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The basic aim of medicine and science has always been to alleviate human pain and suffering so as to give a better and longer life. Over the years the art of medicine has undergone revolutionary changes due to the tireless efforts of countless ancient and modern men. Discovery of new drugs, newer techniques to correct the deficiencies of the past have helped in making medical science reach the pinnacle at which it rests now. Even then, the efforts to further spur on the development of medicine is going on.

Infective peritonitis is one such disease which still causes much sufferings and death, despite the advances of medicine. Efforts to conquer this disease have been going on for nearly a century.

Infective peritonitis is a problem which continues to kill half of the patients so afflicted. Artz et al (1962) over a period of five years found that there were 20 deaths out of 56 cases (34.5%). Altermeier and Cole (1956) reported that more than 50% of their patients in a state of septic shock had diffuse peritonitis. Stephen and Lowenthal (1978) reported a mortality rate of 48% from generalized infective peritonitis.

Significant morbidity has been seen in cases of infective peritonitis. Subsequent complications in the form
of septicemia, faecal fistulas and burst abdomen are very common. The reason for the mortality is readily appreciated when one realises that diffuse peritonitis involves a mesothelial surface of 22,000 square cm. and is equivalent to a 75 to 100% body surface area.

Infective peritonitis generally runs a fulminating course. A profound toxicity usually ensues with extensive inflammation of the peritoneum. The lipopolysaccharide component of the walls of the gram negative bacilli accounts for a good deal of this toxicity. According to Davis (1967) cellular destruction results in the release of numerous vasoactive amines, which have a profound local and systemic effect. Severe peritonitis is also associated with severe fluids and electrolyte imbalance.

Despite better surgical techniques in controlling the contaminating source (perforation, gangrene, anastomotic breakdowns), better antibiotics and supportive therapy a significantly high mortality as stated earlier persists. Most patients die after a protracted course —mean survival time being 4 weeks. The cause of death being multi-system failure secondary to continuing intraperitoneal sepsis.

In our country the morbidity and mortality due to infective peritonitis is quite high. In presence of pus in the peritoneal cavity, antibiotics given parenterally
cannot reach the site of contamination in appropriate levels. By peritoneal lavage the antibiotics are made available in solution form and in high concentrations in the peritoneal cavity. Thus they can also act locally at the site of contamination. Just as debridement plays a major role in the management of surface wounds and burns so also mechanical cleansing by continuous peritoneal lavage, may be expected to benefit the large inflamed peritoneal surface.

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REVIEW OF LITERATURE
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The concept of mechanical cleansing of the peritoneal cavity using lavage is not new, being first advocated for use at the time of operation by Nolan (1893) and by Price (1905).

Price in 1905, managed to reduce the mortality in peritonitis by more than half by performing peritoneal lavage at the time of operation. He opened the abdomen and after dealing with the contaminating source (perforation, gangrene or leaking anastomosis) poured litres of sterile water to wash away all pus and debris. Following this he closed the abdomen without putting in any drain, He concluded that lavage was a good method but sterile water was preferable to saline.

Silvani et al demonstrated that intraperitoneal administration of streptomycin effectively sterilised the peritoneal cavity of dogs with fulminating diffuse peritonitis of appendiceal origin; whereas intramuscular administration did not significantly alter the bacterial flora of the peritoneal exudate. This study was done in 1974.

Zintel et al (1950) after conducting studies on experimentally produced peritonitis in dogs concluded that
penicillin therapy alone over a period of 10 days was as effective as a combination of penicillin and streptomycin.

Reiss et al (1952) in a study of 68 patients treated with terramycin believed that this was a good antibiotic agent, but the combined use of penicillin and streptomycin had real merit.

Barbieri et al (1953) traced the influence of parenteral aureomycin, Chloromycetin, Terramycin and Procaine penicillin on the mortality of experimental peritonitis. They found that these broad spectrum antibiotics lowered the mortality rate but were more effective when combined with large doses of penicillin.

Schatter and Abbott (1953) produced experimental appendiceal peritonitis in dogs. When the dogs were treated with intravenous Terramycin the mortality was 100% but when treated with intraperitoneal terramycin the rate came down to 41%.

Kelley and Vest (1952) have shown that lavage of the peritoneum with a balanced salt solution rapidly restores the metabolic arrangements (fluid and electrolyte imbalance, acid base imbalance) to normal.

Burnet et al (1957) by extensive experiments on guineapigs came to the conclusion that:

1. If there is no complication and peritonitis is the only cause of the patients illness, the method of
removing the cause, lavaging the peritoneum free of removable foreign matter with large quantities of saline containing antibiotics and administering antibiotics systemically is the best method of treatment.

ii) Lavage with saline alone is as good or slightly better than instillation of antibiotic alone.

This agrees with the logic on which this combined procedure was developed.

a. The basic surgical principal of removal or neutralisation of the cause is applied.

b. Lavage removes large quantities of toxins from a great absorptive area and many bacteria which would otherwise have to be dealt with the body defences. Enzymes are removed from further harm to the reparative process.

Chemical irritants and digestive enzymes leaking from ruptured peptic ulcers are removed. All surfaces are exposed to antibiotic solution which can be delivered in concentrations unattainable by systemic administration. With as little as 100,000 units of penicillin in a litre of saline, 100 units per ml are available, while the same amounts given intravenously would deliver only 4 units/ml per hour and intramuscular only 2 ml per hour.

The method is to obtain exposure adequate to thoroughly lavage the peritoneum using a solution of penicillin 1,000,000 units and streptomycin one gram per 500 ml. Next is to remove or neutralise the cause of contami-
nation. All adhesions and barriers are broken down gently
to destroy any hiding pockets for bacteria so that all
surfaces can be bathed in antibiotic solution.

This procedure has also been found useful in:
1. Rarely when gross contamination occurs during operation.
2. In patients with severe peritonitis brought in after shock
has begun who cannot withstand formal operation. They can
be helped over the critical period by inserting drains
under local anaesthesia and after aspirating the purulent
material and lavaging the peritoneal cavity. This greatly
decreases the sepsis and a definitive operation can be done
later on when the patient's condition improves.

They thus summarised that in the treatment
of peritonitis clinical and laboratory evidence indicates
that, the addition of peritoneal lavage with high concentra-
tion appropriate antibiotics in saline combined with the
basic principles of good surgery and the systemic adminis-
tration of antibiotics offered the patient a much better
chance to recover and has few if any ill effects.

Altemeier and Cole (1936) reporting on the
morbidity of peritonitis found that more than 50% of their
patients in a state of septic shock had diffuse peritonitis.

Schweinberg et al (1937) found by experiments
on dogs in which peritonitis was produced experimentally
that the cure rate by giving Auroomycin intraperitoneally
was 80%. They said that Auroomycin should not be given for
more than 48 hours intraperitoneally or it may produce chemical peritonitis which could be fatal.

Barnett and Hardy (1958) demonstrated the value of irrigation of the peritoneal cavity in strangulated intestinal obstruction. Very conclusive evidence was provided for the value of early irrigation of the peritoneal cavity with saline in experimental peritonitis.

Barnett (1960) found the intraperitoneal route of administration of antibiotics superior than other routes of administration in strangulation obstruction.

Silser (1960) reported that he treated faecal peritonitis with lavage by a mixture of penicillin and streptomycin in 0.25% procaine (200 ml). He found no toxicity due to the drugs and an improved survival rate.

Barret (1961) used Neomycin intraperitoneally and improved survival rate. Long term toxicity studies should pathological changes at the highest dose (1.0gm/kg) body weight only with inflammatory changes in liver and lung. For all practical purposes it does not reduce adhesions.

Artz et al (1962) carried out an experiment in which standardized faecal suspension was injected into the peritoneal cavity of dogs and various treatment regimens were evaluated. They found that —
i. In the majority of animals bacteria were not detected in the bloodstream during the first two hours after injection of faecal suspension. Microorganisms began invading at the 3rd hour and increased in number until the animals died usually between 7th and 9th hours.

ii. Penicillin produced a 55% survival whilst a combination of penicillin and kanamycin produced 100% survival rates while kanamycin alone produced a 60% survival.

iii. Various antibiotic combination did not produce a significant difference.

iv. If the antibiotic combination is injected immediately after the faecal suspension is given the route of administration makes little difference. If peritonitis is allowed to develop with a delay of two hours between injection and the administration of the antibiotic combination it is evident that intravenous and intraperitoneal route is better than intramuscular route.

v. After irrigation of peritoneal cavity 85% animals survived in comparison to 45% survival in control group. Thus they concluded that a combination of penicillin and kanamycin produced significantly more survival than either antibiotics used alone. Early irrigation of the peritoneal cavity with saline combined with antibiotic therapy gave significantly superior results to antibiotics therapy alone.
Coligher J.F. (1957), Brown et al. (1960), Jawson et al. (1965) found that in diverticulitis of the colon complicated by perforation or intestinal obstruction, conservative surgery in the form of colostomy and drainage of the peritoneum was the best method.

Cohn and Collar (1962) found that intraperitoneal kanamycin administration significantly reduced the mortality in experimental peritonitis in dogs. Kanamycin was used intraperitoneal 1 gm dissolved in 50 cc of normal saline. No toxicity was seen. The incidence of complication was decreased. They advocated wider usage of intraperitoneal kanamycin when in tra peritoneal antibiotic therapy is indicated.

Schumer et al. (1964) produced peritonitis experimentally in dogs and guinea pigs by resecting the tip of the appendix so that the lumen was open to the peritoneal cavity thus producing a mortality of 95–100%. They found the use of antibiotics and hypothermic lavage irrigation statistically significant regarding the protection of the guinea pig and dog from the ravages of late peritonitis. Guinea pig mortality was reduced from 100 to 10 percent and dog mortality from 95 to 40%.

Cohn and Cottar supported the value of operative peritoneal lavage with antibiotic solution. They reduced mortality from 68–20%. This work was done in 1962.
Burns, Henderson and Ferrill (1962) noticed that in peritonitis peritoneal dialysis reduced sepsis. They also reported perforated duodenal ulcers with severe chemical peritonitis which were also relieved by peritoneal dialysis.

The studies by Thal (1965) on the venous effluent from the inflamed pancreas correlated the level of the vasoactive polypeptides with the systemic manifestations of this disease.

Wall (1965) suggested that most of the toxic substances in peritonitis were water soluble and dialyzable and readily removed by lavage. The removal of these substances together with gross post-operative debris and bacteria is the first major benefit of lavage.

Davis (1967) reiterated that cellular destruction in cases of peritonitis results in the release of numerous vasoactive amines which have a profound local and systemic effect.

Hackfanna et al (1970) carried out a study on the use of continuous post-operative peritoneal lavage in the management of diffuse peritonitis. In their study two groups of patients corresponding in age and pathologic condition were studied over a three years period. Each matched group consisted of 25 patients. The first group received conventional management in the form of supportive
fluid and electrolyte therapy, antibiotics, supportive drugs, such as digitalis and laparotomy with definitive surgical management of the precipitating lesion when indicated. A review of 25 patients treated by conventional means revealed a mortality rate of over 50% in addition to a significant morbidity rate. In the second group of 25 patients was managed in essentially the same manner except that at the conclusion of the laparotomy and definitive surgical management, cannulas and drains were inserted, and lavage was instituted.

Their techniques was after removal of gross detritus, the peritoneal cavity was irrigated with 1-4 litres of a balanced salt solution. Through 4 quadrants stab wounds, two infusion cannulas were inserted in the upper quadrants and 2 large sump drains in the lower quadrants. The two upper cannulas were positioned in the recess of the subdiaphragmatic regions. One of the lower drain was positioned in the pelvic region and the other along a paracolic gutter.

Post operative lavage was begun through the upper cannulas with a balanced salt solution containing antibiotics 25 mg of kanamycin and 1 million units of penicillin was placed in alternate litres. The volume of fluid infused varied with the type of inflammation and the amount of the detritus present. In the first 8 hours up to 16 litres of this solution, was used. The lavage was continued until the per fusate returned clear. Serial samples of the solution were
taken at frequent intervals for examination of turbidity, electrolyte, and protein content, colony counts, and culture and sensitivity studies. Apart from peritoneal lavage, conventional principles of post operative management for all these critically ill patients were followed.

The average quantity of solution used during operative procedure was 2 litres. In the first 8 post operative hours an average of 6 litres was used. Lavage was continued for an average of 48 hours and an average of 24 litres was used per patient.

Peritoneography was done to assess the adequacy of perfusion of the peritoneal cavity in 5 patients. 100cc of couray 60 were added to the lavage solution and rapid dispersion was found from the site of infusion in the midum-lical region to all the recesses of the peritoneal cavity.

A comparison was made of the complications in each of the two groups of matched pair of patients. The total number of patients in each group was 25. The average age of the patients in conventionally treated group was 71 years as compared to an average age of 73 years for those receiving post operative lavage. 15 deaths, six intra abdominal abscesses six wound abscesses, and 3 wound disruptions were encountered in the control group as compared to 5 deaths, one intra-abdo- minal abscess, 2 wound abscesses in the latter group. No wound disruptions were found in the latter group. In the
second group 5 patients treated with lavage died from problems unrelated to the lavage.

They summarized that post operated intraperitoneal lavage helps restore homeostasis in patients with peritonitis by performing an efficacious debri- dment, by restoring normal fluid and electrolyte balance, by correcting abnormalities in the acid base state, by removal of vasoactive amines specially in peritonitis associated with severe pancreatic necrosis and finally by helping to prevent severe protein and fat catabolism.

They suggest that a rational approach to the problem of diffuse peritonitis is to eliminate the cause and to utilize operative and early post operative continuous peritoneal lavage with copious quantities of a balanced salt solution containing kanamycin and penicillin.

They found that this technique reduced the mortality rate from severe peritonitis by 40% and the morbidity rate by 50% in a group of 25 patients.

Brown et al (1970) advocated the use of intraperitoneal noxythiolin in faecal peritonitis. Noxythiolin is a simple chemical compound which undergoes slow decomposition and liberates free formaldehyde. It is relatively non toxic when given intraperitoneally to animals and has a high therapeutic rate. When a lethal gram negative peritonitis was induced in guinea pig with proteus and coliform organisms,
intraperitoneal injection of noxythiolin offered a significant protection. In humans with faecal peritonitis the use of noxythiolin intraperitoneally reduces the mortality and morbidity of the condition.

Noxythiolin is chemically oxymethylene methylthiourea and in solution undergoes slow decomposition to liberate free formaldehyde, the reaction being accelerated by the addition of heat.

\[ \text{CH}_3\text{NH}_2 + \text{NH}_2\text{CS} \rightarrow \text{CH}_3\text{NH} - \text{CH}_2\text{CS} \rightarrow \text{CH}_3\text{NH}_2 + \text{HCHO} \]

Since formaldehyde is toxic the solutions must be prepared fresh and are not suitable for autoclaving. Drug is soluble in water, a 3.6% solution being isotonic. The use of this compound was previously limited to surface application and bladder irrigation. It is not suitable for systemic use.

In all cases of severe peritonitis noxythiolin has been used by the author. Those cases in which faecal contamination was present were also included. 23 cases were treated. The routine treatment was to control the causative lesion (in most cases this demanded a proximal colostomy), peritoneal toilet and instillation of 2.5 to 5.0 gms noxythiolin in 100 ml of distilled water into the peritoneal cavity before closing the wounds. Most cases were also given broad spectrum antibiotics and supportive treatment in form of blood transfusion, fluid and electrolytes and cortisone as demanded by
the patient's condition. Only 3 deaths occurred - a mortality of 13%. Two were due to massive pulmonary embolism and after resolution of pulmonary condition, the death was due to multiple residual abscesses. It was thus suggested by the authors that this simple substance noxythiolin is a useful addition in the therapeutic armamentarium in all cases of peritonitis.

Stephen et al (1978) found a mortality of almost 50% from generalised infective peritonitis. A worsened prognosis could be predicted by several factors assessed pre-operatively. The usual cause of death was continuing intra-peritoneal sepsis. This was manifest as multisystem failure in an intensive care environment.

Wakely and Hunter (1977) after a clinical trial recommended the use of operative lavage for peritonitis associated with pancreatic necrosis.

Stephen and Lowenthal (1979) carried out a study on continuing peritoneal lavage in high risk peritonitis.

Twenty-nine patients with peritonitis were selected for lavage over a period from 1975 to 1977. The criteria for selection were either hypotension (blood pressure less than 100 mm Hg) multisystem failure with multiple intra-peritoneal abscesses, the presence of intra-peritoneal fascia or anastomotic breakdown.
All patients were operated upon in an attempt to control the contaminating source. The peritoneal cavity was cleared both mechanically and by repeated saline washing. The first operative lavage contained the same antibiotics as the post operative dialysis fluid. A minimum of 3 large portex drains were inserted in the hepatorenal pouch, the subsplenic area and the pelvic cavity.

After operation patients were treated with parenteral gentamycin, cephalothin sodium and lincomycin. The major benefit was in those patients in whom there was greatest peritoneal contamination. This fits in well with the concept that lavage produces a continual cleansing action of recurring residual debris left after operative washing.

The antibiotic combination was chosen as it was shown to be effective in treating the gram negative, the gram positive and aerobic organisms. The lavage consisted of 1.5% Dianene solution as used for peritoneal dialysis. To each litre was added 3.5 m. mole of potassium chloride, 10 mg of gentamycin, 30 mg of lincomycin and 50 mg of cephalothin. One hour cycles of one litre were used.

For 5 minutes the solution was run in through a blood warmer, retained for 30 minutes and drained out over 25 minutes. Each drain was used exclusively for 6 cycles. The other being temporarily spigoted, progressively using each in clockwise direction. After 72 hours the lavage was ceased.
drains were left in situ for another 24 hours and removed if no significant fluid was issuing.

Of 27 patients treated six deaths occurred. The age of the patients was not significantly different from the same author's study in 1970-75. There was a significant decrease in the mortality rate, which was 21.6% whilst in the previous study the mortality was nearly 50%.

The relationship between cause of peritonitis is highlighted by the striking difference which occurred in those patients with gross intraperitoneal contamination, anastomotic breakdown with widespread spillage, or multiple intraperitoneal abscesses was highly significantly improved using lavage. There was no significant difference in the survival rates in patients with lesser degrees of contamination.

Six lavage treated patients died. Four died from continuing peritoneal contamination due to multiple bowel perforation from ischaemic gut and three cases from an uncontrollable fistula in the other. Two other patients had no peritoneal sepsis at the time of death. No death was attributed to antibiotic toxicity.

The higher rate of survival for those patients treated with continuing lavage compared favourably with those managed conventionally. This occurred exclusively in high risk patients known to have poor prognosis. But they said that the use of peritoneal lavage would not be undertaken lightly. It requires careful monitoring of the fluid balance.