
CASE REPORT

Failure of Electrical Mains and Backup Generator Supply During Cardiopulmonary Bypass

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Abstract

Electrical failure during cardiopulmonary bypass is serious, but fortunately a rare occurrence. We report a case of main power failure, associated with total equipment failure caused by a backup generator power surge. The measures taken in the successful management of such an accident are described.

Introduction

Accidents during cardiopulmonary bypass (CPB) occur once every 300 procedures (1) and result in serious injury or death once every 1000 cases (2). Electrical failure is a common cause of such accidents, but gives rise to little morbidity or mortality (3), as backup procedures and devices have proved effective. We report a case of electrical power failure followed by a massive surge of emergency generator voltage which resulted in total equipment failure.

Case Report

Routine coronary bypass surgery was being performed on an 85 kg. male. After one hour and four minutes, as rewarming was commenced, main power failure occurred in the operating theatre. Hand cranking of the main arterial pump was immediately begun, and an emergency battery operated power source (Cobe) (a) was connected to the pump console. Rewarming ceased due to current limitations of this power source. Main supply was restored to the operating theatres after five minutes, but lasted only 45 seconds at which stage all power in the theatre failed. The operating light, which had independent battery backup was unaffected. Hand cranking was recommended and a flashlamp was used to observe blood reservoir level.

The arterial line pressure was maintained at pre-power failure level 120 mmHg as measured by an aneroid manometer (b) connected to the output line of the arterial pump. The aorta was intermittently palpitated to estimate perfusion pressure. Smoke was noted to come from the arterial pump when the trip switch was reset. This was interpreted as failure of the pump's electrical control. Ten minutes after the brief resumption of

power, hospital electricians provided power points supplied by a petrol driven generator. However, the pump and physiological monitors did not function when connected to this alternative power source, which had been confirmed as live by phase testing. A backup pump was now connected to this alternative power source and functioned. Tubing inserts of this pump were changed to suit the arterial boot and the pump was switched to the arterial position. The changeover was accomplished in two minutes at a patient core temperature of 32°C. Hand cranking was discontinued and arterial flow adjusted to 4.8 liters per minute. Patient monitoring was commenced by means of a Hewlett Packard battery operated monitor (Unit No. 78353B) (c) and a water blanket circulator was connected to the oxygenators heat exchanger. Rewarming proved inadequate with this device due to its low flow rate, 0.5°C rise in core temperature after 13 minutes of use. The side of the Cobe thermo chiller was removed and the internal trip switch reset (15 Amperes), with the restoration of power. A 200 milliamperere (MA) fuse was replaced in the control box of the thermo chiller and further warming was begun. When the core temperature reached 36°C, the patient was weaned from CPB without difficulty. Total bypass time was two hours, 36 minutes.

The patient subsequently made an uneventful recovery and was discharged home on the 11th postoperative day.

Discussion

Electrical power failure is a common cause of accidents occurring during CPB. An incidence of 78 electrical accidents per 10,000 procedures were reported by Stoney and Kurusz respectively (3). Death or serious injury occurred in approximately 1% of these accidents. The initial power failure in this case was due to damage by a mechanical excavator to the underground power line supplying the operating theatre suite. The backup generator did not immediately function and was started mechanically. The power surge was responsible for breaking all main input fuses and trip switches in electrical apparatus connected to the main supply, thus rendering it

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b. Tycos, Arden, NC

c. Hewlett-Packard, Boeblingen, West Germany

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inoperable. The defibrillator (Seward Medical 9922) (d) did not have a main input fuse, and consequently, the power surge destroyed its charging circuit. The backup generator was shut down and normal main power supply was restored to the theatre shortly afterwards as the damaged cable had been repaired. Prompt availability of portable battery powered monitors proved invaluable in this case.

Failure of the backup generator to function automatically was subsequently found to be due to its main power sensing line being proximal to the site of damage. The cause of the power surge was later found to be a faulty speed control on the generator.

Hand cranking with positive rotation of the roller pump head has been reported to be an efficient alternative method of emergency perfusion (4). In this case, the arterial line pressure was maintained at pre-accident values by hand cranking the pump using the in-line aneroid pressure gauge. The adequacy of aortic pressure was confirmed by manual palpation. Hand cranking without systemic mean arterial pressure monitoring was performed for a total of 16 minutes.

In summary, the accident proves that no backup system is foolproof and that a strategy for total electrical failure during bypass should be drawn up. Essential items to be immediately available in the case of power failure include a pump handcrank and a battery operated light source to observe blood reservoir level. An aneroid arterial extracorporeal pressure gauge is necessary to assess the efficacy of hand cranking.

A portable petrol driver generator should be available for use outside the theatre, together with extension cables to bring power into the O.R. Possible damage by electrical surge to the thermo chiller and its control box requires the immediate availability of a backup unit. Battery operated monitors and defibrillator will replace those damaged by an electrical surge. Post bypass, the lungs may be ventilated by a gas-driven ventilator if an electrical ventilator has been used.

Extra personnel will be required to constantly monitor the venous reservoir if a battery-operated level sensor is not used, and to obtain the various items of backup equipment. A knowledge of the different emergency operating times of battery-operated equipment is required. With such a protocol established, electrical failure occurring during CPB should not result in serious sequelae to the patient.

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