sion, in the white muscle of *M. saliens, M. capito* and *M. auratus* it was possible to demonstrate a growth cycle as revealed by the appearance of new fibres. Consistent with this cycle was the absence of new small fibres in *M. chelo*, the species with the smallest increase in length during the experiment. The small, new fibres that we found in the Mugilidae were similar in their distribution and diameter to those found by Willemse and Van den Berg in different postlarval stages of the eel with Sudan black B[22]. The reason for this autumnal growth is not clear; it may be caused by the more favorable conditions of food availability or the higher water temperature or both. We are conducting research to verify whether or not this cycle of growth is annual in the mullet and to clarify the genesis of these newly formed muscle fibres, which could come from satellite cells or which might arise by fibre splitting[44].

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Survival enhanced by skin-wound trauma in mice exposed to ^{60}Co radiation[1, 2]

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Summary. A 4%-body-surface skin wound given 24 h before exposure of mice to ^{60}Co radiation raised the LD 50/30 from 825 to 975 rads, resulting in a dose reduction factor of 1.2. Enhanced survival of mice wounded before radiation was independent of extramedullary splenic myelocytopoiesis.

Increased mortality is observed in rodents subjected to wound trauma after midlethal doses of radiation[3,4]. In animals receiving lethal doses of radiation before wounding, survival times are decreased compared to irradiated controls. Contrary to the decreased survival noted in rodents subjected to wounding after radiation, wounding before radiation may enhance survival. However, the data supporting this are equivocal. In rats, survival was increased[4] only slightly or not at all[5] in animals wounded before midlethal radiation does. In mice, a small increase in number of survivors was noted when midlethal irradiation followed wounding[3]. The purpose of this report is to establish that wounding before midlethal and lethal doses of radiation enhances survival and that survival is independent of extramedullary splenic myelocytopoiesis.

Materials and methods. Female (C57BL/6 X CBA)F1 Cum BR mice were obtained from Cumberland View Farms, Clinton, Tennessee, at 5 weeks of age and quarantined for 2 weeks in groups of 15 mice each. Animals were used only if they were free of histologic lesions of common murine diseases and of *Pseudomonas* sp. Splenectomy was done when indicated on 10-week-old mice under methoxyflurane anesthesia. Wounding and irradiation were performed when the mice were 14–16 weeks of age. All animals were housed 4 per autoclaved plastic filter-topped cage, and they were fed Wayne Lab-Blox diet and chlorinated (12 ppm) water. The mice were kept in controlled environment rooms throughout the study. A 2.0–2.5 cm^2 circular wound was cut in the anterior dorsal skin fold and underlying panniculus carnosus muscle with a steel punch cleaned by immersion in 70% ethanol. Such a wound constituted about 4% of the mouse total skin surface area. Wounding was done under methoxyflurane anesthesia between 10.00 h and 14.00 h, 24 h before or after ^{60}Co exposure. The

Table 1. Survival of mice given a 4%-body-surface skin wound either 24 h before or 24 h after whole-body radiation

Radiation dose (rads)	Wounded before irradiation		Wounded after irradiation		Irradiated only controls	
	Survival fraction*	MST ± SE**	Survival fraction	MST ± SE***	Survival fraction	MST ± SE
700	31/31	-	26/31	23.6 ± 1.7	31/31	-
800	42/47	23.0 ± 0.3	18/44	7.1 ± 0.2	33/47	19.6 ± 0.8
900	45/47	20.0 ± 8.0	9/47	10.4 ± 0.8	2/47	15.3 ± 0.3
1000	10/47	12.2 ± 0.8	0/47	8.4 ± 0.4	0/47	12.6 ± 0.2
1100	0/32	9.3 ± 0.3	0/32	8.4 ± 0.4	0/32	12.0 ± 0.2
$LD_{50/30}$	975 ± 25		790 ± 80		825 ± 40	

* Survival fraction, number of animals living for 30 days/total number of animals treated; ** MST ± SE, mean survival time ± SE; *** All MST significantly less than irradiated controls ($p < 0.01$).

Table 2. Survival of splenectomized mice wounded 24 h before of 24 h after 900 rads ^{60}Co radiation

Treatment	Splenectomized*		Sham-splenectomized		Unoperated controls	
	Survival fraction**	MST ± SE***	Survival fraction	MST ± SE	Survival fraction	MST ± SE
4%-body-surface skin wound 24 h before 900 rads	20/20	-	19/20	15	20/20	-
4%-body-surface skin wound 24 h after 900 rads****	0/20	9.6 ± 0.6	1/20	9.5 ± 0.6	2/20	10.8 ± 0.6
900 rads ^{60}Co radiation	3/20	16.9 ± 0.9	4/20	15.3 ± 0.7	1/20	14.4 ± 0.6

* Mice were 10 weeks old when splenectomized and 14 weeks old when wounded and irradiated; ** Survival fraction, number of animals living for 30 days/total number of animals treated; *** MST ± SE, mean survival time ± SE; **** All MST are significantly less than that of irradiated controls ($p < 0.01$).

wounds were left open and not treated in any manner. Irradiated nonwounded mice were subjected to anesthetic either before or after exposure to radiation. Whole-body irradiations of 40 rads/min by bilaterally positioned ^{60}Co elements were performed on mice placed in plexiglas restrainers. A 50-cc AFRRI-designed tissue-equivalent ionization chamber calibrated against a National Bureau of Standards ionization chamber was used for dose determinations. These were verified by thermal luminescence dosimetry conducted within tissue-equivalent mouse phantoms. Mice exposed to radiation were observed for 30 days.

Results. The 30-day survival of mice wounded either before or after radiation is presented in table 1. Survival fractions of mice wounded before radiation were generally greater than those for mice wounded after radiation or for mice exposed only to radiation. The mean survival times of mice wounded after radiation were lower than those for mice in the other treatment groups. Bacterial infections, as detected by swollen cervical lymph nodes, resulted in early death in mice wounded after radiation.

Survival of splenectomized mice wounded before or after exposure to 900 rads of ^{60}Co is depicted in table 2. The data support the thesis that extramedullary hematopoiesis is not a factor in promoting survival of mice wounded before radiation. Furthermore, a normally adequate transplant of 5×10^6 nucleated spleen cells taken 10 days after wounding followed by 900 rads are insufficient to promote survival in syngeneic mice given 1000 rads.

In mice wounded before irradiation, wound closure occured about 10 days after wounding. Wound sizes increased in mice wounded after radiation to a maximum of 3–4 days after wounding. Wound closure in these animals was delayed about 4 days over that seen in mice wounded before radiation but was otherwise uncomplicated. Splenectomy and sham-splenectomy did not alter the sequence of events noted above in either treatment procedure.

Discussion. The present data support the hypothesis that skin wounding in mice enhances survival from midlethal and lethal doses of ^{60}Co radiation when given 24 h before exposure. Wounding 24 h after radiation did not significantly alter the LD 50/30 from that of radiation controls but did result in changes in the time sequences of wound healing.

Wounding promotes a profound perturbation in the mature and immature myelocytopoietic elements[6,7]. The necessity of undamaged centers of myelocytopoiesis for enhancement of wound healing as well as survival from radiation was shown in wounded rats subjected to radiation and partial body shielding[8]. In mice undergoing bone marrow depletion, the spleen can act as a reserve for both mature and immature elements. The myeloproliferative spleen in the mouse and the lack thereof in the rat may account for the equivocal data surrounding wound-enhanced survival from radiation. In this report we show that splenic myelocytopoiesis in mice cannot account for the enhaced survival noted in animals wounded before radiation. Our findings support the idea that recovery from radiation enhanced by wounding is bone marrow-oriented and is not a specialized function found only in animal species with extramedullary myelocytopoiesis.

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2 Research was conducted according to the principles enunciated in the "Guide for the Care and Use of Laboratory Animals" prepared by the Institute of Laboratory Animal Research, National Research Council.

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