TABLE 1. Results of Local Anesthetic Procedure in a Patient with Scleroderma

Area of Injection	Drug	Dose (ml)	Duration of Sensory Anesthesia (hours)
Right axilla (deep)	Lidocaine, 1 per cent, with epinephrine	20	24
Left upper arm (subcutaneous)	Lidocaine, 1 per cent	2	8
Left upper arm (subcutaneous)	Lidocaine, 1 per cent, with epinephrine	2	12
Left anterior abdomen (subcutaneous)	Lidocaine, 1 per cent	2	7
Left anterior abdomen (subcutaneous)	Lidocaine, 1 per cent, with epinephrine	2	10

sis (scleroderma). Arch Intern Med 123:22–25, 1969
4. Ritchie JM: Local anesthetics: Effect of *p*H on activity. Science 162:1394–1395, 1968
5. Sackner MA: Digestive Tract Manifestations, Scleroderma. Edited by IS Wright. New York and London, Grune and Stratton, 1966, chapter 10
6. Sung C-Y, Truant AP: The physiological disposition of lidocaine and its comparison in some respects with procaine. J Pharmacol Exp Ther 112:432–443, 1954

Malignant Hyperthermia—An Ounce of Prevention

GERALD EDELIST, M.D.*

Malignant hyperthermia [1] is characterized by fever, often associated with rigidity, following the administration of a muscle relaxant and/or potent inhalational anesthetic agent.[2] In most reports describing this syndrome a plea is made for early recognition and treatment [3] as a means of decreasing the alarming mortality rate, which is approximately 60 per cent.[1] The following report describes a patient in whom the symptoms were recognized and treated early, leading to a remarkably benign clinical course.

REPORT OF A CASE

A 5-year-old girl, one of identical twins, was scheduled for tonsillectomy and adenoidectomy. The child weighed 18.2 kg. Aside from a history of allergy to several antigens and several bouts of pneumonia and bronchitis, she was an active, healthy child. The hemoglobin was 12.9 gm, leukocyte count 8,900. Premedication consisted of a 60-mg pentobarbital suppository and 0.4 mg atropine, intramuscularly, an hour prior to operation. Anesthesia was induced with nitrous oxide–oxygen–halothane, and five minutes after induction a single dose of 20 mg of succinylcholine was given intravenously. The patient did not relax and the jaw became so rigid that it was impossible to open it to attempt intubation. At this time the heart rate was 160 beats/min. The possibility that this response represented an early symptom of malignant hyperthermia was entertained and the procedure was terminated. The rectal temperature was 37.5 C. The patient was taken to the recovery room and immediately wrapped in two cooling blankets of the Aqua-K-Thermia type with the servomechanism set to maintain the temperature at 37 C for the duration of the day (18 hours). The heart rate of 160 beats/min promptly decreased over a period of 20 minutes to 100 beats/min. Blood-gas values at the time of admission to the recovery room were: *p*H 7.47; $Paco_2$ 24 mm Hg; base deficit 4; Pao_2 96 mm Hg. These results prompted us to feel that the excessive hypermetabolic state associated with the syndrome had been aborted, and no further therapy was instituted.

A tonsillectomy and adenoidectomy scheduled to be performed on the patient's identical twin was cancelled, although the preoperative medication of 60 mg nembutal and 0.4 mg atropine had been given, and studies were undertaken to determine whether our presumed diagnosis was correct. Table 1 shows the results of the laboratory tests

* Associate Professor, Department of Anaesthesia, University of Toronto; Anaesthetist-in-Chief, New Mount Sinai Hospital, Toronto, Ontario, Canada.

TABLE 1. Results of Laboratory Tests

	Day 1			Day 2		Day 3	
	Anesthetized Child		Control	Anesthetized Child	Control	Anesthetized Child	Control
	10 Min	3 Hours, 10 Min					
Na^+ (mEq/l)	136	137	—	139	138	140	142
K^+ (mEq/l)	3.6	4.0	—	4.8	4.3	4.2	4.4
Cl^- (mEq/l)	101	103	—	103	105	102	105
CO_2 (mEq/l)	20	20	—	23	22	25	24
Total Protein (gm/100 ml)	6.8	7.4	—	6.9	6.7	6.7	6.8
Albumin (gm/100 ml)	4.7	5.3	—	4.5	4.4	4.4	4.4
Ca^+ (mg/100 ml)	9.9	10.8	—	10.6	10.5	10.5	10.5
Alkaline Phosphatase	34	36	—	31	31	28	33
Total Bilirubin (mg/100 ml)	0.6	0.8	—	0.7	0.5	0.5	0.5
BUN (mg/100 ml)	12	13	—	14	12	12	8
Sugar (mg/100 ml)	115	85	—	75	95	90	90
PO_4 (mg/100 ml)	5.6	4.2	—	4.6	4.5	5.0	5.0
SGOT (Karmen units)	40	251	—	451	35	345	35
LDH (Wroblewski units)	356	820	—	1056	332	1260	400
CPK (international units)	215	215	—	227	111	185	45
Mg^+ (mg/100 ml)	2.3	2.3	—	2.3	2.0	2.0	2.05

done with the unanesthetized twin used as the control subject. In addition to these studies a concomitant coagulogram of the identical twin was interpreted as suggestive of fibrinolysin.

DISCUSSION

The laboratory findings in the anesthetized twin are typical of those in the reported cases of malignant hyperthermia. The most striking findings were the marked elevations of SGOT, CPK, and LDH. Under normal conditions these intracellular enzymes are found in only small amounts in the serum. However, with the disruption of the internal cellular structures or with increased permeability or disintegration of the cell wall, many of the cellular enzymes leak into the interstitial fluid and find their way into the blood.[4] The increased levels would indicate that muscle damage had occurred, probably during the period of muscular rigidity, allowing the intracellular enzymes to leak into the extracellular fluid. This mechanism could also account for the increase in potassium from day 1 to day 2. The elevation in blood sugar on day 1 is in keeping with a similar finding in Landrace pigs when they developed malignant hyperthermia.[5]

It is a rare opportunity indeed in the clinical situation when the ideal control subject, an identical twin about to undergo a similar procedure and treated in the same manner except for the induction of anesthesia, is available. The fact that this unanesthetized twin had a CPK of 111 units the day after the day the operation was scheduled is of great interest. A normal value for this child in our laboratory would be 45 units or less. One of the mechanisms suggested for the etiology of malignant hyperthermia is a defect in either the sarcoplasmic reticulum or other cell membranes, accentuated by anesthesia and muscle relaxants, allowing the concentration of calcium in the cell cytoplasm to increase.[5] This would stimulate actin and myosin in the muscle cell to remain in the shortened state, requiring ATP to be broken down to ADP. This breakdown of ATP would far exceed its ability to be reformed, and ATP would not be available to meet the functional metabolic needs of the cell membrane, which would then permit leakage of the intracellular muscle enzymes into the extracellular fluid, accounting for the increase in muscle enzymes noted. Although the full-blown clinical biochemical phenomenon is trig-

gered by the anesthetic agent or muscle relaxant, it may be that the people affected by this membrane defect are normally in a subclinical state manifested by elevated muscle enzymes. This may account for the elevated CPK and the high-normal SGOT and LDH values in the control child. If so, then determining the CPK, LDH, and SGOT values might be a valuable way to screen patients preoperatively in an attempt to detect those who might be affected.

On the other hand, the increased CPK may have been a response to the 60-mg nembutal suppository which the child did receive in preparation for her proposed operation. There is reason to suspect that the severity of the syndrome is related to the dose of the precipitating drug, because no patient who has had less than ten minutes of general anesthesia has died.[1] Could the mild elevation of CPK in the unanesthetized twin be a response to a subanesthetic dose of a barbiturate or to the atropine?

Clinically, only two signs of malignant hyperthermia were manifested in the affected twin, the rigidity in response to succinylcholine, and the tachycardia. There were no signs of hyperthermia, tachypnea, neurologic disturbances, changes in skin color, or severe acid–base disturbance. Yet the biochemical data leave little doubt that had the anesthetic been continued the full-blown clinical picture would probably have emerged.

Concluding Comment

Prophylactic preventive early therapy in response to a high index of suspicion remains, for the present, the only clinically conventional way of decreasing the mortality rate due to malignant hyperthermia. This suggests that all children should routinely have their temperatures monitored and that any increase in temperature or unusual rigidity during anesthesia should lead to its termination as rapidly as possible.

The author gratefully acknowledges the help of Dr. B. Britt and Dr. K. Hellmann in the management of this case.

References

1. Britt BA, Kalow W: Malignant hyperthermia: A statistical review. Canad Anaesth Soc J 17:293–315, 1970
2. Britt BA, Therreau ME, Haist C: Metabolic error of muscle metabolism after recovery from malignant hyperthermia. Lancet 2:895, 1970
3. Britt BA, Gordon RA: Three cases of malignant hyperthermia with special consideration of management. Canad Anaesth Soc J 16(2): 99–105, 1969
4. Hoffman WS: The Biochemistry of Clinical Medicine. Fourth edition. Chicago, Year Book Publishers Inc., 1970, pp 60
5. Berman MC, Harrison GG, Bull AB, *et al.*: Changes underlying halothane-induced malignant hyperpyrexia in Landrace pigs. Nature 225:653, 1970
6. Britt BA, Kalow W: Malignant hyperthermia: Aetiology unknown! Canad Anaesth Soc J 17: 316–330, 1970

Anesthetic Management of a Patient with Epidermolysis Bullosa Dystrophica

Richard A. Hamann, M.D.,* and Peter J. Cohen, M.D.†

Epidermolysis bullosa, a rare dermatologic condition, constitutes a major anesthetic hazard due to the formation of bullae following pressure or friction. Two varieties of the disease have been described.[1,2] The simplex type affects only the skin, especially that of the hands and feet, and healing occurs without scarring. The dystrophic form affects the mucous membranes as well; severe scarring occurs, locomotion is affected, and in some cases the teeth are rudimentary. Cutaneous infec-

* Resident in Anesthesia.
† Professor and Chairman.
Received from the Department of Anesthesia, University of Colorado School of Medicine, Denver, Colorado.