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OESOPHAGEAL ATRESIA AND TRACHEOESOPHAGEAL
FISTULA AT KENYATTA NATIONAL HOSPITAL ;
A REVIEW OF PRE-OPERATIVE, INTRA-OPERATIVE,
POST-OPERATIVE AND ANAESTHETIC MANAGEMENT

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DECLARATION

This dissertation is my original work and has not my knowledge been presented for a degree in any other University.


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This dissertation has been submitted for examination with my approval as University supervisor.

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SUMMARY

A review of pre-operative, intra-operative, post-operative and anaesthetic management of 54 patients, operated on at Kenyatta National Hospital, for oesophageal atresia with tracheoesophageal fistula, was done. These were patients operated on during a period of 8 yrs. (1976 - 1987).

Four aspects of the supportive management for these patients, during the pre-operative, intra-operative and post-operative periods, were chosen to form the main subject for this study i e .

- 1). Prophylaxis against and treatment of pulmonary complications of this congenital anomaly, during the three periods of treatment.
- 2). Fluid therapy for these patients, during the three stages of treatment.
- 3). Body temperature control and maintenance, during the three periods of management
- 4). Nutritional management of these patients, pre-operatively and post-operatively.

This study sought to establish the mortality rate in this series of patients and to compare it with those mortality those mortality rates reported elsewhere in other centres.

Concerning the four aspects of supportive management chosen for this study, inadequacies were found as follows:-

- a). Measures taken to prevent pulmonary complications were inadequate especially during the pre-operative period, with these improving post-operatively .
- b). Fluid therapy was occasionally inadequate both qualitatively and quantitatively, during all the three periods of management. Occasionally, fluid overload was also seen.
- c). Body temperature maintenance and regulation measures were often inadequate, especially during the pre-operative and intra-operative periods, with some patients remaining hypothermic during this two periods of their management.
- d). Insufficient use of hyperalimentation where this was indicated, hence twenty-two of the patients had no extra nutritional support,

other than intravenous dextrose solutions. Some patients were introduced to oral feeding before radiological screening to rule out anastomotic leaks. The importance of this aspect of investigation can not be over emphasised, since mortality rate amongst patients who developed anastomotic leak, was 100 % in this study.

Mortality rates were seen to raise and fall, depending on the efficiency of the supportive care offered.

Together with these four aspects of supportive care, other factors affecting survival in patients born with oesophageal atresia with tracheoesophageal fistula were reviewed ;

- a). Prematurity with low birthweight, mortality rate was 100 % for babies who were born prematurely and who weighed less than 1800 gms at birth.
- b). Age in days at time of operation was also seen to reflect on mortality in this study. Survival was less likely, the older the patient, in days, at time of operation.

c). Patient's A. S. A. grade on admission, as determined by their general condition, presence and severity of systemic illness, complicating either the oesophageal atresia with tracheoesophageal fistula, or other congenital malformations mortality rate rose, the poorer the A. S. A. grade of the patient~~s~~ was at admission.

d). Post-operative complications, amongst which, **aspiration** pneumonia and mechanical and /or technical faults occurred most frequently and were responsible for mortality rates of 75 % and 66.7% respectively in the groups of patients who developed them.

Inadequate supportive care combined with the other extra factors listed above caused a mortality rate of 61.1% in total, in this series of patients, which was thought to be unacceptably high, when compared to mortality rates reported from other centres.

Scanty investigations that were considered helpful in the management of these patients, and inadequate record keeping , especially during the pre-operative and intra-operative periods, were frequently observed.

Anaesthetic techniques applied on these patients locally, were seen to correspond well, with with these applied elsewhere, but monitoring was minimal, which resulted into failure to recognise various intra-operative complications. No intra-operative deaths were recorded but four patients had cardiac arrests, while two patient patients developed hypothermia . Post-operative complications , mainly pulmonary and circulatory, caused high mortality, Mechanical and /or technical faults, occurring during the post-operative management of these patients, also resulted with frequent deaths. These faults occurred mainly in those patients who remained intubated and were either on spontanous breathing or mechanical ventilation post-operatively in the Intensive Care Unit.

INTRODUCTION

The first description of congenital oesophageal atresia, was by Duston in 1670 according to Brewer et al, 1980 (1) and that of the tracheoesophageal fistula, by Gibson in 1679(1).

In 1912 Ritcher of Chicago, using intra-tracheal anaesthesia, delivered by a home-made respirator, transpleurally ligated the fistula and performed gastrostomy, but the patient died post-operatively. The first survivors were reported by Ladd and by Levin, independently, in 1939, at Boston Childrens' Hospital and at the University of Michigan Hospital, respectively. In 1938, Robert Shaw performed a primary anastomosis in an infant, who survived to the twelveth day post-operatively, Cameron Haight was the first (1943) to succeed using a primary repair and ligation, of the tracheoesophageal fistula, in a 4 day old infant, using 0.25% piperocaine local anaesthesia. Recent improvements in surgical, anaesthetic and neonatal intensive care, have allowed for increased survival rates, in infants born with oesophageal atresia, with or without

tracheoesophageal fistula , to above 75% in most centres. Full-time babies born with this condition but otherwise normal , are now expected to survive. Koop et al, 1974

(2), found a survival rate of 92% in full-term, otherwise normal babies. This increased to 100 % , in the authors' last 9-year term of study. Buker et al (3) found a decrease in mortality rate to 8%, in the years 1965-1972, as compared to 54%, in the years 1953-1956. Abrahamson et al, 1972 (4), at the Hospital for the sick Children, Toronto, found a survival rate of 74 % , in their 176 patients, with birth weight higher than 2500 gms, in the years 1955-1969. This rose to 100% in the same study, in the same kind of patients, in the years 1969-1972.

Survival has also improved for poor risk patients, born with oesophageal atresia, with or without tracheoesophageal fistula i.e those born prematurely and underweight, as well as those with other congenital malformations

Blyth et al, 1984 (5) found that 56 % of the patients in their series, were born with additional congenital malformations and that mortality rate in these patients was 48%, with a trend towards improvement. Koop et al, 1974 (2) , found an improvement in survival rate, in patients with severe anomaly, from 37% to 50% , during the first 15 years and the last nine years of the same study. The same authors found an improvement in patients with severe pneumonia, from 48 % to 72% and a survival rate of 52 %, amongst prematurely born babies, in the same study. Holder et al, 1981 (6) , found no pre-repair deaths, in their group A and B of Waterston's classification, 27% mortality rate in their group C patients. The authors had no mortality in group A patients, post-operatively , 11% mortality in group B and 13% mortality in group C patients post-operatively. (For Waterston's classification of risk groups of patients born with oesophageal atresia, with tracheoesophageal fistula, see Waterston et al, 1962 . ref. 8).

Oesophageal atresia and tracheoesophageal fistula can occur separately, but more often, they occur in combination. Several classifications of this anomaly have been used by various surgeons.

The one most commonly quoted, is that by Vogt, drawn in 1929, following his radiological studies of these patients: Wilton et al, 1951 (7).

The following are the types of the anomaly as given in Vogt's classification

Type I - complete absence of the oesophagus

Type II - upper and lower oesophagus

Type IIIA - fistula between upper oesophageal pouch and the trachea or bronchus

Type IIIC - fistula between both segments and the trachea or bronchus.

Other classifications were those suggested by Keith 1910, Ladd 1944, Swenson 1948, Gross 1953, Koop et al, 1954 (8). Waterston, Haight and Postlethwait (9), prefer to use anatomical descriptions of the varieties of this anomaly, so as to avoid confusion. The most frequently occurring type of these varieties is the Vogt's type III B. Wilton et al 1951 (7), Buker et al (3) and Dudgeon et al, 1974 (10).

Holder et al, 1981 (6) had 86% of their patients belonging to Vogt's type III B. The H-type abnormality is found in older children, who usually have a history of repeated respiratory tract infections with a cough. Endoscopy of the trachea and oesophagus confirms the diagnosis. This type of fistula makes up 1.8% to 4.2% of the total number of these varieties as confirmed by David et al, 1974 (11).

A most reasonable estimate of the incidences of oesophageal atresia with or without tracheoesophageal fistula, seems to be 1: 3000 to 4000 live births, as given by Postlethwait et al (9). Familial trends of the occurrences of this congenital anomaly were reported by Sloan and Haight in 1956, who found the anomaly in both brothers born one year apart.

Eugel et al, (9) , reported the same type of atresia with fistula in the distal segment, in a mother and daughter.

Kiesewtter et al, 1980 (41), found an oesophageal atresia with a distal fistula in the father and an H-type tracheoesophageal fistula in his daughter.

Kiesewtter et al, 1980 (41), found an oesophageal atresia with a distal fistula in the father and an H-type tracheoesophageal fistula in his daughter. David et al, 1974 (11) found an association between twinning and presence of oesophageal atresia, with tracheoesophageal fistula. It is thought that either twinning predisposes the embryo to oesophageal atresia or that both twinning and oesophageal atresia share and premature delivery, should alert the clinician to the possibility of the presence of oesophageal atresia.

Holder et al 1981 (6), reported that 34 % of the infants born in Britain with oesophageal atresia and distal fistula, are prematurely delivered.

Other signs of this anomaly include excessive mucus seen after delivery, episodes of choking on feeding, coughing, respiratory distress and cyanosis

Abdominal distension is seen in presence of distal fistula or H-type of fistula . Pulmonary changes may be present, depending on the severity of aspiration. Air in the stomach may be seen on the abdominal plain X-ray, except in cases of atresia alone or with fistula in the proximal pouch of the oesophagus.

Radiological studies are done with a radio-opaque catheter passed into the upper oesophagus, for the following purposes;

- a). confirming the extent of the proximal pouch.
- b). to determine the severity of the pulmonary involvement.
- c). to examine for air in the stomach and bowel.
- d). to exclude some of the to other concomitant anomalies.
- e). to note the side that the aorta is situated on, so as to be able to decide on which side to perform thoracotomy.

Use of contrast media for radiological studies has been condemned.

Lister et al, 1979 (12), reported an overflow pneumonia following use of contrast media.

Hicks et al, 1981 (13), found that 14% of their 52 patients in whom no contrast media was used, had severely abnormal chest films, as compared to 28 of the patients in whom contrast media was used and who had severely abnormal chest films.

Paxton et al (14), described a method diagnosing H-type of fistula by endoscopy or oesophagoscopy, with methylene blue, injected under direct vision. Intra-gastric measurement of oxygen concentration was used to diagnose the same type of fistula by Sheldon et al (15).

Although great technical achievements have been made, many of the infants born with oesophageal atresia still die. The high-risk infants constitute at least 25% of the population of patients born with this anomaly, as given by Karl et al, 1958 (16), with a mortality of 15-60 %, as according to the same authors.

Factors associated with mortality in these high risk patients include :-

a). Prematurity at birth and low birth-weight.

Buker et al, (3) found the highest mortality rate in patients weighing between 5 and 5½ Ibs at birth. Koop et al, 1965 (17), found a 38% survival rate in premature patients, as compared to 92 % in full-term infants.

Waterston et al, 1962 (8), found that survival was most unlikely where birthweight was less than 4½ Ibs, more likely in cases where birth-weight was above 5½ Ibs. Abrahamson et al, 1972 (4), found a survival rate of 45 % in patients weighing below 2500 gms as compared to 74 % in the group of patients weighing above 2500 gms.

b). Aspiration pneumonia significantly lowers survival chances in these patients. Emery et al, 1971 (18)

Waterston et al, 1962 (8).

Emery et al, 1971 (18)(8). Holder et al,

1964 (19); Hamitton et al, 1969 (19)

Swenson et al, 1967, (20) found that 50% of the mortality in their series was due to respiratory tract infections, developed post-operatively.

c). Concomittant congenital malformations e.g. cardiovascular, gastrointestinal, genitourinary, musculoskeletal respiratory, and mongolism.

Swenson et al, 1967 (20), found a 67% incidence of other congenital anomalies in their series of patients. Haight et al, 1957 (9), reported a 100 % mortality rate in all their three patients, born with cardiovascular anomalies. Other authors reporting on associated congenital malformations included Mellins et al (21), Greenwood and Rosenthal (21); Diffins ~~et~~ at Hannalla et al, 1975 (22), described a case of laryngeal web, found in an infant born with oesophageal atresia with tracheoesophageal fistula.

A combination of the above factors in the same patient, significantly lowers survival chances for the patient. Waterston et al, 1962 (8), classified these patients into risk groups on the basis of presence or absence of these complications.

Hertzler et al, 1965 (23), found a survival rate of 29.2% in patients with other congenital malformations and pneumonia, as compared to 75.6%, seen in otherwise healthy patients, Bar-Maor et al, 1981 (24), found a 50% mortality rate in patients with low birthweight, associated congenital malformations and pneumonia.

What better survival rate is seen in patients born with oesophageal atresia, with or without tracheo-oesophageal fistula, is as a result of better surgical, as well as supportive care for these patients, during the pre-operative, intra-operative and post-operative periods. Some of the aspects of the supportive care have been chosen as the subject for review in this study i.e.

- a). Prophylaxis against and treatment of pulmonary complications, where these are already present, during the three periods of management.
- b). Fluid therapy.
- c). Nutritional management.
- d). Maintenance and control of body temperature.

In considering mortality in our series of patients, in connection with the above listed four aspects of supportive management, other factors, most likely to affect survival rate in these patients will also be looked into i.e.

AIMS OF STUDY

1. To review the supportive management as given to patients admitted at Kenyatta National Hospital with oesophageal atresia, with or without tracheoesophageal fistula, in as far as the four aspects listed in the "introduction" are concerned and to determine how mortality in this series of patients, was associated with each aspect separately.

2. To determine the mortality rate in this series of patients and compare it with other mortality rates, as reported by different authors from different centres as documented in literature.

- 3). To review the anaesthetic management of the patients in this series and compare this with what is practised elsewhere, as reported in literature.

MATERIALS AND METHODS

Case history study for 56 patients, admitted to Kenyatta National Hospital for repair of oesophageal atresia, with or without tracheo-oesophageal fistula was done. Case files for the study were obtained from records office at the above hospital. The population was of patients treated between 1976-1987 inclusive. One patient out of this number was not operated on, due to this extremely poor condition on admission. A second patient's records were very inadequate. These two patients were excluded from the study, leaving a population of 54 patients.

Methodology was planned in three sections and details filled in as follows: -

1). Pre-operative period

- i). patient's age at admission and at operation, birthweight and maturity at birth.
- ii). patient's general condition, as judged by presence or absence and the severity of systemic illnesses, complicating either the oesophageal atresia or other congenital malformations.

Patients were graded on these bases,

according to A. S. A. grading system.

- iii). presence of other congenital malformations.
- iv). ward on which patient was nursed pre-operatively.
- v). regime of fluid therapy, the former being calculated on average in mls. over 24 hrs.
- vi). nutritional maintenance of these patients, during this period.
- vii). temperature control and maintenance pre-operatively .
- viii). other relevant investigations i.e. blood urea and electrolytes' , blood gas analyses, chest X-rays.
- ix). measures for prophylaxis against pulmonary complications

Intra-operative period

- i). pre-medication
- ii). anaesthetic techniques applied
- iii). blood loss and transfusion intra-operatively.
- iv). fluid infusion during this period.
- v). body temperature control intra-operatively.

vi). Post-operative period

- i). mode of respiration that the patient was maintained on, post-operatively i.e. was the patient extubated at the end of the operation or did he remain intubated.

In case of the latter, did the patient remain on spontaneous breathing through the endotracheal tube or was he mechanically ventilated.

- ii). measures taken to control and maintain optimum body temperature post-operatively i.e. incubator care.
- iii). frequency of physiotherapy, suction and changing of patient's position and other measures taken to prevent pulmonary complications during this period.
- iv). fluid therapy-types and quantities given.
- v). nutritional maintenance post-operatively
- vi). drug treatment
- vii). other relevant investigations e.g. blood urea and electrolytes, levels.
- viii). post-operative complications

The above information was analysed and presented in form of tables and graphs, as illustrated further on in this study.

RESULTS

In this study, out of 54 patients there were 33 deaths i.e. mortality of 61.1% . All but one patient, were referral patients from centres outside Kenyatta National Hospital.

The one patient was born at the above hospital, discharged home, but was re-admitted with features suggestive of oesophageal atresia with tracheo-oesophageal fistula. There were 25 male and 29 - female infants. Eleven infants in the series were born prematurely.

Twenty eight patients (50.9 %) weighed more than 250 gms at birth, fourteen patients (25.5 %), weighed 1800-2500 gms at birth, three patients (5.5%) weighed less than 1800 gms and no birthweight records were available for the remaining nine patient (18.2%).

Table I illustrates how birthweight reflected on mortality in this series of patients. Lack of birthweight records for nine patients, made it difficult to predict what survival chances would be expected for patients born with what birthweight. However, judging, from the records available and taking birthweight as isolated factor deciding on the survival or death of the patients, it is observed that infants weighing more than 1800 gms at birth, had a 35.7% survival rate in this series.

Mortality rate in infants weighing less than 1800 gms at birth, was 100%.

Table II illustrates the various age groups in days, at which the patients were operated on how reflected on the outcome of management in these patients.

The majority of patients were operated on, on their 4th-5th day of age, while the next largest group was that of patients operated on, on their second to third day after birth. Three patients were operated on at an age older than ten days.

Mortality was highest. i.e. 100%, in the group of patients older than 10 days at operation time, followed by that in the two to three days age group. There was a gradual rise in mortality rate starting with the 4-5 days age group above ten days age group.

Table III is an illustration of the various A. S.A. grades of patients in the series. No patient in this study was placed in A. S. A. grade V. The effect of A. S. A, grade of patients upon their survival rate, as an isolated factor, is also depicted on the same table. Mortality rate rose gradually from A. S. A. grade II (50%) to A. S.A. grade IV. However, A. S.A. grade I patients had a mortality rate of 55.6% Additional congenital anomalies were found in four patients (7.4%) in this series, two patients had other cardiovascular abnormalities, one patient had unilateral undescended

testis, while three patients had bowel and anorectal malformations. Three out of these four patients died post-operatively. All patients in this series were nursed on a general paediatric surgical ward pre-operatively.

The following were the measures prescribed for supportive management pre-operatively

- i). nil by mouth
- ii). intravenous fluids of different types and quantities
- iii). oropharyngeal suction
- iv). incubator care (where this was supposed to be available)
- v). head-up tilt position for the patient.
- vi). antibiotics, either in single or a combination of them.

All patients had emergency thoracotomy planned and done. Five of the patients had thoracotomy and gastrostomy done and were next planned for oesophageal anastomosis if and when their condition improved. They all died before the repair oesophageal anastomosis. No patients in the series received any other type of parenteral feeding pre-operatively, other than dextrose solutions intravenously.

All patients were on record as having been fed once or more, before the diagnosis of oesophageal atresia with tracheoesophageal fistula was made.

Table IV illustrates the amount and types of fluids, given to patients during their pre-operative management, on average, over 24 hrs.

One patient in the series received less than 100 c.c. of fluids on average, over 24 hrs, while five patients received 100-150 c.c. of fluids, on average over 24hrs.

The highest mortality rates were seen in the groups of patients receiving 100-150 c.c. of fluids, on average, over 24 hours and that receiving over 500 c.c. of fluids, on average, over 24 hrs. The lowest mortality rate (o%) was seen in the group of patients, receiving 300-350 c.c. of fluids.

Half-strength darrows in combination with 5% dextrose solution was most commonly prescribed, then 5% dextrose solution given alone.

Temperature recording, for any patients, during their pre-operative period was **36.8c**. Though prescribed, details of incubator care - i.e. temperature settings, were not available. No other measures taken towards enviromental and body temperature regualation, preo-operatively for any patient, were on record.

Records on relevant investigations as out lined in "material and methods" , were not available for any patients, suggesting that these were either not carried out , or were not put down in record. An exception to the latter, were the chest X-ray, which were done on every, except four patients in the series. Reports on the Chest X-rays were generally on the location of the radio-opque catheter in the upper oesophageal pouch

and only occasionally, on the state of the lung fields. Where the latter were reported on pneumonic changes were noted.

All patients were commenced on antibiotics pre-operatively, either in single, or a combination of them. Pre-medication was commonly with atropine alone, but two of the patients in the series, had 5 mg of pethidine each, in addition to atropine. One other patient received 2 mg of pethidine for pre-medication, Eleven patients had no pre-medication given at all.

Twenty two patients in this series had no intra-operative notes and no information available on the anaesthetic techniques applied. Out of the remaining 32 patients, 30 of them had the following anaesthetic technique applied;

- a). awake intubation
- b). induction with a volatile agent (halothane was the agent always used)
- c). maintenance of anaesthesia with oxygen-gas-volatile agent.
- d). intermittent positive pressure using (IPPV), the Ayres T-piece with Jackson Rees modification .(JRM).

In some cases muscle relaxants were given , to facilitate IPPV. The two remaining patients were induced with halothane before intubation and the rest of the anaesthetic management followed in line with the above . Where non-depolarising muscle relaxants were used, reversal was always done with neostigmine and atropine in the appropriate dosages.

All patients in this series, were nursed in the intensive care unit post-operatively. Respiration in the patients, post-operatively, was maintained as illustrated on tables VI and VII. Mortality in each of these groups of patients, is also illustrated on the same tables.

Mortality rate in the mechanically ventilated group was higher i.e. 70.8% as compared to that in the non-ventilated group of 50%. of the dead patients in the mechanically ventilated group, nine belonged to A. S. A. grade I was ventilated and therefore the 100% mortality, calculated for this group of patients bears no statistical significance. In both groups of patients, mortality rose higher as the A. S. A. grade went from II to IV.

All patients received incubator care post-operatively. Temperatures in the incubators ranged from 28^o C -32^o C. There was humidified oxygen air mixture supplies to every patient inside the incubator, with those not extubated receiving the mixture through their endotracheal tubes. Patients received physiotherapy with suction and changing of position on 2-5 hrly bases. Quantities of fluids given to the patients, post-operatively, are as shown on Table VIII.

Four patients received fluids amounting to 50-150 c.c. on average over 24 hrs with a mortality rate of 100%.

Twenty four patients received 150-250 c.c. of fluids, with mortality rate of 62.5% . Thirteen patients received 250-350 c.c. of fluids and mortality rate in

in this group was 68.3% . Five patients received an average over 24 hrs and mortality rate in this group, was the lowest i.e. 20 % .

Two patients receiving over 450 c.c. of fluids, had a mortality rate of 100 % . Thirty-two patients were introduced to other nutritional mixtures, in addition to the dextrose solutions, post-operatively. The nutritional mixtures included expressed breast nasogastric feeding tube, gastrostomy of parentally patients started on feeds as follows:-

- a). 5 patients fed on the 1st day post-operatively with EBM.
- b). 4 patients were fed on the 2nd post-operative day on EBM.
- c). 7 patients fed on 3rd post-operative day on EBM
- d). 4 patients fed on 4th day post-operatively on EBM
- e). 8 patients fed on their 6th post-operative day on EBM.

Loctogen was usually given in addition to EBM . Sorbitol was given to patients in whom gastrostomy or nasogastric tube feeding was contra-indicated e.g. cases of anastomotic leaks. Twenty-four patients were fed before having radiological studies, to rule out the possibility of an anastomotic leak.

All patients in the series were on some antibiotic of another, in single or a combination and these were changed as per reports on investigations of culture and sensitivity, done on tracheal aspirates. Other medications were introduced into the management as the need arose. Post-operative hypoxaemia was seen in sixteen patients (29-6%).

as detected on blood gas analyses of the firstly taken samples of blood. Twelve of these patients were in the non-ventilated group and the rest belonged to the ventilated fgroup. Five patients had no blood gas analyses done at all during their stay in the intensive care unit, due to the breakdown of the blood gas analyser.

Post-operative complications were seen in forty five patients

83.3 % .. Some of these had been passed on from the pre-operative period . As depicted on Table X, complications were either due to systemic illness separately or in combination with mechanical and/or technical faults, developing during the post-operative management.

Deaths occurring due to each of these complications, are also shown on the same table. Bronchopneumonia occurred most frequently, with a death rate of 75 %. Leaks (anastomosis) with wound infection and sepsis were also common, with a mortality rate of 100% .

Of the mechanical faults, blocking and/or displacement of the endotracheal tubes and self-extubation occurred in fifteen patients and ten out of these (66.6%) died.

The average duration of stay in the intensive care unit was 4.2 days.

DISCUSSION

Improved supportive care for patients born with oesophageal atresia, with or without tracheoesophageal fistula, has greatly improved the survival rate. Other than supportive care, there are the other factors that affect survival in these patients and that can not be influenced much i.e. prematurity with low birthweight and presence of other congenital anomalies.

New developments in the surgical management of these patients include staged operation for the underweight, those with other severe congenital abnormalities and in those, whose general condition does not allow for major operation. Staged operation entails performing gastrostomy and thoractomy for ligation of the tracheoesophageal fistula, with oesophageal anastomosis being done at a later stage. At times, cervical oesophagostomy is also performed to facilitate continuous suction from the upper oesophageal pouch. Gastrostomy has been performed for purposes of feeding and decompression of a distended abdomen, to allow for easier respiration, during and after operation, as documented by Holder et al in 1981 (6) and Myers et al, 1968 (26). Jones et al, in 1980 (27), reported on a case of stomach rupture associated with assisted ventilation

in a case of oesophageal atresia with tracheoesophageal fistula. However, gastrostomy can result in wasted ventilation, as it provides a low resistance gas vent, as suggested by Karl et al, in 1985 (16).

Hertzler et al, in 1965 (23), found a survival rate of 80% in patients undergoing staged operation, as compared to these having primary repair.

Brereton et al, in 1978 (19), found no advantages of staging the operation, as compared to primary repair. Other authors to share this last opinion included Cozzi and Wilkinson (1975) Holder et al, (1962); Koop and Hanitton (1965). The five patients who had staged operation in this study, all died before final oesophageal anastomosis was performed. Other newer surgical technique, include the adoption of an extra-pleural approach, replacing the old transpleural approach in this operation.

Improved patient's general condition before the operation, significantly improves their chances of survival during the operation and post-operatively. In this respect, Brereton et al in 1978 (19); Lister et al, in 1979 (12); Emery et al, in 1971 (18); Waterston et al, in 1962 (8), all recommended a delay of up to 48 hours before operation, while the patient's general condition is improved upon, where this is necessary.

In this study, all the patients had emergency thoracotomy planned and performed ; Mortality was seen to be highest where patient's . A. S. A. grade pre-operatively was poor.

Most neonates born with oesophageal atresia, with or without tracheoesophageal fistula, develop aspiration pneumonia and the latter is severe, where patients are fed before diagnosis is made. Prophylactic measures against and therapy for this pulmonary complication, should commence at the earliest possible stage i.e. as soon as diagnosis of this congenital anomaly is suspected. These should include,

- a). Nil by mouth or through the nasogastric feeding tube, from the pre-operative, to the post-operative period, when the patient's condition allows.

These patients have incompetence of the lower oesophageal sphincter and gastroesophageal reflux often may occur, as shown by Whittington et al, in 1972 (28). Leinger et al, in 1972 (29), did silastic banding of the oesophagus before repair, to prevent gastroesophageal reflux. Bar-Maor et al, in 1981 (24), recommended use of cimetidine infusion before operation, to lower the acidity of the gastric contents and therefore lessen the amount of pulmonary damage occurring in the event of aspiration .

Filston et al, 1982 (30), used a Fogarty catheter balloon, to occlude the tracheoesophageal fistula vent and help with ventilation before repair was done.

- b). Continuous suction of the oropharynx and the upper oesophageal pouch, to prevent accumulation of secretions and over spilling into the respiratory tract. Tracheostomy and cervical oesophagostomy have been performed, to facilitate this procedure.
- c). Positioning and nursing the patient in reverse Trendelenburg position with an inclination of 20-30° . Full prone position results in accumulation of secretions to the oesophagus.
- d). Frequent turning of the patient to prevent atelectasis and pneumonia, Chest physiotherapy with suction
- f). Antibiotic therapy, commenced pre-operatively and altered as indicated by reports on culture and sensitivity tests done on tracheal aspirates.
- g). Oxygen supplementation as required.
- h). Decompression of the stomach through gastrostomy, to facilitate easier breathing.

Nine patients in this series, were found to have bronchopneumonia with severe respiratory distress pre-operatively and six patients died of the same post-operatively .

Out of eight patients with post-operative bronchopneumonia six of them died i.e. 75%. Holder et al, in 1964 (9), found that 62% of their 352 patients, died due to pulmonary complications. Mayrhofer et al, in 1959 (31), found that eight patients in their series, died of pneumonia and that seven of these had acquired

it pre-operatively.

Swenson et al, in 1967 (20), found a 50% mortality rate in their series due to respiratory tract infections. A review of the prophylactic and therapeutic measures against pulmonary complications, shows that these were prescribed for every patient pre-operatively in this series, however, records to confirm that these were actually carried out as prescribed were unavailable .

An exception to this, was antibiotic therapy. Pre-operative investigations, relevant to the pulmonary system, were scantily done ie. no patients in the series, had their blood gas analysis done and four patients had no chest X-rays by the time they went for operation . Where Chest X-ray were done, the state of the lung fields was seldom reported upon. More often, the report was on the position of the radio-opaque catheter, in the upper oesophageal pouch.

Post-operatively, prophylaxis and treatment for pulmonary complications, included;-

a). Regular physiotherapy, suction and changing of patients' position at 2-5hrly intervals.

Koop et al, (17) however recommended position changing at 1 hrly intervals.

b). Oxygen supplementation in form of a humidified oxygen-air mixture, supplied for every patient in the incubator.

- c). Mechanical ventilation , where this was found necessary post-operatively. The disadvantages in this, were the very commonly occurring mechanical faults, resulting in a high mortality , in the ventilated patients.
- d). The altering of the antibiotic regime, as dictated by reports on the culturing and sensitivity tests of the microorganisms done on tracheal aspirates. Bearing in mind that nine patients already had bronchopneumonia before surgery and that 8 patients had the same post-operatively , the likely thing is that, no patients developed bronch-pneumonia post-operatively and that all the eight patients, six of whom died, had carried bronchopneumonia forward from the pre-operative period. This deduction advocates for more intensified prophylactic measures against aspiration pneumonia during the pre-operative period. If need be, repair of the oesophageal atresia with or without tracheo-oesophageal fistula, could be deferred, while patients general condition is improved upon, especially where pulmonary state concerned. Mortality rate due to post-operative bronchopneumonia was highest in this series of patients compared to any other, found at any other centre, as published in literature. As noted earlier, all the patients in this series, had been fed once or more times before diagnosis of oesophageal atresia was made.

This fluid therapy, both qualitatively and quantitatively, is essential in the supportive care of patients born with oesophageal atresia. The neonate may be originally over hydrated, but rapidly becomes dehydrated, if normal fluid intake is not maintained. Mayrhofer et al, in 1959 (31), suggested that the daily water loss in an infant is up to 4% of his body weight and is twice the percentage lost by an adult. Different authors have recommended different types of fluids for these patients i.e. Mayrhofer et al, in 1959 (31) recommended use of 5% dextrose in water, in view of the relatively poor ability of the neonatal kidneys, to excrete sodium chloride. Not more than 15% of the total fluid given, should be in form of saline.

Postleswaith et al (9), recommended the following schedule for fluid maintenance;

- a). 1-2 days of age to get 65ml/kg/24 hrs
- b). 2-7 days of age, to get 85ml/kg/24 hrs
- c). over 7 days of age, to get 100mls /kg/24hrs

The same authors suggested the use of 5% dextrose, adding to this 2 meq /kg/24 hrs of potassium chloride and a multivitamin preparation. All other abnormal losses e.g. gastric aspirates, should be replaced with equal amounts of isotonic solution. Young et al, in 1973 (32), suggested that 50mls/kg/24hrs of fluids, on the first day of life and 150 mls /kg/24hrs by the tenth day of life, would be adequate. This excludes replacements of any other losses Swenson et al, in 1969 (33),

suggested that an intake of $765 \text{ mls} / \text{m}^2 / 2\text{hrs}$, would be the minimum requirement of fluids post-operatively (this works out to $3-4 \text{ mls/kg/hr}$). Other losses must be strictly replaced as these occur.

The newborn's low renal threshold for glucose, may cause osmotic diuresis, if an excess of 10% dextrose solution is infused. Bennett et al, in 1975 (34), recommended potassium supplementation post-operatively, especially because aldosterone secretion rate might be higher during this period. The authors recommended $3-4 \text{ hrs/kg/hr}$ of dextrose in lactated Ringer's solution for intra-operative and post-operative fluid therapy.

The same authors reported that hypovolaemia causes intra-operative cardiac arrests in 1:600 infants, as compared to 1:2,300 in adults, although infants have better cardiovascular compensatory mechanisms.

They concluded that infants are more often inadequately hydrated intra-operatively. Humidification and nebulization of the infants environment reduces his fluid loss and requirement. Bennett et al, in 1975 (34), found the insensible water loss in a normal neonate to be as much as $33.5 \text{ mls/m}^2 / 24\text{hrs}$, with the very ill neonate losing as much as $80 \text{ mls/m}^2 / 24 \text{ hrs}$, of fluid. Fever, sweating, hyperventilation, acidosis and use of infra-red heaters for neonatal warmth, all increase fluid requirements. Laboratory measured deficits of electrolytes should be corrected accordingly.

Anaemia should be corrected, to ensure maximum oxygen carrying capacity in the neonate. This should preferably be done with packed erythrocytes transfusion, or with whole blood, where hypovolaemia is present. Bennett et al, (34), suggested the following formula for the calculation of the amount of packed cells, or whole blood needed;

Volume of packed cells = $1.5 \text{ ml}/\% \text{Hct raise}/\text{kg body weight}$.
whole blood = $2.5 \text{ ml}/\% \text{Hct-raise}/\text{kg volume of body weight}$.
Volume of frozen cells = $1.10 \text{ ml}/\% \text{Hct raise}/\text{kg bodyweight}$.
Davenport's law of blood transfusion is still popular in deciding when and how to replace blood loss intra-operatively i.e. less than 10% loss is not replaced, more than 20 % loss must be replaced and in between these figures, replacement of blood will depend on the patient's general condition. Blood replacement should be milliliter for milliliter of loss. Lowe et al, in 1970 (35), described a paediatric suction trap, at their hospital, used for blood loss measurements. Experience in visual judging of blood loss, is said to be most accurate. Where electrolyte solutions have been used to replace blood loss, blood transfusion poses a danger of fluid overload.

If frozen cells are used in electrolyte solution in large quantities, proteins and clotting factors must be added .

Blood must be warmed and filtered before transfusion.

Bennett et al, in 1975 (34), recommended the use of

physiologic solutions or Hartman's solution in quantities of 0.5 - 2.0 ml/ml of blood given, in order to reduce the incidence of pulmonary complications post-operatively and to correct for the extra-cellular fluid loss, due to the initial hypotension. This review of fluid therapy applies to any newborn surgical patient and bears relevance to the management of patients born with oesophageal atresia, with or without tracheoesophageal fistula, during their pre-operative, intra-operative and post-operative periods.

A review of the fluid therapy given to the patients in this study, showed some inadequacy in both quantity and quality. Over infusion was occasionally seen. Inadequate infusion occurred mostly pre-operatively and usually resulted from displacement of the intravenous lines, with discontinuation of the fluid infusion for prolonged periods of time.

Pre-operatively, one patient in the series received less than 100 c.c. of fluids, on average over 24 hrs; 4 5 patients received 100-150 c.c. of fluids, on average over 24 hrs, while 6 patients received above 500 c.c of fluids an average over 24 hrs. The first two groups of patients' was over-infused and at a risk of fluid overload. Patients' birthweights were not aligned against the amounts of fluids

infused, but the bulk of the patients in this study, was operated on at the age of 4-5 days. The ideal amount of fluids for any of the patients in this series, should have in between the two extremes. The combination of fluids used, must be balanced enough, to provide for the water, caloric and electrolyte requirements of these neonatal patients. Allowance may be given for lack of particular types

of a given time, but the undesirable results in mind, of infusing excess of fluids, lacking in one or the other element. must be borne in mind.

Hypertonic solutions will overpower the concentrating ability of the neonatal kidneys. Most of the authors, favour a balanced combination of 5% dextrose solution, with half-strength saline.

In this study , 37 % of the patients received half-strength darrows alone.

Either of the two preparations may have been used i.e. the commercially supplied one, or the local preparation. The latter is most frequently used and has the following composition, 400mls of 5% dextrose; 100mls of normal saline; 4 mls of 20% pottasium chloride solution and 15 mls of sodium bicarbonate solution of 8.4 % strength . A combination of half-strenth darrows with 5% dextrose solution was given to 29.9% of patients' while 12.6% received 5% dextrose

solution alone. A combination of normal saline with Hartmann's solution was given to 3.7 % of the patients, while 9.2 % received a combination of half-strength darrows with 10% dextrose solution. Clearly, some of the fluid regimes used pre-operatively, were inadequate in their caloric and/or electrolyte content.

Intra-operatively , fluid therapy was occasionally inadequate as well i.e. in cases where patients received 40 c.c. or less of fluids. Mortality was highest in the latter group of patients, followed by the group of patients receiving a higher quantity of fluids i.e. 80-120 c.c. None of these patients died intra-operatively, though cases of cardiac arrest occurred in 4 patients. Hypovolaemia could have been one amongst the many causes of the cardiac arrest.

Bennett et al, in 1975, suggested on intra-operative fluid regime of 3-4ml/kg/hr during an anaesthetic. Churchill-Davidson, in 1984 (35), recommended 5-6 mls /kg/hr, of 4% dextrose solution and 0.88% saline solution, with monitoring of blood pressure, heart rate, pulse, urine output and peripheral perfussion. In absence of an ultra-sonic nebulizer within the patients' breathing circuit, then as much as 1 ml/l of minute volume/hr, within a closed circuit could be required as extra fluid. Where a nonrebreathing circuit is in use, then as much as 2.5 ml/l. of minute volume /hr, of extra fluid may be required.

It is clear from recommendations given by various investigations on intra-operative fluid therapy, that patients who received less than 40. c.c. of fluids

remained under hydrated, while those receiving fluids in excess of 120 c.c. intra-operatively, were fluid overloaded.

The average duration of operation in this series was $1\frac{1}{2}$ hrs. Post-operative fluid therapy in amounts is depicted on Table VIII. Types of fluids were not rectified, as was done for the pre-operative regime, where the purpose was to indicate that not always were the regimes of fluids given to these patients balanced as well as they should be .

Swenson et al (37), recommended a post-operative fluid regime of 765mls /m²/ day, but Bennett et al (37), thought that this was the minimum requirement and recommended 3-4ml/kg/hr, as being ideal.

The same authors thought that for proper fluid therapy in these neonatal surgical patients, one should have an estimate of their body compartments by volume, the specific electrolyte changes and water and electrolyte distribution, the alterations in acid-base status and caloric needs. The same authors recommended giving 5% dextrose in adequate quantities, so as to meet metabolic demands.

This prevents hypoglaecemia, encourages neoglucogenecis and limits glycogenolysis. This last effect, plus the protein spairing effect of normeglaecemia reduce pottasium loss in a patient who ~~has~~ been subjected to surgery. The metabolic requirement in these patients should be maintained at 59/kg/day, supplied by 5 % dextrose or 10 % dextrose solutions. The same authors found that large quantities of hypotonic fluids, infused into newborns, were responded to by a raise in aldosterone scretion rate (ASR).

This results in increased sodium re-absorption in the renal tubules and a low concentration of urine.

This situation may lead to hypertonic dehydration.

If ASR. R. is raised, pottasium supplementation would be required Bennett et al, in 1975 (34), recommended use of lacated Ringer's solution intra-operatively and post-operatively for the following purposes,

- a). maintenance of renal haemodynamics, as opposed to the depression of renal blood flow and glomerular filtration rate of 40-80 % , seen without salt solution infusion.
- b). prevention of post-operative acute renal ~~shut~~ t down (a complication that carries 70 % mortality rate in surgical patients).
- c). avoidance of acute water-retention post-operatively
- d). a marked reduction in the incidence of significant intra-operative and post-operative hypotension
- e). a decrease in the need for blood transfusion.

f). The use of physiologic solution, similar in composition to the fluid in the interstitial space. This solution however lacks in it's buffering capacity and it's use in large quantities would require addation of colloid albumin or plasma.

None of the patients in this study, who received 50-150 c.c. of fluids, on average over 24 hrs, survived, while mortality in the groups of patients receiving 150-250 c.c. of fluids was 62.5%. Mortality was also 100% in the group of patients, receiving over 450 c.c. of fluids, on average, over 24 hrs, The least mortality was seen in the group of patients receiving 350-450 mls. of fluids, on average over 24 hrs, This latter amount of amounts of fluids given over 24 hrs, appears to be ideal for post-operative maintenance and most closely correlates with the amounts given by most of the investigators, given the fact that the average stay in the intensive care unit was 4.2. days and that the majority of patients, were operated on at an average age of 4-5 days.

Where repair of oesophageal atresia with tracheoesophageal fistula is delayed for more than a few days in these patients, total parenteral nutrition may be considered, so as to prevent further catabolism, as 5 % dextrose solution provides only a fraction

of the basal caloric needs. Post-operatively, hyperalimentation must continue and gastrointestinal feeding started when the patient is ready for it. Different authors offer different opinions, concerning feeding in patients with oesophageal atresia with or without tracheoesophageal fistula, especially post-operatively.

Wilton et al, in 1951, suggested giving drops of water between 12 and 24 hrs after operation with daily radiographic examination, to keep watch over the state of the lungs and pleural cavity, for the first five days post-operatively. Churchill-Davidson, in 1984 (36), suggested gastrostomy following thoracotomy to facilitate feeding, Santos et al, (38), did oesophageograms on all their patients to rule out anastomotic leaks and gastroesophageal reflux, before feeding was commenced. The screening was done on 7th-10th day post-operatively. Oral feeding was only started after removal of the chest tube. Koop et al, in 1965 (17), fed their patients through gastrostomy on the 2nd and 3rd post-operative day, after the first stage of repair, there being no fear of vomiting and aspiration. The same authors however, were against routine gastrostomy, as this has a complication rate of 38.5 % in newborns (reported by Connot and referred to in ref. (17)), with a mortality rate of 30%, in patients with gastrostomies, performed for oesophageal atresia. Pyloric stenosis has been known to follow gastrostomy, but the latter is

is said to be life saving where it is indicated.

Mayrhofer et al, in 1959 (31), fed their patients through gastrostomies done 24-48 hrs, after the main operations, under local analgesia. Same procedure was also recommended by Swenson et al, in 1958 (39) and Humphreys et al, in 1956 (40). Mayrhofer et al, fed their patients on 8th -10th post-operative day. Koop et al (2), fed their patients either through gastrostomy or nasogastric feeding tubes on the 3rd post-operative day and oral glucose was given in the 6th day, unless there was concern over the oesophageal anastomosis. Formula was given by mouth when a barium swallow had shown no leak at the anastomosis and the chest tube had been removed. Where complications made feeding by other means difficult, then high calorie alimentation by intravenous route has been recommended Hendren et al, in(1964) and Martin et al, (1961⁵). routinely did gastrostomy for feeding. Holder and Ashcraft (1966, 1970), strongly recommended gastrostomy for the same purpose. Postlethwait et al (9), believed that decision on gastrostomy should be made depending on the patient's condition, except in cases where primary repair has to be delayed.

In this study, 32 of the 54 patients, were fed on some nutritional mixtures post-operatively. This was either through gastrostomy nasogastric feeding tube or parenterally and the feeding mixtures included expressed

breast milk, lactogen and sorbital. Patients were commenced on feeds as stated earlier in the study. The rest of the 22 patients, were maintained on various intravenous fluid. Twenty-four patients were fed either through nasogastric feeding tube or orally, before they had radiological screening, to rule out anastomotic leaks and gastroesophageal reflux. Radiological screening should be on the 7th -10th day post-operatively and until then, patients are either on parenteral feeding or on glucose solutions through the nasogastric feeding tube. Mortality rate was 100 % in this study, for patients who developed anastomotic leaks and this would emphasise the need for radiological screening before feeding with formula is commenced, to avoid this fatal complication. Having said that, most of the patients in this series were started on some extra feeding programme early enough post-operatively, to supplement for the intravenous fluids. This is in keeping with recommendations from most investigations. Five patients had had gastrostomy done, before the final oesophageal anastomosis, but all these patients died before the final repair and the benefits of gastrostomy in this study, are not seen. However, gastrostomy performed for both feeding purposes and for decompression of a tense abdomen before repair of oesophageal atresia with tracheoesophageal fistula, would serve a useful purpose. This could be done under local anaesthesia.

Gastrostomy done post-operatively for feeding, seems a sure way of avoiding leakage of feeds into the oesophageal anastomosis, which might occur, where a nasogastric feeding tube may have slipped up above the level of the fistula.

Feeding programme should have been introduced during the management of the remaining 22 patients either pre-operatively or post operatively. Optimum body temperature maintenance in the supportive care of these patients to guard against hypothermia, must be commenced earliest possible, including incubator care, where this is available, set at temperatures not lower than 32° ; use of cotton wool padding or contact mattress, as recommended by Lewis et al, in 1973 (42). Koop et al in 1973 (2), in their series of patients, found that infants admitted with body temperatures below 35.5° seldom survived. Body surface temperature should be maintained at 36° c Hypothermia results in hyperkalemia and hypoglaecemia, as suggested by Lister et al (12) and Paxson et al (43). When subjected to pre-medication, anaesthesia and surgery, neonates become poikilothermic and are unable to control their body temperature. This is important, especially in anaesthetised patients, who have

vasodilatation, which enhances heat loss, as peripheral blood flow increases. The neonates temperature could, under such circumstances, drop by as much as 5.5. °C.

In this study, temperature recordings ranged from 35.5°C to 36.8 °C pre-operatively. Though measures against hypothermia were almost routinely prescribed for every patient on admission, records to show how, or whether or not these were effected, were not kept. This left doubt as to whether or not the prescribed measures were adhered to and if so, to what extent. As can be seen from the recorded range of temperatures, some of the patients remained hypothermic, indicating inadequate protection from heat loss. Use of cold fluids during the pre-operative period, could have cooled these patients further.

Measures taken to maintain optimum body temperature intra-operatively for any of the 32 patients, whose anaesthetic notes were available, also lacked. Two patients were said to be hypothermic on arrival into the intensive care unit, post-operatively. The two patients died. Temperature maintenance and recording for these neonatal surgical patients, should be part of the intra-operative management, given the various factors that might result in hypothermia, e.g.

fluid infusion, blood transfusion, vasodilatation due to the anaesthetics in use, which result in peripheral heat loss and also ventilation with dry and cool gases. Four patients in this study had cardiac stand still intra-operatively. Hypothermia, as a cause, can not be totally ruled out. Post-operatively, all patients in this series, were nursed inside incubators, which served to improve on any hypothermia that the patients may have developed intra-operatively. Incubator temperature ranged between 28-32 °C. Though these were generally below the recommended temperature levels of 32 °C and above, there were no incidences hypothermia in the intensive care unit.

Other factors that negatively affect survival in patients with oesophageal atresia with or without tracheoesophageal fistula

In quating mortality rate figures in association with the four aspects of supportive management, that formed the subject of this study, it indicated that death in any one of these patients would be, most likely, multifactorial. Blaming the death of a patient on one particular systemic disorder, or on inadequacy of management concerning one aspect of the supportive care, would be wrong. It is with this in mind, that other crucial factors that significantly affect survival chances in these patient, were reviewed, as follows:

1). Prematurity at birth and low birth weight, which affected eleven patients in this study. Death rate in the group of patients who weighed 1800 gms or less, at birth, was 100% and this improved in groups of patients born at term and weighing more.

Baker et al (3); Koop et al, (17); Waterston et al (8); Abrahamson et al (4), all reported higher mortality rates in premature and underweight at birth children, as compared to mature babies, whose birth weight was acceptable.

2). Age of the patient in days at operation time, also clearly affected survival chances. The older the patients were at operation, the poorer were the chances of survival in general.

- 3). The patient's A. S. A. grade on admission also reflected on their survival chances and the poorer the A. S. A. grade, the poorer were the patient's chances of survival in this study.
- 4). Presence of other congenital malformations and their complications, also contributed to mortality in this study. Investigators elsewhere, found that this was so at their centres e.g. Haight in 1957 (21), reported 100% mortality rate in his patients who had other cardiovascular abnormalities; Rosenthal in 1976 (9) reported 79.2% mortality rate in his patients as being associated with cardiovascular abnormalities, as compared to 22.7% mortality rate, seen in otherwise healthy patients;

Diffins et al, 1970 (9) also had 19 of their patients with imperforate anus in their series and eleven of these died.

In this study, as is shown on Table X, all patients born with extra congenital malformations died.

5). Post-operative complications, some of which will have been referred to during discussion on supportive care , concerning the four aspects that formed the subject of this study.

Differentiation was made between the purely systemic disorders and situations where mechanical and /or technical faults, occurring during the management of these patients contributed to the complex of the post-operative complications. The latter occurred in 17 patients, eleven of whom died. Other post-operative complications involved the respiratory, cardiovascular systems and thermal disorders. The latter occurred in two patients, who developed hypothermia intra-operatively and this was noted on admission into the intensive care unit. Mortality rates were always high in patients with post-operative complications.

Anaesthetic Management

Anaesthetic management is a part of the intra-operative care, given to these patients and it is essential that correct techniques of anaesthesia are carefully applied. It is also necessary that this management is put down in record,

for purposes of retrospective studies such as this one and also, since intra-operative management could influence the type of post-operative management.

Mayrhofer et al (31), outlined the special problems encountered during the anaesthetic management of these patients, as follows:-

- a). frequency of prematurity that is observed in this group of patients.
- b). frequency of other congenital malformations, the complications of which could seriously derange the physiological functioning of the patients' body.
- c). The presence of associated aspiration pneumonia, seen almost always, by the time that these patients present for anaesthesia.
- d). troublesome distension of the stomach and bowel, when higher inspiratory positive pressure is given to these patients, during assisted mode of ventilation, either in the pre-operative or intra-operative periods.

The authors recommended that an inspiratory positive pressure of 8 cm H₂O, be used in ventilating these patients. While giving sufficient pulmonary ventilation, this pressure level would not cause unwanted disturbances. The same authors listed down the principle requirements for safe anaesthetic in these patients as follows;

- 1). enough oxygenation and proper inflation of the lungs.
- 2). efficient elimination of carbon dioxide.
- 3). normal circulating blood volume, maintained by replacing blood and plasma losses.
- 4). maintenance of a clear airway done by removing blood and secretions, from the tracheobronchial tree.
- 5). normal body temperature, maintained before, during and after surgery.
- 6). the infant should recover soon after surgery, with no undue respiratory depression.

The same authors give the steps of the anaesthetics as follows:-

- a). a flat precordial stethoscope should be placed on the left side of the chest, as soon as the infant comes into theatre for operation. This is considered to be an indispensable piece of monitoring for the patients respiration, cardiac activity , allowing for timely correction of any abnormalities.
- b). Intubation may be done awake. The authors however suggest a small dose of suxamethonium, to facilitate this manouvre . Plastic tubes with a bulge about 2 cms above the tip, that do not easily slip too low in the airway, are considered best.

In the series of Mayrhofer et al (31), laryngeal oedema, most frequently followed trauma or bacterial contamination . The authors recommended use of a water lock, to minimise the inspiratory pressure, even when patients are on assisted ventilation. Amongst the anaesthetic drugs used, volatile agents are more preferred to intravenous ones, due to the ease with which anaesthetic depth can be changed. Suxamethonium and nitrous oxide-oxygen mixture have been used, with the dose of the earlier being $\frac{1}{4}$ to $\frac{1}{2}$ mg per kg body weight, lasting between three and six minutes. Postlethwait et al (9), suggested that the surgeon should ligate the fistula as soon as it has been identified, to aid the anaesthetist in his job of assisting respiration, without causing abdominal distension. Elevation of the infants head, till ligation of the fistula has been done, also assists in this task. Koop et al (2), advised against inducing with bag and mask, as this forces the anaesthetic gases into the stomach, causing distension. They preferred awake intubation. The authors used atropine 0.1 mg to 0.15 mg intravenously , before awake laryngoscopy and intubation. The authors advised that, the tip of the endotracheal tube be placed just above the carina, to minimise forcing gases through the tracheoesophageal fistula. The endotracheal tube is initially pushed into a major bronchus, then withdrawn slowly, until both

lungs are ventilated adequately and equally. Separate authors agree on the following measures, as additions to the anaesthetic;

- 1). precordial stethoscope monitoring, with ECG, Doppler measurement of blood pressure and a rectal temperature probe, being optional.
- 2). normal body temperature maintenance
- 3). use of humidified anaesthetic gases.
- 4). meticulously replacing blood loss as it occurs.

Mayrhofer et al (31), suggested giving 10-20 mls of blood, as prevention of shock is easier than its treatment.

Their average blood transfusion was 30-50 mls, given slowly in portions of 5 mls.

- 5). blood gases should be determined as indicated.

Separate authors agree on use of controlled ventilation and a non-rebreathing anaesthetic system,

with oxygen concentration of 30-70% as required.

Use of either D-tubocurarine or pancuronium for prolonged muscle relaxation, may be used to facilitate IPPV. Only 32 patients out of the 54 in this series had their anaesthetic management put down in record. On most occasions, this was similar to what has been practiced else-where as documented.

Thirty of the patients had the following anaesthetic technique applied.

- a). awake intubation after oxygenation
- b). prolonged muscle relaxation was obtained using either D-tubocurarine or pancuronium
- c). Intermittent positive pressure was given using Ayres T-piece with the Jackson Rees modification (JRM)
- d). reversal of the non-depolarising muscle relaxants was always with neostigmine and atropine.
- e). maintenance of the anaesthesia was always by oxygen - gas -halothane mixture.

The remaining two patients were induced with halothane, before intubation and the rest of the procedure was as outlined above. The average amount of blood transfused was 30 c.c., though records on blood loss were not available for any of the patients. Intra-operative fluid therapy, temperature maintenance and use of other drugs, has already been discussed earlier on in the study. Intra-operative complications whose causes could also include the anaesthetics used, have also been dealt upon earlier. It is noted that some of the causes for the cases of intra-operative cardiac arrest could have been secondary to

- i). hypovolaemia even haemorrhagic
 - ii). hyperthermia
 - iii) hypoglycaemia
 - iv) electrolyte imbalances.
- investigations and record keeping made it

difficult to identify the cause of this intra-operative complication more specifically.

In conclusion, a mortality rate of 61. % of found in this series of patients, compared poorly with the rates reported elsewhere e.g. Koop et al, in 1974 (2), reported survival rate of 66% overall, with full-term babies having a 70% survival rate, while prematures survival rate was 50 % , The latter group had a 100% mortality rate in this study. In the authors same study, a 100% survival rate was later found in full-term babies with no pneumonia . Bar-Mar et al, 1981 (24), reported a mortality rate of 50% in their series, amongst patients with low birth weight and other congenital malformations. Birth weight of below 1800 gms result in 100 % mortality in this series. Abrahamson et al, in 1972 (4), reported a survival rate of 74% in their group of patients who weighed more than 2500 gms at birth, as compared to mortality rate of 64. 3% in this study. In the same authors study, babies weighing less than 2500 mg at birth had a survival rate of 45 %, compared to 35.7% seen in this study. Holder et al, in 1864 (9), found a mortality rate of 64% as having been due to pneumonia. The latter caused a 75% mortality rate in this study, Hicks et al , in 1981 (13) found an overall survival rate of 79 % in their series of 100 patients. Blyth et al, in 1984 (5) at Christchurch, found an overall mortality of 48%, but the authors noted an improvement in survival figures in their study.

CONCLUSION

At the end of this study, it was concluded that mortality rate in this series of patients, was unacceptably high, especially as compared to the mortality rates reported by various authors, from other centres. This was true in both the group of patients who had only oesophageal atresia and tracheoesophageal fistula who were otherwise healthy, as well as the poor-risk group of patients.

Some inadequacy in the supportive management, as given to these patients at Kenyatta National Hospital clearly came out, especially concerning the four aspects of the management, that were chosen to form the subject of review in this study i.e.

- 1). Inadequate fluid therapy, both quantitatively and qualitatively. This was more evident during the pre-operative and intra-operative periods, than post-operatively.
- 2). Inadequate measures to prevent pulmonary complications were taken, especially during the pre-operative period of management, with the exception of antibiotic therapy. However the situation concerning this aspect of management was much improved post-operatively
- 3). Body temperature regulation and maintenance was inadequate during the pre-operative and intra-operative periods, with some patients, remaining hypothermic during the two periods. Insufficient record keeping,

especially pre-operatively and intra-operatively, was not only a hinderance in carrying out this study, but it also made it difficult to recognise what possible influence that pre-operative and intra-operative management would have had on the post-operative management e.g. failure to record intra-operative blood loss made it difficult to ~~replace~~ this loss correctly post-operatively

4). no extra nutritional mixture were given to 22 of the patients in the series, except for the glucose solutions given intravenous and series of the patients were fed orally, before having radiological screening to confirm them fit for this type of feeding, in a situation where mortality rate was 100% for the patient who developed anastomotic leak, followed by wound sepsis. Investigations that might have been helpful in offering the correct type of supportive care to these patients, were scantily done, especially during the pre-operative period.

Anaesthetic management for those patients whose intra-operative notes were available, was seen to correspond very much with that practised at other centres. Monitoring was, however, very scanty during anaesthesia. This made it difficult to recognise a start of the abnormalities that eventually caused cardiac arrest, seen in 4 patients. Hypothermia that developed in two of the patients intra-operatively also was not recognised in time. Other factors were also seen to significantly affect mortality in this study i.e. prematurity and low

RECOMMENDATIONS

- 1). Prescribed measures of supportive care for these patients, should be strictly adhered to and started promptly, by those responsible for carrying them out.
- 2). Prescribed fluid therapy should be more balanced qualitatively. and quantatively .
- 3). More intensified relevant investigations and record keeping should be done, especially pre-operatively and intra-operatively, to enable better follow up of the management post-operatively.

This also includes radiological screening of patients, before deciding on oral nutrition formula, post-operatively.

Hyperalimentation should be more frequently used where indicated, pre-operatively and post-operatively.

- 4). Delaying of repair, while the patients general condition is improved, could be recommended only with better supportive care pre-operatively.
- 5). Better monitoring during anaesthesia would be helpful.
- 6). Clinicians should watch out for this congenital anomaly, where birth is premature and birthweight is low. This would help in recognising these

patients early and having them operated on early enough, before complications develop, due to the oesophageal atresia with or without tracheoesophageal fistula and due to any other congenital malformations that might coexist. This would improve on the patients A. S. A. grade on admission and therefore increase their survival chances.

7). More strict observation and monitoring of these patients during their post-operative management in the intensive care unit is required, so as to minimise incidences of mechanical faults and to detect them early enough where and when they occur.

TABLE I.

Distribution Of Birthweight And Mortality
In Each Group

Birthweight in Gms.	No. Of Patients	No. Of deaths	% Out Of No.in the group	% Out Of total mortality in the series
Above 2500 gms	28	18	64.3%	54.5%
1800 -2500 gms	14	9	64.3%	27.3%
Below 1800 gms	3	3	100%	9.1%

9 patients had no record on birthweight.

TABLE II.

Distribution Of Age Groups (In Days)

And Mortality Rate In Each Group

Age Group at operation Time (in- Days)	No. Of Patients	No. Of Deaths	% Out Of No. In The Group	% Out Of The Total Mortality
2-3 days	14	12	70.6%	36.4%
4.5 days	21	9	45%	27.3%
6.7 days	10	5	50%	15.20%
8-9 days	6	4	66.7%	12.1%
Above 10days	3	3	100%	0.03%

Table III

A. S. A. Grade Distribution with Mortality Rates
 In Every Grade And contribution Towards Total
 Mortality, Made By Each Grade.

A. S. A. Grade	NO. OF Patients	NO. OF Deaths	% Out Of No. In The Grade	% Out Of Total Mortality In The Series
I	9	5	55.6 %	15.2 %
II	22	II	50 %	33.3 %
III	20	14	70 %	42.2 %
IV	3	3	100 %	9.09 %

TABLE IV

Distribution of Amounts And Types of Fluids Administered Pre-Operatively

Amount (an average over 24 hrs in c.c.)	Type Of Fluids + No. Of Patients In The Group								
	HSD. 5%DEXTROSE	NORMAL SALINE	5% DEXTRO	5%DEXTRO	H.S.D.	H.S.D.	NORM.SALINE		
	+ HSD	+ HARTMANN'S	SE.	+ 50%) DE.	50%DEXTROSE	10%D.	5%DEX	TOTAL	
0-100	0	0	0	1	0	0	0	0	1
100-150	3	1	0	0	0	0	1	0	5
150-200	3	4	0	1	1	0	1	0	10
200-250	4	3	0	2	0	0	1	0	10
250-300	5	3	0	1	0	0		1	10
300-350	3		0		1	0		0	4
350-400	1	1	2		0	0		0	4
400-450	0	1	0		0	1		1	3
450-500	1		0		0	0			1
Above 500	1		0	2	0	0	2	1	6
TOTAL	21	13	2	7	2	1	5	3	54

TABLE V

Amounts Of Fluid Given Intra-operatively (only for 32 patients with intra-operative records

Fluid amounts in mls	No. Of Patients in the group	No. Of Deaths	% Out Of The No. In the group	Total
0 - 40	2	2	100 %	2
40 - 80	7	3	42.86 %	7
80 - 120	13	8	61.45 %	13
Above 120	10	6	60 %	10

22 patients had no record on their intra-operative management.

TABLE VI

ILLUSTRATION OF VARIOUS GRADES OF PATIENTS
VENTILATED POST -OPERATIVELY AND THEIR MORTALITY RATES

A. S. A.	NO. OF PATIENTS	NO. OF DEATHS	% OUT OF NO. IN THE GROUP
I	1	1	100 %
II	9	4	44.4 %
III	12	9	75.%
IV	3	3	100 %
TOTAL	25		

TABLE VII

Groups Of Non-ventilated Patients

In Various A. S. A. Grades And Mortality Rates.

A S A Grade	NO. Of Patients	NO. Of Deaths	% Out Of No in The Group
I	8	4	50%
II	13	7	53.9 %
III	8	5	62.5 %
IV	0	0	0
Total	29		

TABLE VIII

Distribution Of Amounts Of Fluids Given
Post-Operatively Plus Mortality Rates

Amount of Fluids on average/24 hrs in c.c.	No. Of Patients	No. of deaths	% Out Of No. Of Patients in group
50 - 150	4	4	100%
150 - 250	24	15	62.5%
250 - 350	19	13	68.3%
350 -450	5	1	20 %
Above 450	2	2	100 %
Total	54		

TABLE IX

PRE-OPERATIVE COMPLICATIONS

Respiratory System:

No. of Patients	No. Of Deaths
9	6

B. Pneumonia with Severe
hypoxia

2). Circulatory System;

Dehydration ;	15	11
Peripheral cyanosis with Anaemia;	3	3
	3	3

3). Thermal Disorders;

Hypothemia;	-?	?
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4). Gastro-intestinal;

Abdomerial distension;	4	4
Mecomein ;ug plug syndrome;	1	1

5). Others;

Jaundice;	1	1
Prematurity;	17	71
Congenital malformations;		
i). undersecuded testis;	1	1
ii). small bowel ; atresia,	2	2
iii). Congenital heart disease;	2	2
Neonatal sepsis;	1	1

TABLE X.

POST -OPERATIVE COMPLICATIONS

1). Respiratory System:

	No. of Patients	No. of Deaths
Bronchopneumonia with severe hypoxia	8	6
Pneumothorax and lung collapse	2	2

2). Circulatory Disorders

Dehydration	2	1
D I C	1	1
Fluid overload with CCF	1	1
Peripheral cyanosis with hypotension	2	2

Thermal Disorders

Hypothermia	2	2
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Mechanical and Technical

Faults: (iatrogenic)

Blocked/displaced tubes + self extubation	15	10
machine failure	2	1

Others

Leaks with wound infection and sepsis	4	4
Abdominal distension	3	3
Jaundice	2	1

TABLE XI

DISTRIBUTION OF VARIOUS AGE GROUPS OF THE PATIENTS
AND THE RESPECTIVE ASA GRADES

ASA GRADES	AGE		GROUSP			(IN DAYS)	
	2-3	4-5	6-7	8-9	OVER 10	TOTAL	
I	1	6	2			9	
II	7	9	4	2		22	
III	6	6	3	3	2	20	
IV iv			1	1	1	3	
TOTAL	14	21	10	6	3		

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