobin. Description of technique followed in this study has been reported elsewhere⁴. Wintrobe's hematocrit was employed to determine the volume of packed red cells and the morphological classification of anemias presented by this investigator was followed.

Sedimentation of red corpuscles was determined in 85 cases by the method described by Wintrobe and Landsberg⁵.

The anemia in individuals in whom the mean corpuscular volume was greater than 94 cubic micra and in whom the mean corpuscular hemoglobin concentration was 30 per cent or higher, have been classified as macrocytic. The cases in which the mean corpuscular volume was between 80 and 94 cubic micra and the mean corpuscular hemoglobin concentration 30 per cent or greater, were classified as normocytic. Those in whom the mean corpuscular volume was less than 80 cubic micra and the mean corpuscular hemoglobin concentration 30 per cent or higher, have been classified as simple microcytic. Those instances in which the mean corpuscular hemoglobin concentration was 29 per cent or less, whether the mean corpuscular volume was greatly or little reduced, or even normal, have been classified as hypochromic anemia⁶.

Seventy per cent of the individuals studied had ingested variable quantities of quinine sulphate *per os* one to five days before blood studies were made. The total amount of quinine varied from 1 to 4.5 gms. Very few individuals presented signs of active symptomatology and these were mostly ambulatory cases. Five per cent were bedridden when blood was removed for study.

RESULTS

Red Blood Cells and Hemoglobin.

The mean erythrocyte count for the entire group was 3.95 millions per cu. mm., the highest and lowest counts being 5.70 and 1.98 millions respectively. The mean hemoglobin for the group was 12.38 gms. (85%), and the figures for hemoglobin ranged from 7.25 gms. (50%) to 16.6 gms. (114%).

Seventy per cent of the cases showed a red cell count below four millions, while in ten per cent only the hemoglobin was below 10.2 gms. (70%). In only five individuals of the entire group normal values for erythrocytes and hemoglobin were found.

A macrocytic type of anemia was found in thirty-four per cent of all cases; normocytic anemia in thirty-seven per cent; simple microcytic in sixteen per cent, and hypochromic in thirteen per cent.

The mean corpuscular volume for all cases was 92.65 cubic micra which is characteristic of normocytic anemia, values ranging from 68 to 134; the mean corpuscular hemoglobin was 31.25 micromicrograms, fluctuating between 19 and 55; the mean corpuscular hemoglobin concentration was 33.1 per cent, ranging from 18 to 48 per cent. The mean volume of packed red cells amounted to 36.11 cc. with variations between 22.89 and 49.02 cc. Examination of stained smears from individuals presenting anemia revealed the usual changes in morphology of red cells. No nucleated reds or other abnormal red cells were encountered, nor were there other signs of active blood formation. Reticulocyte counts were not made. No changes of importance were detected in the morphology of leukocytes or platelets.

White Blood Cells.

The total leukocyte count for the group of 100 cases ranged between 2,150 and 11,825 per cu. mm. with a mean count of 5,987 cells per cu. mm. Thirty-five per cent of the cases showed a leukopenia (below 5,000) and in sixty-one per cent the leukocytes ranged between normal limits. In only four per cent was the count over 10,000, but never higher than 12,000.

Differential Leukocyte Counts.

Two hundred cells were counted. The mean for juvenile neutrophils was 1.83 per cent with fluctuations between zero and nine per cent; for staff forms (Stabkernige) the mean percentage was 12.16, figures ranging from two to thirty-one per cent. The segmented neutrophils presented a mean of 35.84 per cent with fluctuations of twenty to sixty per cent. The mean of eosinophils was 10.2 per cent, with variations from 1 to 29.5 per cent. Eosinophilia was not considered significant because of intestinal helminth infestations. Basophils: mean percentage, 44 per cent; variations from 0 to 1 per cent; lymphocytes: mean percentage, 34.4; lowest, 16 per cent, highest, 60.5 per cent; monocytes: mean percentage, 5.38, with fluctuations from one to sixteen per cent. This percentage was found in one case only.

Platelets.

The mean count was 172,000 per cu. mm., the highest and lowest counts being 330,000 to 40,000 respectively. No

objective evidence of bleeding or purpura were present in individuals with counts below 100,000 per cu. mm. The platelets ranged between normal limits in all but eight per cent of individuals whose counts were found to be below 100,000 per cu. mm.

Chronicity of Symptoms in Cases Studied.

Eighty-three per cent of the individuals were cases of chronic malaria and seventeen per cent were classified as acute cases.

Spleen Examinations.

Thirty-eight per cent of the individuals presented a palpable spleen and in fifty-eight per cent the organ was not felt. In four per cent the spleen was not examined. No enlargement of liver was found in any individual.

Temperature.

Twenty-five per cent of the cases had a normal temperature. In fifty-seven per cent the temperature varied from 37.1 to 40°C. Fourteen per cent had subnormal temperature, the lowest recorded being 36.5°C. No record of temperature was obtained in four per cent of the cases.

Sedimentation Rates.

The mean sedimentation rate for 85 individuals was 17.85 mm., the highest and lowest being 26 and 4 mm. respectively.

COMMENTS

The anemia in malaria is believed to be due to a rapid destruction of blood subject to the activities of the protozoan parasite. Hence the blood picture is characterized by signs of destruction and production of red blood cells with evidence of bone-marrow activity. This state of affairs may occur in the active stages of an early infection, but certainly was not characteristic of the cases reported in the present study. Two factors may possibly play a part in explaining the surprisingly small degree of anemia found in this group when studied as a unit: Immunity to the disease, and degree of nutrition of individuals studied. Most persons had resided in this endemic malarial region for several years and had suffered repeated attacks since childhood. It is difficult to state whether this host-resistance is racial or acquired, but

it is a well-known fact that the negro in Africa, although he does get malarial fever, does not get it so frequently or so severely as the European, in spite of the fact that the latter is much less exposed to infection⁷. The majority of cases examined were well nourished and well developed, active and vigorous subjects, and it was not unusual to find them in the best of spirits going about their way with a temperature of 40°C. and presenting no complaints whatsoever.

The dietary of the Puerto Rican peasant⁸ has in general been found to be a liberal and daily consumption of dry beans, polished rice and salted codfish but deficient in meat and dairy products. We were able to notice, however, that the group studied consumed a liberal amount of crab meat, particularly during the summer and fall when hard-shell land crabs are abundant in this region. In many homes visited by us on different days we frequently observed that this form of fresh animal protein constituted the main dish of two meals in the family dietary, being served with such vegetables as yuca, sweet potato or with corn meal and polished rice. Fresh fish is frequently consumed in this region also, particularly during the summer.

Contrary to expectations, a large percentage (34%) of the individuals studied presented a macrocytic type of anemia, the mean cell volume for the entire group being 92.65 cubic micra, which is very near the normal maximum. Suárez and Costa-Mandry (loc. cit.) reported a tendency to macrocytosis and hyperchromic anemia in the chronic cases studied by them. A mean cell volume of 112.9 cubic micra was obtained in one of the chronic cases. The highest mean cell volume found by us was 134. But the average of Suárez' both acute and chronic cases (16 in all) showed the characteristics of a normocytic anemia. We are unable to account for the presence of a macrocytic anemia as no other studies were made in our cases. However, there were no evidences of apparent liver disease.

The leukocytes did not, as a rule, show the characteristic leukopenia mentioned in the literature, as only thirty-five per cent had a definite leukopenia. Nor there was an increase in monocytes often mentioned also. No myelocytes were found in any case. While the percentage of juvenile neutrophils remained around normal (1.83%), the mean percentage for staff forms was increased above normal figures (12.16%).

The segmented forms, however, were considerably decreased, the mean for the group being 35.84 per cent. Such figures in the granular leukocytes would indicate a degenerative shift. A trend towards relative lymphocytosis was shown by the lymphocytes.

With few exceptions the platelets remained within normal limits.

The sedimentation rate was also within normal range in most cases.

CONCLUSIONS

Hematological studies were made in one hundred individuals suffering from malaria, eighty-three per cent of which were chronic and seventeen per cent acute cases. Though seventy per cent of cases had red cell counts below four millions per cu. mm., only ten per cent showed hemoglobins below 10.2 gms. (70%); the degree of anemia for the entire group was considered slight, the mean red cell count being 3.95 millions and the mean hemoglobin, 12.30 gms. (85%). Examination of stained smears did not show much evidence of active blood formation. A macrocytic anemia was found in thirty-four per cent of the cases; normocytic anemia in thirty-seven per cent; simple microcytic in sixteen, and hypochromic in thirteen per cent. Characteristic leukopenia was detected in only thirty-five per cent of the cases. Schilling hemograms showed a degenerative shift in the granular leukocytes. No remarkable changes were observed in the platelets or in sedimentation rate of red corpuscles. Racial or acquired resistance to the disease and a high animal protein content in the dietary of the population studied are believed to be important factors responsible for the slight degree of anemia encountered.

It is inferred from this study that the blood picture in malaria in Puerto Rico is not in itself of diagnostic value apart from the finding of the causative organism.

SUMMARY

Enumeration of erythrocytes, leukocytes, platelets and differential white cell counts were performed in 100 cases of malaria in Puerto Rico. Estimation of hemoglobin and determination of the volume of packed red cells were made also.

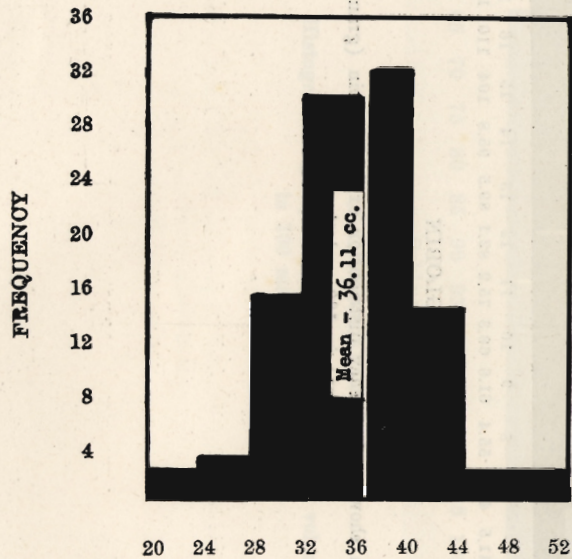
Mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentrations and sedimentation rates were determined. Examination of spleens was made and temperature of each case was recorded. Feces were examined for intestinal parasites in twenty individuals.

ACKNOWLEDGMENT

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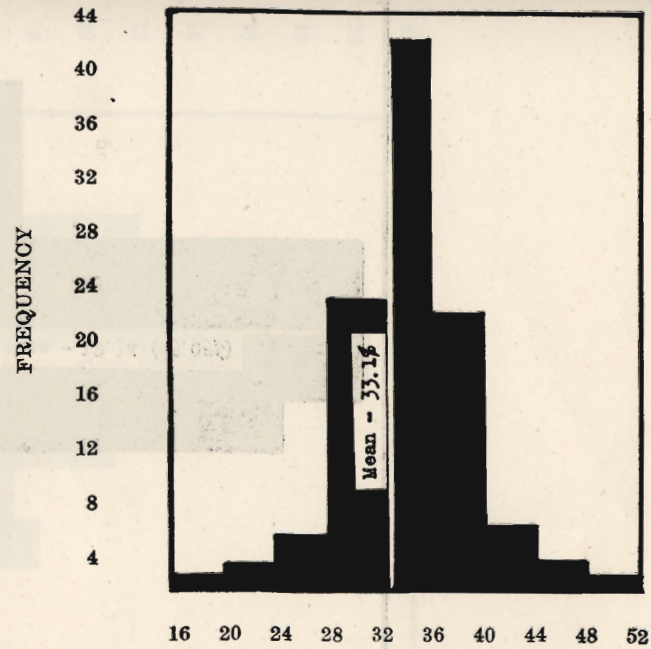
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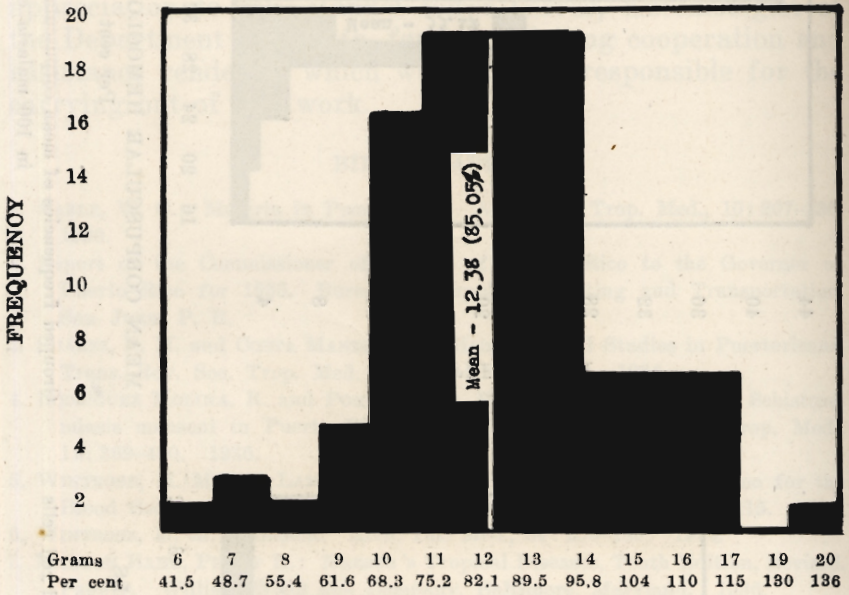
VOLUME OF PACKED RED CELLS
cc. per 100 cc. of blood

Frequency distribution of volume of packed red cells
in 100 malaria cases



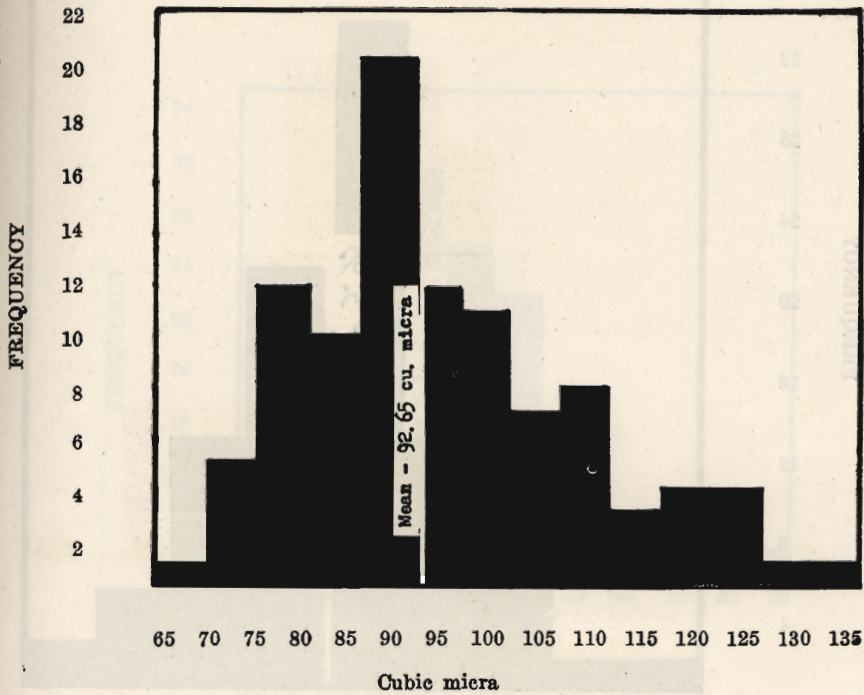
MEAN CORPUSCULAR HEMOGLOBIN CONCENTRATION
Per cent

Grouped frequencies of mean corpuscular hemoglobin concentration
in 100 malaria cases



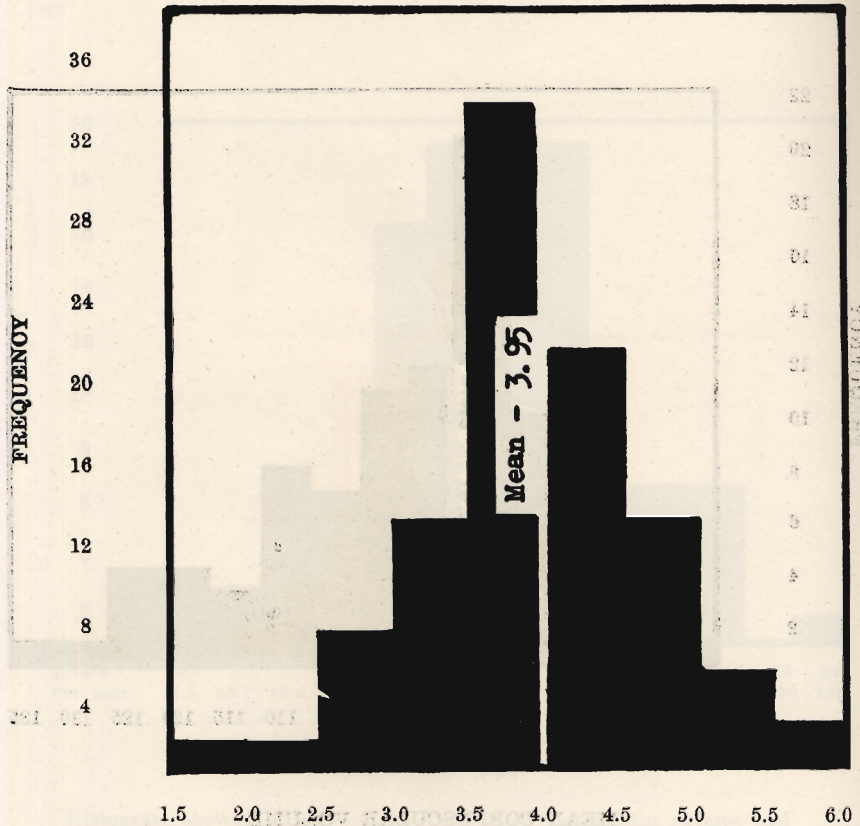
HEMOGLOBIN
Grams—Per Cent

Histogram showing frequency distribution of hemoglobin (grams and per cent) in 100 malaria cases



MEAN CORPUSCULAR VOLUME

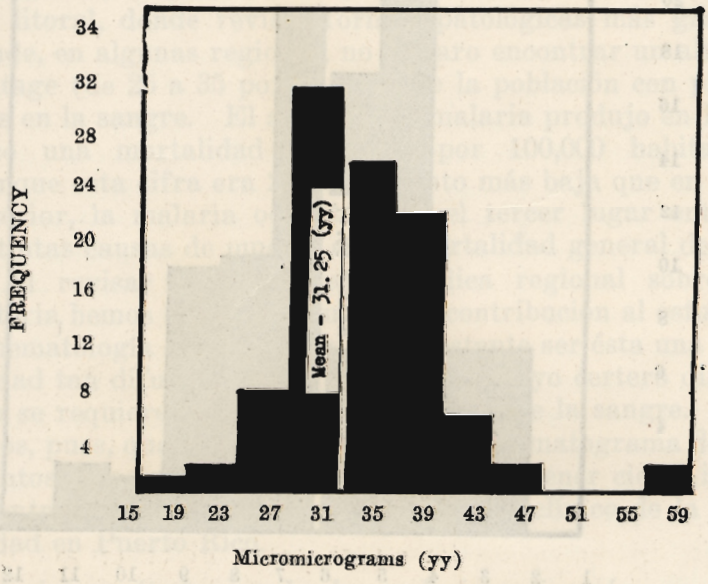
Histogram of grouped frequencies of mean cell volume in 100 malaria cases



RED BLOOD CELLS

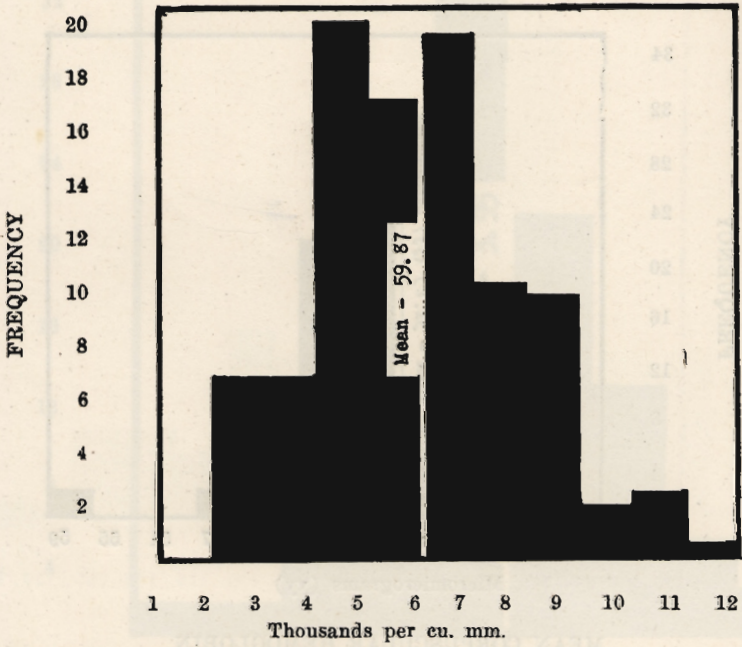
Millions per c. mm.

Histogram showing grouped frequencies for red blood cells in 100 malaria cases



MEAN CORPUSCULAR HEMOGLOBIN

Grouped frequencies of mean corpuscular hemoglobin
in 100 malaria cases



WHITE BLOOD CELLS

Grouped frequencies of leukocytes in 100 malaria cases