

normal to mildly enlarged spleen compared to patient with CNNA. On the other hand **Yassen et al.**[20], reported that no significant differences as regards, age, sex, abdominal pain, bleeding esophageal varies, serum albumin, bilirubin, ALT, AST, PT were found between both culture positive and negative groups. However, several studies stated that bacterial infection in cirrhotic patients is an important cause of liver function deterioration and development of complications [21,22].

In our study, the most prevalent pathogens were Gram-positive bacteria especially *Staph epidermidis* and *Micrococcus luteus*. Our findings were in agreement with several studies that showed a high frequency of Gram-positive bacterial infections associated with SBP as the study of **Cholongitaset al.**[23], and that was done by **Alexopoulou et al.**[24]. Also, **Fernandez et al.**[12] reported that Gram-positive bacterial infections were more frequently in the hospitals than Gram-negative infections (55.6% vs 36.0%, respectively) and this finding was in agreement with our study as our patients were all from the admitted patients in our department. On the other hand, many studies as those done by **Nguyen et al.**[15], and **Bibi et al.**[25], Gram negative bacteria were more prevalent especially *E.coli*.

Kim et al.[17] found 64.9% of the patients were infected with Gram-negative infections and 35.1% with Gram-positive infections. *Escherichia coli* was the most common isolate (32.5%), followed by *Klebsiella pneumonia* (19.5%) and for patients with Gram-positive bacterial infections, *Enterococcus* species and *Staphylococcus aureus* were the most common isolates (13.0%), these findings were opposite to our findings where 76.4% of our culture positive samples were caused by Gram-positive bacterial infections while only 23.5% of these positive samples were caused by Gram-negative infections. Our results were similar to previous studies in which the commonest strain of Gram-negative bacteria among patients infected with Gram-negative organisms was *E.coli*.

The predominance of Gram-positive bacteria in our study and in previous studies may be explained by the fact that patients with cirrhosis frequently require hospital care, recurrent hospitalizations or hospitalizations in intensive care units [26].

As regards to the antibiotic resistance profile of Gram positive bacteria isolated in our

study, we found that the rate of MDR in *Micrococcus luteus* among all isolated Gram-positive bacteria was 22.2% but it was 100% sensitive to each quinolone, vancomycin, tetracyclin and tigecyclin. While among isolated *Dermaococcus* 11.1% were MDR, but still 100% sensitive for each linezolid, tetracycline, tigecyclin and nitrofurantoin. *Kocuriarosea* were XDR with a ratio of 11.1% but still 100% sensitive to both gentamycin and linezolid.

The rate of MDR among *Enterococcus faecalis* and *faecium* were 7.4% and 14.8% respectively, but they had 100% sensitivity to tigecyclin, rifampicin and trimethoprim sulfamethoxazole. These results are different from **Zhang et al.** [27] who found MDR rates was 0.0% , 71.4% in *Enterococcus faecalis* and *faecium* respectively with 100% susceptibility to linezolid but it was similar to us in 100% sensitivity to tigecyclin.

In our study, *Staphylococci* were 100% resistant to oxacillin, 100% vancomycin resistance in *staph lentus* but 33.3% of *Staph epidermidis* still sensitive to vancomycin. These findings are different from **Zhang et al.**[27] who found 0% resistance to vancomycin. *Staphylococci* in our study were 100% sensitive for each gentamycin, quinolone and Trimethoprim sulfamethoxazole which represent suitable lines for prophylaxis and treatment. Our results were in agreement with others who found the prevalence of infections caused by multiresistant bacteria (e.g., methicillin-resistant *S. aureus* and *Enterococcus faecium*) is increasing in cirrhotic patients [11].

As regards antibiotic profile of Gram-negative bacteria *E.coli* and *pandorecaea* spp. were resistant to all tested antibiotics, In contrast to **Oliveira et al.**[28] who found that 19% of *E. coli* are (MDR), in our study quinolone resistance was 100% in Gram-negative dissimilar to **Zhang et al.**[27] who found 41.5% only quinolone resistance.

When we studied the clinical characteristics of the patients and their relation to the type of bacteria (Gram-positive and Gram-negative), patients with Gram-negative bacteria had statistically higher polymorphonuclear leucocyte count and prothrombin concentration. Patients with Gram-positive bacteria had statistically significant higher level of ascitic lymphocytes, total bilirubin, direct bilirubin, prothrombin time, and serum creatinine, and had statistically significant lower level of albumin and hemoglobin, [27] mentioned that, patients infected with GNB had worse liver

function, higher MELD score, higher inflammatory index, and a higher risk of progressing to ACLF (acute or chronic liver failure). These results suggest that more attention should be paid to patients infected with GNB.

In our study, the association of high total bilirubin, high serum creatinine, and SBP with Gram-positive bacteria is a strong predictor of mortality during hospitalization and this is in agreement with **Coral et al.** [29] who found the mortality rate in SBP infected patients with or without renal impairment was 36% and 6% respectively. Also, **Sort et al.** [30], **Salerno et al.** [31-32]. Found plasma volume expansion with intravenous albumin decreases renal impairment and mortality in patients with cirrhosis and SBP more than use of antibiotic therapy alone.

In this study, there is a significant difference in ascitic protein, ascitic cell count, hemoglobin, liver coarseness and spleen size between first and recurrent peritonitis. Hemoglobin is decreased in patients with first SBP while ascitic cell count and proteins are decreased in recurrent peritonitis. Also, liver coarseness and change in spleen size were more prominent in first SBP.

Limitations of this study

First, the patients included in this study were from a single hospital in Sohag University. Therefore, the results might not be applicable to different hospitals. Second, we detected organisms out of the usual microbiological profile of species: *g. Dermacoccus nishinomiyaensis*, *Kocuriarosea* and *Pandoraea* spp. These organisms are found on the normal skin as commensals and are unusual causes of peritonitis. To be accurate that they are the cause, another 10 ml of ascitic fluid should be aspirated and cultured, if revealed the same organism it is surely the cause, but that could not be possible as we cultured the organism on the media and pure colonies were preserved in -80 °C for further identification by VITEK II. Third, this study did not include patients with culture positive ascitic fluid with (PMN) count less than 250/mm³ and in clinical practice; patients with this condition are occasionally treated with antibiotics.

Conclusion

Spontaneous bacterial peritonitis is a serious problem in cirrhotic patients with increased morbidity and mortality. Screening the causative organism periodically is very important to both identify the cause and to select the proper antibiotic

for prophylaxis and treatment. Also, infections caused by MDR and XDR bacteria should be a current concern, and new antibiotic strategies are needed for this special population. Individualized antibiotic treatment based on local epidemiology is the key for success, not neglecting the urge to preserve renal function of these complex patients.

Recommendations

Antibiotic prophylaxis and treatment therapy should be adjusted according to the results of culture and sensitivity of the isolated organisms. Future studies including a direct comparison with another well-validated molecular method of bacterial DNA detection and identification, as well as standard microbiological culture diagnostics are recommended. Further studies conducted in larger patient populations involving multiple hospitals will be necessary.

Conflict of interest

The authors declared no conflict of interest.

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