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THE ACUTE RADIATION SYNDROME IN THE  $^{137}\text{Cs}$  BRAZILIAN  
ACCIDENT, 1987

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introduction

On September 13, 1987, two scavengers removed the head of a radiotherapy device, with a 50.8 TBq  $^{137}\text{Cs}$  source from an abandoned clinic in Goiania, the capital city of State of Goias, in the central part of Brazil. They loaded it onto a wheelbarrow to a plot shared by dwellers of a housing development, including one of the scavengers (RSA), where they tried to disassembly it. Actually, the shutter of the collimator orifice was broken and small fragments of the source, removed with a screwdriver, were spread out over the area.

Apparently, the apparatus remained at the disassembly area until September 18, 1987, when its capsule with the source was transported by another individual to a junkyard owned by patient DAF, who noting, at night, a striking blue glow from the capsule, took it from the dump where it was to the living room of his house to be exhibited to his relatives, neighbors, friends and onlookers.

On September 21, 1987, patients AAS and IBS attempted to disassembly the source, producing minute fragments of  $^{137}\text{CsCl}$ , some of them transformed into powder and offered to individuals as "souvenirs".

On September 28, 1987, DAF's wife (MGF) ascribing the clinical manifestations presented by herself and others to the exposure to the shining "object", took part of it by bus to the Sanitary Surveillance Division of Goiania (SSD), with the help of one of her husband's employees. Suspecting of a "toxic gas", SSD personnel, called the Fire Corps who cordoned off the area. On September 29, 1987, a physician and a nuclear physicist identified the material as radioactive and the National Commission on Nuclear Energy

(CNEN) was summoned. (1)

Table 1 summarizes population triage. Twenty persons had to be hospitalized, 17 out of this number with bone marrow depression, but only eight patients with the most severe degree of bone marrow impairment will be discussed.

#### Medical Facilities, Exams and Therapeutic Management

All patients with the Acute Radiation Syndrome (ARS) were admitted to the Goiania General Hospital (HGG) and later to the Marcilio Dias Naval Hospital (HNMD) in Rio. The most severely affected patients were referred from HGG to HNMD.

Table 2 gives information on the routine and periodical exams for the evaluation of the ARS patients.

The hemopoietic phase of ARS was the only one observed in the Goiania accident, and the basic medical handling of the patients consisted of: (2-3)

- a) admission in rooms with reverse isolation;
- b) diet without raw vegetables or uncooked food;
- c) nails trimming and scrubbing;
- d) local neomycin in the nasal cavities;
- e) gut sterilization with oral trimethoprim / sulfamethoxazole and nystatin if neutrophils were less than  $1.5 \times 10^9/L$ ;
- f) systemic antibiotics if fever was greater than  $38,5^{\circ}C$  or other signs of infection in a granulocytic patient (neutrophils  $< 0,75 \times 10^9/L$ ): empirical antibiotic regimen consisted of IV gentamicin, cephalotin and carbenicillin, changed to cefoperazone, imipenem and/or piperacillin (two patients received vancomycin and one amikacin and cefoxitin) as a result of the evolution and/or cultures; persons with persistent fever ( $> 48 - 72$  hours) received amphotericin B;
- g) irradiated (25 Gy) red packed cells and platelets infusions to maintain hemoglobin  $> 1,55$  mmol/L (10 g/dL) and platelets  $> 20 \times 10^9/L$  or whenever bleeding occurred in a patient with a platelet count  $< 60 \times 10^9/L$ ;
- h) acyclovir, beginning about 3 weeks after exposure, to prevent herpes virus activation;
- i) anthelmintics, such as thiabendazole and mebendazole, in accordance with the results of stool exams or empirically (eosinophilia).

Six patients with the ARS received recombinant human granulocyte-macrophage-colony stimulating factor (rHuGM-CSF) (4-5-6) at a dose of  $500 \mu g/m^2/day$ . Prussian Blue was given to all the ARS patients, who had internal contamination with  $^{137}Cs$ .

## Associated Conditions

Associated medical problems, such as local radiation injuries, external and internal contamination will only be mentioned in this paper (see Table 3). Doses rates refer to values after initial decontamination procedures, whereas body burdens are those calculated before the administration of Prussian Blue.

## Dose Estimation

Dose estimates were based on cytogenetics and were performed at the Instituto de Radioprotecao e Dosimetria (IRD) of CNEN by Dr. Adriana Ramalho and at Oak Ridge (selected cases) by Dr. L. Gayle Littlefield, at the Radiation Emergency Assistance Center / Training Site (REAC/TS), but important internal burdens in some patients, the non-uniform distribution of the doses, the protracted/acute kind of exposure and the lack of an ideal calibration curve ( $^{60}\text{Co}$  was used in Brazil and  $^{60}\text{Co}$  and  $^{132}\text{I}$  in the USA), all contributed to difficulties in the interpretation of the results. Regardless, the clinical and hematological responses were the most important parameters considered in the treatment of the ARS patients. (7-8-9)

Unfortunately, the onset of prodromal manifestations after exposure could not be correctly determined in some patients because the character of the exposures and also because of poor information reported by the patients in virtue of their low cultural background and fear of legal incrimination. Patient RSA, for instance, was mentally handicapped. Because of all that the "clinical" estimated doses (Table 4) were mainly based on the evolution of neutrophils, specially on the day they reached  $\leq 0.5 \times 10^9/\text{L}$ .

Lymphocytes counts in peripheral blood although markedly depressed in all patients did not serve for immediate prognosis because the time elapsed between exposures, the accident recognition and hospitalizations.

## Case Descriptions

Descriptions are limited to manifestations and complications related to the ARS. Information on prodromal symptoms are found in Table 4.

a) RSA, male, 22 years old, scavenger

This retardate patient, removed the head of the radiotherapy device from the Goiania clinic on September 13, 1987, (day 0) and experienced prodromal manifestations about 2 to 3 hours after trying to break it open, which itself took about 2 hours. He remained asymptomatic for one week when

erythema and blisters appeared on both hands. Epilation started on the scalp, and probably in the beginning of the 2<sup>nd</sup> week.

RSA had daily exposures from the source since day 0, each one of ignored length, until September 18, 1987, when the source was sold to DAF.

The patient was admitted to HGG on day 17, in a poor general health, confused and dehydrated. Alopecia was evident on the scalp and radiodermatitis were observed on the right axilla, both forearms and hands. There were ulcerations on the edges of the tongue and left conjunctival hyperemia.

The patient was referred to HNMD on day 18 with  $2.5 \times 10^9/L$  leukocytes,  $30 \times 10^9/L$  platelets and a hemoglobin of 2.04 mmol/L (13.2 g/dL). There was progressive fall of the leukocytes and platelets and nadir was reached on day 25 (leukocytes  $0.15 \times 10^9/L$ ; no neutrophils; platelets - day 22 -  $3.3 \times 10^9/L$ ) when he developed a spiking fever ( $38,5^\circ C$ ). Gut sterilization was attempted with oral sulfamethoxazole / trimethoprim and nystatin. On day 21 IV gentamicin, carbenicillin and cephalotin were started. Fever persisted, but all cultures were negative.

The patient needed amputation of the right forearm at its upper third on day 31, due to deterioration of the lesion and a blood pool imaging study that showed no vascularization in the affected area.

On day 23 parenteral nutrition was initiated, as well as amphotericin B, because of persistent fever. On day 34 the antibiotic regimen included amikacin and cefoxitin as substitutes for gentamicin and cephalotin. On day 35 the patient became afebrile and thereafter the evolution was favorable. All cultures were negative and the patient was discharged on day 50 to Golanias, with  $7.8 \times 10^9/L$  leukocytes,  $4.5 \times 10^9/L$  neutrophils,  $300 \times 10^9/L$  platelets, a reticulocyte index of 2.29 and a hemoglobin of 2 mmol/L (13 g/dL).

b) WMP, male, 19 years old, scavenger

The kind exposure of this patient is similar to RSA's, although very likely much less important after day 0. The patient noted transient erythema on the left hand on the 1<sup>st</sup> post-exposure day, blisters on both hands on day 7 and epilation, mainly on the legs on day 13.

WMP was admitted to HGG on day 17 with skin lesions on the hands, legs and feet and transferred to HNMD in the next day. Blood count showed  $5.6 \times 10^9/L$ , platelets  $43.4 \times 10^9/L$  and hemoglobin 2.24 mmol/L (14.5 g/dL).

Neutrophils reached the nadir on day 34 ( $0.35 \times 10^9/L$ ) and

GM-CSF was started. Figure 1 shows the patient hematological evolution.

Two days after GM-CSF was initiated leukocytes (granulocytes) started to increase with a shift to the left and immature forms. Platelets started to increase as well and the patient developed a spiking fever four days after the beginning of GM-CSF. It is worth mentioning that monocytes and lymphocytes started to recover only around day 56.

On day 38 *Staphylococcus* sp grew in a culture of the tip of an IV catheter but the patient remained well until day 47 when clinical course was complicated by sepsis (*Pseudomonas aeruginosa*) successfully treated with vancomycin (the skin lesions were suspicious), cefoperazone and imipenem. Dopamine had to be used to maintain blood pressure. Left heart failure was another complication, managed with digitalis and diuretics.

GM-CSF was discontinued on day 50 and thereafter evolution was uneventful. WMP was discharged on day 86, with  $2.8 \times 10^9/L$  leukocytes,  $91.5 \times 10^9/L$  neutrophils,  $220 \times 10^9/L$  platelets and a hemoglobin of 1.59 mmol/L (10.3 g/dL).

c) DAF, male, 36 years old, owner of a junkyard

The patient had the first exposure to the source on September 18, 1987 (day 0). He handled the source then "many times" up to day 10 and on day 3 he asked patients AAS and IBS to disassembly the source. In the next day, prodromal manifestations appeared.

DAF remained asymptomatic until day 10, when he observed erythema on both hands.

The patient was hospitalized in HGG on day 12 and was removed the next day to HNMD. (leukocytes  $0.6 \times 10^9/L$ ; platelets  $63 \times 10^9/L$ ; hemoglobin 1.84 mmol/L - 11.9 g/dL).

Epilation started on the scalp on day 15 and was notable also on the beard and pubic hair, demonstrating a whole-body exposure pattern.

Because of fever and a leukocyte count of  $0.7 \times 10^9/L$ , with  $0.35 \times 10^9/L$  neutrophils, the patient was started on day 14 in oral sulfamethoxazole/trimethoprim and IV gentamicin, carbenicillin and cephalotin. Fever subsided but extensive oral monilliasis appeared, demanding the use of amphotericin B and parenteral nutrition. Fever would then appear only during the administration of amphotericin B.

Leukocytes and platelets reached the nadir about day 17 ( $0.15 \times 10^9/L$  and  $20 \times 10^9/L$ ). No neutrophils were observed in the peripheral blood since day 18.

On day 32, as bone marrow showed some recovery, monilliasis had disappeared, the patient was feeling well and there was no fever, antibiotics and parenteral nutrition were discontinued. All the hemocultures were negative.

Evolution was favorable and the patient was discharged on November 4, 1987 (day 47) with  $7.0 \times 10^9/L$  leukocytes,  $210 \times 10^9/L$  platelets, a reticulocyte index of 1.05 and a hemoglobin of 1.85 mmol/L (12 g/dL).

d) LNF, female, 6 years old

Prodromal manifestations (see Table 4) started in this patient on September 24, 1987, 3 hours after she handled, while eating, fragments of the source, brought home by her father (a brother of DAF) and transformed into powder. Manifestations subsided in the morning of the next day.

Erythema appeared two days later on the palm of the left hand and plantar area of the left foot. Otherwise, the girl remained well and on day 6, due to the accident identification, her history and the detection of a dose rate of 0.5.Gy/h under her bed, (the floor of the house was washed and water drained to the floor under LNF's bed) she was admitted to HGG and transferred in the next day to HNMD.

It is worth mentioning the high count on the patient's left hand, i.e, 1.5 cGy/h. Internal contamination was also impressive (see Table 3), with an internal dose rate on day 16 of 25 cGy/day and a committed dose of 3 Gy. The estimated committed dose in the 70 years was 12 Gy.

During hospitalization in HNMD leukocytes and platelets had a significant decrease (see Figure 2).

An ulcer on the tongue and diffuse oral monilliasis, causing important dysphagia, demanded parenteral nutrition. Hematemesis, melena and epistaxis were major bleeding manifestations. Fever ( $38^{\circ}C$ ) started on day 9 and because of important granulocytopenia, IV gentamicin, cephalotin and carbenicillin were administered. Amphotericin B was used on day 17 because of the worsening of oral monilliasis.

After initiation of systemic antibiotics, the patient became afebrile and all cultures were negative. On day 26 fever ( $39,5^{\circ}C$ ) resumed and cultures performed. In the next day the patient became septic and antibiotics were changed to cefoperazone and piperacillin but the patient died on day 29. Blood cultures yielded *Klebsiella* sp. sensitive to the antibiotics that were used.

GM-CSF was used (day 22 to day 28) with no apparent result.

Prussian Blue, 6 g/day, was very effective in lowering the cesium burden, so that a blood activity of 52.92 MBq/L on day

10 was reduced to 18.14 MBq/L on day 24, but we should not neglect the effective half-life of  $^{137}\text{Cs}$  in a 6 year old girl (8.8 days for 44% of the burden and 32 days for 56% of the burden).

Autopsy was performed with radiation protection techniques and disclosed multiple areas of hemorrhage through the whole skeletal musculature and different organs. As of the writing of this paper the histopathological and post-mortem bacteriological studies of all the four patients that died were not available.

e) IBS, male, 22 years old, scavenger

On September 23, 1987 his employer (DAF) asked him and AAS to disassembly the source. This task was partially accomplished in two days, with operations that took 30-45 minutes each day. In the morning of day 2, the patient complained of anorexia, nausea and vomiting, 2 daily episodes for 2 days. Thereafter, IBS remained asymptomatic, and after the accident identification he was admitted to HGG (day 7), with a negative physical examination, except for erythema on the right hand fingers and bullae on the right palm and perineum.

There was a progressive fall of the leukocytes and platelets and on day 25 leukocytes dropped to  $1.3 \times 10^9/\text{L}$ , neutrophils to  $0.75 \times 10^9/\text{L}$  and platelets to  $32 \times 10^9/\text{L}$ . (see Figure 3)

IBS was transferred to HNMD on day 26, on the use of carbenicillin, gentamicin and cephalotin.

Perineal moniliasis was observed on day 28, when leukocytes reached  $0.55 \times 10^9/\text{L}$ , neutrophils  $0.31 \times 10^9/\text{L}$  and platelets  $16.2 \times 10^9/\text{L}$ . Patient was started on GM-CSF and topical ketoconazole.

In the next day he developed a fever ( $38,5^{\circ}\text{C}$ ) and antibiotics were changed to cefoperazone and piperacillin. The patient remained afebrile for two days, but on day 32 fever resumed ( $39,6^{\circ}\text{C}$ ), he became somnolent and shocky. Medication consisted then of GM-CSF, red packed cells and platelets infusions, dopamine, cefoperazone, piperacillin and vancomycin. Blood and skin cultures of the perineum yielded *Klebsiella* sp. sensitive to the antibiotics that were used.

Shock was irreversible and the patient died at 6:40 a.m., on October 27, 1987 (day 34). There was no apparent response to GM-CSF in the peripheral blood.

Autopsy disclosed radiodermatitis areas on hands, thighs, scrotum, penis, gluteal and inguinal regions. The pericardium was hemorrhagic, as well as the lungs and the interventricular septum and subendocardial wall of the heart.

f) MGF, female, 36 years old, housewife

This patient (DAF's wife) was exposed to the <sup>137</sup>Cs source from September 19 (day 0) to September 28, 1987 for variable periods of time. On the morning of September 21, 1987, she experienced prodromal manifestations (Table 4). She was admitted to HGG, on day 11, complaining of anorexia.

The patient had a previous history of "anemia" and because a hemoglobin of 1.39 mmol/L (9 g/dL), her prolonged exposure and alopecia on the scalp, she was referred to HNMD on day 14.

MGF's clinical course at HNMD was guarded, with progressive alopecia on the scalp, oral and probable esophageal monilliasis and spiking fever. Leukocytes, neutrophils and platelets had an important drop, reaching values as low as  $0.05 \times 10^9/L$ , zero and  $27.7 \times 10^9/L$ , on days 27, 25 and 19, respectively. (see Figure 4).

A bleeding diathesis was characterized by skin and palatal petechiae, very large bilateral orbital hematomas and rectal bleeding. The patient was treated with oral contraceptives, red packed cells and platelets infusions. GM-CSF was initiated on day 31.

Gentamicin, cephalotin and carbenicillin were initiated on day 16, but had to be titrated in virtue of the development of acute renal failure on day 29, one day after the addition of amphotericin B to the antibiotic regimen. Acute renal failure responded well to hydration and furosemide, but the patient became frankly septic on day 33. Antibiotics were changed to cefoperazone and piperacillin, but the patient died on October 23, 1987, at 12:00 a.m. (day 34).

Hemocultures on day 27 were positive for *Klebsiella* sp. sensitive to the drugs that were being used. Hemocultures and vaginal secretion cultures of day 34 yielded *Klebsiella* sp. and *Escherichia coli*.

Autopsy showed diffuse hemorrhage in all organs, more severe in the lungs and heart. Cerebral edema was also observed and the cerebrospinal fluid was xanthochromic.

g) AAS, male, 18 years, old, scavenger

This patient has an identical history to IBS's with the exception that he was probably exposed for a short time on September 18, 1987. We consider September 23, 1987 day 0 and on day 2 he complained of anorexia and nausea for the whole day. Thereafter, the patient remained asymptomatic, but on day 7 he had a burning pain on the right palm.

AAS was admitted to HGG on day 7 with erythema and edema on the right palm, together with erythema on the tips of the fingers of both hands. Blood count was normal, but severe



pain appeared on both hands, so that the patient was removed to HNMD on day 10. Epilation on the right half of the scalp started on day 12 and was progressive during hospitalization. Leukopenia and trombocytopenia were also progressive and leukocytes reached the nadir on day 27 ( $0.35 \times 10^9/L$ ) and platelets on day 25 ( $11 \times 10^9/L$ ). On day 24, the patient became somnolent and in the next day GM-CSF was started. (see Figure 5)

On day 28 a fever ( $38,5^{\circ}C$ ) appeared and cefoperazone and piperacillin, after specimens were collected for cultures, were initiated. Amphotericin B, because the persistence of fever, was added to the regimen on day 33, but the evolution was unfavorable, the patient maintained high fever, shocked and died at 12:00 a.m., on October 28, 1987 (day 35), with a bone marrow response characterized by  $26.2 \times 10^9/L$  leukocytes, with an important shift to the left (41% band and 38% segmented neutrophils) and immature forms. *Klebsiella* sp grew in blood cultures.

Autopsy showed diffuse congestion of all organs and disseminated hemorrhagic spots in the stomach and intestines.

n) MGA, female, 57 years old, housewife

On September 22, 1987 (day 0), the patient went to her daughter's (MGF) to nurse her. MGA slept for two nights in the living room of MGF's house, about 2 meters far from the source. Around 3 hours after arriving at her daughter's, the patient experienced anorexia and nausea, followed by 4 to 5 daily episodes of vomiting that lasted 3 days. On day 3, MGA was hospitalized in a small hospital near Goiania with "dehydration".

On day 9, the patient, free of symptoms, was taken by a relative to a triage facility in Goiania, where external contamination on clothes, hands, feet and hair was detected. A blood count showed leukocytes  $2.7 \times 10^9/L$  and platelets  $280 \times 10^9/L$ .

MGA was admitted on day 13 to HGG presenting erythema on the scalp and small reddish spots on the plantar areas. During hospitalization at HGG, alopecia on the scalp became progressive. On day 16 a bone marrow aspirate showed "moderate to severe depression of the bone marrow". Leukocytes and platelets started dropping and on day 20 blood count was: leukocytes  $1.8 \times 10^9/L$ ; neutrophils  $1.0 \times 10^9/L$ ; platelets  $108 \times 10^9/L$  and hemoglobin  $1.76 \text{ mmol/L}$  ( $11.4 \text{ g/dL}$ ). The patient was then started on oral nystatin and sulfamethoxazole / trimetropim.

On day 26 petechiae and hematomas first appeared, leukocytes reached  $0.9 \times 10^9/L$ , platelets  $21 \times 10^9/L$  and the patient was removed to HNMD on day 27. Evolution was characterized by rectal bleeding, oral and vaginal monilliasis, severe anorexia

and vomiting. Leukocytes reached the nadir on day 31 ( $0.3 \times 10^9/L$ ) and a fever ( $38.5^\circ C$ ) appeared. GM-CSF was initiated on day 30, as well as IV cefoperazone and piperacillin. On day 32 parenteral nutrition was started. Fever subsided after the initiation of the antibiotic regimen, but anorexia and vomiting continued. A ultrasound study of the abdomen was negative.

Five days after the administration of GM-CSF, leukocytes increased to  $2.6 \times 10^9/L$  and soared to  $23.8 \times 10^9/L$  on day 39, i.e., 9 days after GM-CSF. Neutrophils showed a marked increase, with an important shift to the left and immature forms (Figure 6). Monocytes also had an important elevation.

The antibiotics were withdrawn 8 days after its initial prescription, while the patients had a favorable clinical and hematological evolution.

All cultures were negative but those of the oropharynx, rectum and vagina, which yielded *Klebsiella* sp, sensitive to the antibiotics that were used. The patient was discharged on November 25, 1987 (day 64), with  $7.2 \times 10^9/L$  leukocytes,  $4.75 \times 10^9/L$  neutrophils,  $350 \times 10^9/L$  platelets and a hemoglobin of 2 mmol/L (12 g/dL).

#### Conclusions

The Goiania accident is of particular interest from several viewpoints. It was one of the most serious radiation accidents in the world. The time elapsed between the start of the accident and its identification, the poor cooperation of the victims to establishing a reliable reconstitution of the exposures, the almost complete fragmentation of the source, the protracted/acute pattern of exposures and associated conditions like whole body and local irradiation, external and internal contamination, were some of the difficulties for the handling of the Goiania patients.

Doses estimates by cytogenetics were hindered by problems that have already been mentioned. A "clinical" dose estimate was established based on the onset of prodromal manifestations (when possible) and the clinical and hematological evolutions. Here again, in virtue of the kind of exposures, it was difficult to compare the hematological curves with classical ones observed after acute exposures.

GM-CSF was used in six out of the eight ARS patients, but interpretation of the results is difficult because in all patients the drug was started after the hematological nadir was reached. A paper on the use of GM-CSF in the Goiania accident has been published.(10)

Infection was the immediate cause of death in all patients who died including one whose bone marrow was clearly

recovering. This corroborates the need of a strict infection control protocol for the handling of persons with important bone marrow impairment.

Cesium elimination from the organism was successfully achieved by using Prussian Blue, but other therapeutic approaches should be researched to face any other eventual huge internal contamination with that radionuclide, like the one observed in patient LNF.

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**TABLE 1 - POPULATION TRIAGE**

**PERIOD: SEPTEMBER 30 TO DECEMBER 21, 1987**

<b>NUMBER OF PERSONS .....</b>	<b>112.800</b>
<b>INTERNAL / EXTERNAL CONTAMINATION .....</b>	<b>129</b>
<b>CONTAMINATION OF CLOTHES AND SHOES .....</b>	<b>120</b>
<b>PERSONS HOSPITALIZED .....</b>	<b>20</b>
<b>BONE MARROW DEPRESSION .....</b>	<b>17 (8)</b>

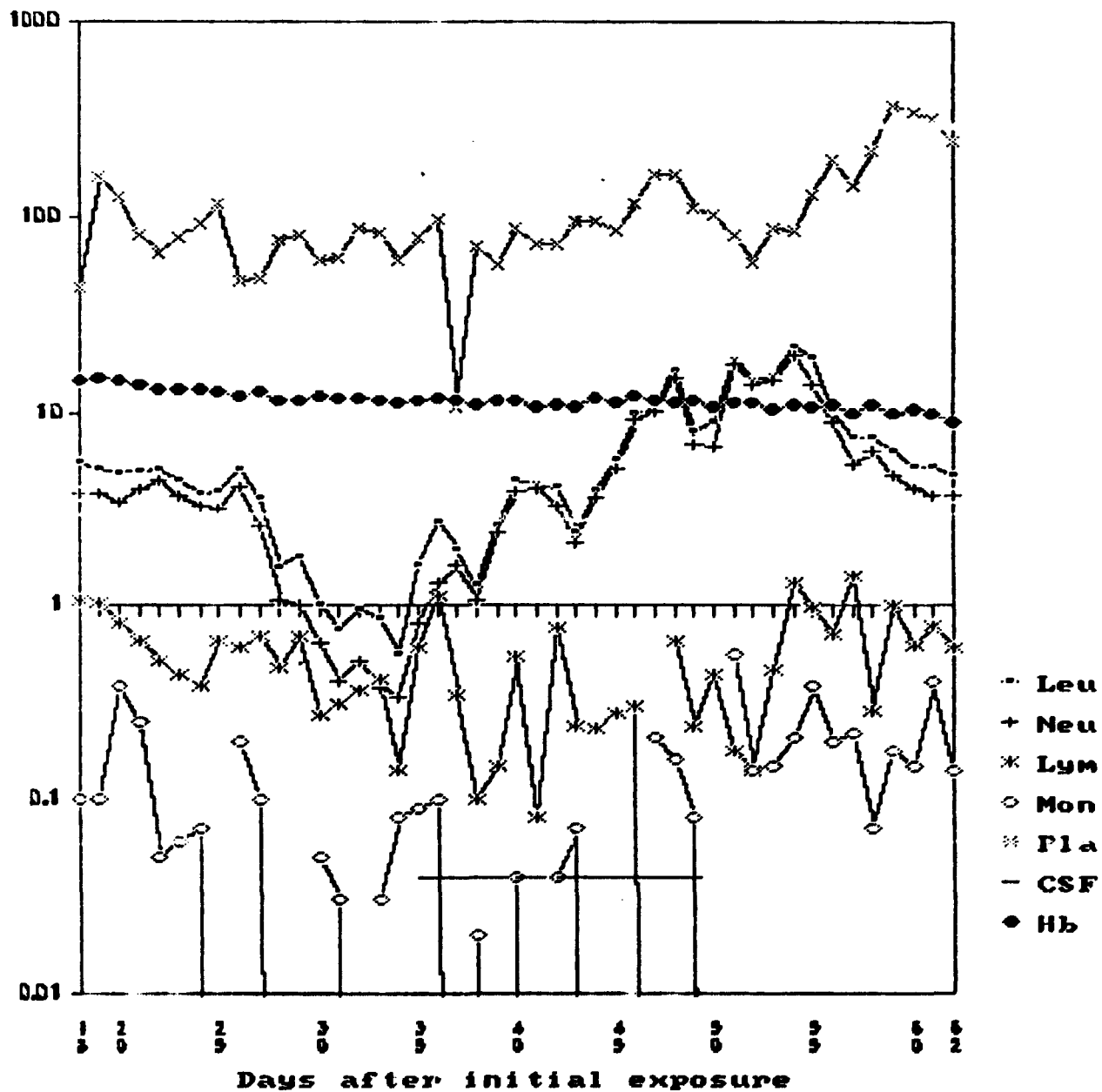
**TABLE 2 - ROUTINE AND PERIODICAL EXAMS**

<b>ON ADMISSION</b>	<b>CHEST X-RAY, URINALYSIS, STOOL EXAMINATION, EKG.</b>
<b>DAILY</b>	<b>BLOOD COUNT: WBC, RED CELLS, RETICULOCYTES, PLATELETS; HT, HB, URINE AND FECES BIOASSAYS FOR Cs ESTIMATION.</b>
<b>TWICE WEEKLY</b>	<b>TOTAL PROTEIN, ALBUMIN, GLOBULIN, LIVER ENZYMES, BUN, CREATININE.</b>
<b>VARIABLE</b>	<b>BONE MARROW ASPIRATES AND BIOPSIES, BLOOD AND OTHER SITES CULTURES, CYTOGENETICS FOR TOTAL DOSE ESTIMATION, ETC.</b>

TABLE 3 - ARS - ASSOCIATED CONDITIONS

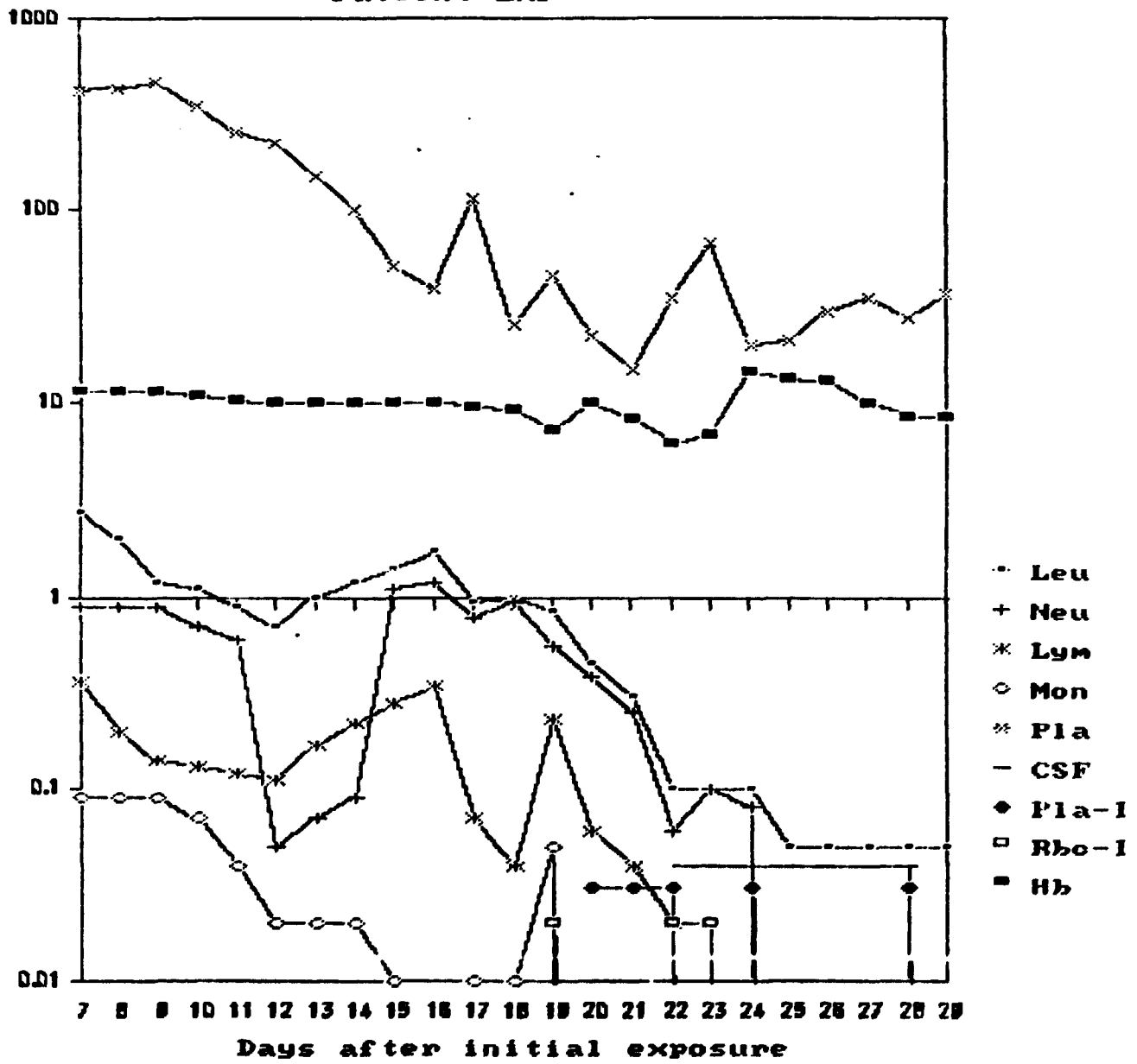
PATIENT	EXTERNAL CONTAMINATION		CALCULATED INITIAL Cs INTAKE (MBq)	LOCAL RADIATION INJURY
	MEAN SKIN DOSE RATE (mGy / h)	"HOT SPOT" (mGy / h)		
R S A	0.10	0.18 - CHEST	169 (28.1 X ALI)	YES; SEVERE
W N P	0.20	0.30 - ABDOMEN	39 (6.5 X ALI)	YES; SEVERE
D A F	0.10	6.0 - HANDS	115 (19.1 X ALI)	YES; MILD
L N F	2.50	15.0 - L HAND	1.677 (279.5 X ALI)	YES; MINOR
I B S	0.05	1.0 - R HAND	60 (10 X ALI)	YES; SEVERE
N G F	0.012	0.018 - R AXILLA	34 (5.6 X ALI)	YES; MINOR
A A S	0.70	0.80 - R HAND	120 (20 X ALI)	YES; SEVERE
N G A	0.01	0.06 - R FOOT	10 (1.6 X ALI)	YES; MINOR

**Figure 1 - Serial Blood Counts  
Patient WMP**

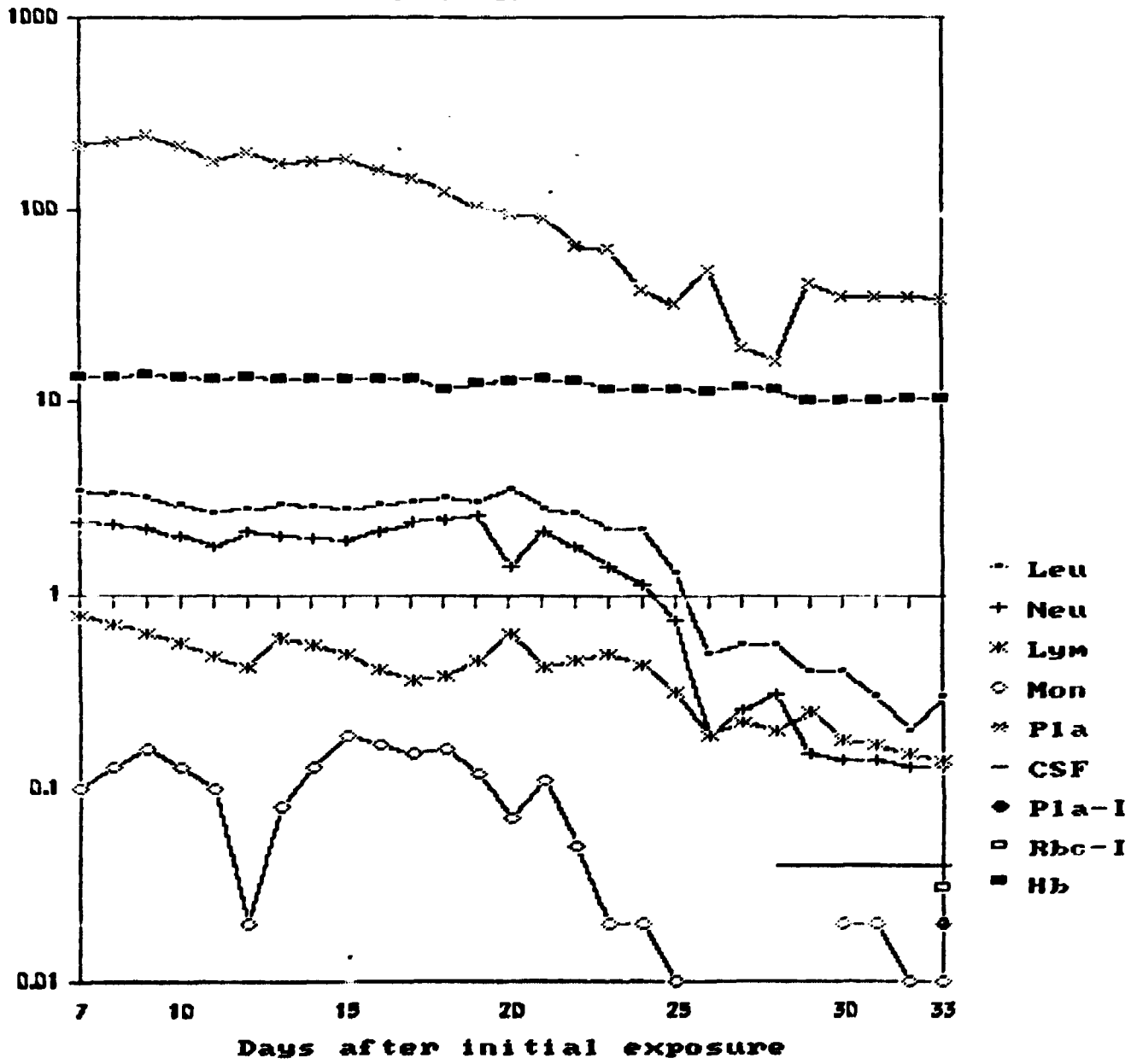




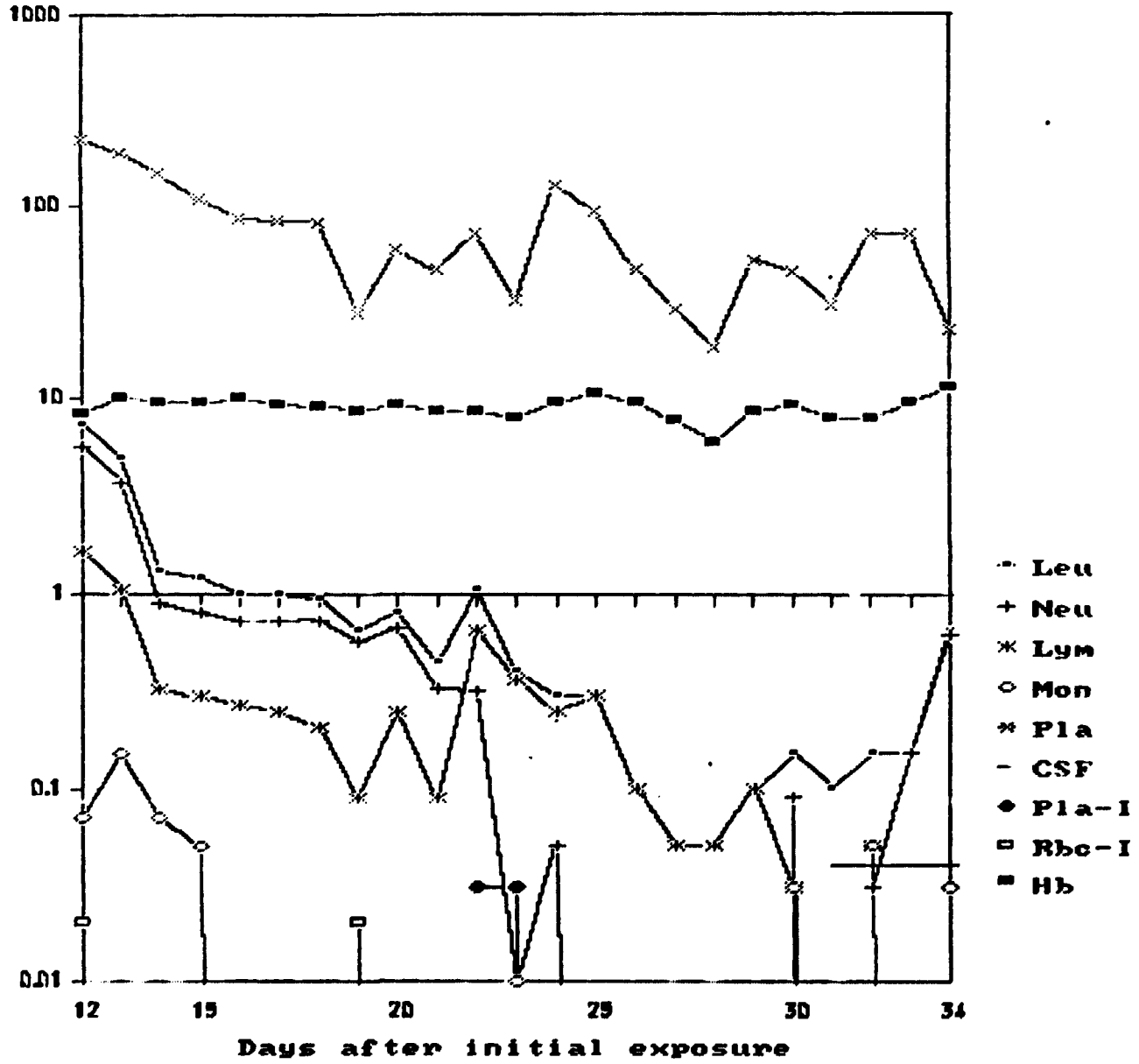
**Figure 2 - Serial Blood Counts  
Patient LNF**



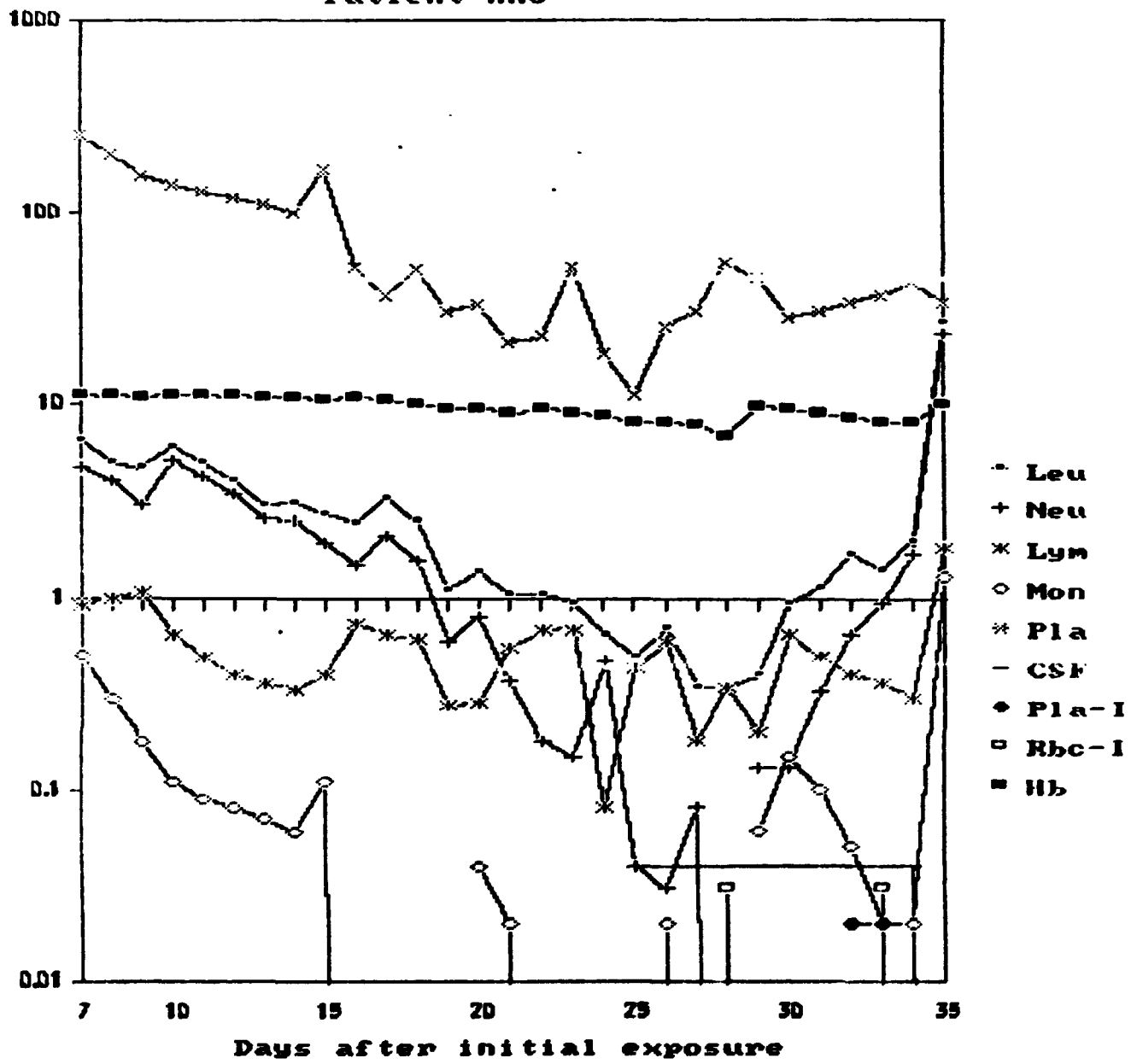
**Figure 3 -- Serial Blood Counts  
Patient IBS**



**Figure 4 - Serial Blood Counts  
Patient MGF**



**Figure 5 - Serial Blood Counts  
Patient AAS**



**Figure 6 - Serial Blood Counts  
Patient MGA**

