Determinants of mortality and impact of therapy in patients with leptospirosis admitted for intensive care in a Sri Lankan hospital – a three year retrospective study

P. N. Weeratunga¹, S. Fernando², S. Sriharan³, M. Gunawardena⁴,
S. Wijenayake⁴

¹University Medical Unit, National Hospital of Sri Lanka, Colombo, Sri Lanka, ²Cardiology Unit, Teaching Hospital Karapitiya, Galle, Sri Lanka, ³Faculty of Medicine, Tropical Medicine Research Unit, University of Colombo, Colombo, Sri Lanka, ⁴Department of Anaesthesiology, General Hospital Kalutara, Kalutara, Sri Lanka

Introduction: Leptospirosis is a disease of epidemic proportions in Sri Lanka. There is paucity of data on the determinants of mortality and impact of therapy in patients with leptospirosis admitted to critical care settings in endemic territories.

Methodology: This retrospective cross-sectional study was performed in patients with serologically confirmed leptospirosis admitted to the intensive care unit of the General Hospital, Kalutara from January 2011 to April 2014. Associations between socio-epidemiological, clinical and laboratory parameters and patient mortality were examined.

Results: Forty-five patients were included. The mean age was 49.11 (SD = 16.95) and majority (92%) were male. Percentage mortality was 44.4%. Patient mortality was associated with age > 40 ($p = 0.012$), symptoms of uremia ($p = 0.017$), evidence of CNS involvement ($p = 0.039$), presence of oliguria ($p = 0.002$) and anuria ($p = 0.014$), presence of multi-organ dysfunction syndrome (MODS) ($p < 0.001$), CRP > 96 ($p = 0.036$), platelet count < 20,000 ($p = 0.045$), Potassium > 5.0 ($p = 0.05$), metabolic acidosis with pH < 7.2 ($p = 0.03$), INR > 2 ($p = 0.037$) and requirement of mechanical ventilation ($p < 0.001$). Cox regression analysis revealed MODS and potassium > 5 to be independently associated with mortality.

Conclusions: A high mortality rate is noted. The presence of MODS and serum potassium concentration > 5.0 was independently associated with mortality in this retrospective study of patients with confirmed leptospirosis in a critical care setting.

Keywords: Leptospirosis, Intensive care, Mortality

Introduction

Leptospirosis is a disease of epidemic proportions in the Sri Lankan context with an annual reported incidence of 14/100000 cases.¹ The epidemiological trends of the disease demonstrate an increasing incidence over time.¹ Leptospirosis is considered as a re-emerging disease in a Sri Lankan context and there was reported substantial increase in reported incidence with 35.7/100000 cases in 2008 associated with outbreaks related to flooding. Furthermore, documented cases have been found in 9 out of 25 districts covering large areas of central, west and south of Sri Lanka. The case fatality rate is considered to be 2.8% of the disease,² though it is possible to be higher than reported.

Leptospirosis is a biphasic illness occurring as a biphasic illness with an initial bacteremic phase followed by an immune phase. The initial phase is characterized by fever, generalized myalgia, abdominal pain and conjunctival suffusion lasting for 3–8 days. It is followed by the immune phase, usually in the second week, with patients having recurring fevers, myalgia, aseptic meningitis, rash or uveitis and may last for as long as 30 days.³ Although majority of infections of leptospirosis are clinically asymptomatic, it has potential to evolve into a life-threatening illness with complications such as acute kidney injury (AKI), coagulopathy, disseminated intravascular coagulation, myocarditis, acute respiratory distress syndrome (ARDS) ultimately culminating in multi-organ dysfunction syndrome and resulting in considerable morbidity and mortality.⁴

Correspondence to: Praveen Weeratunga, University Medical Unit, National Hospital of Sri Lanka, No. 4/1, High Street, Walana, Panadura, Sri Lanka, Email: prav782@yahoo.com

Severe manifestations of leptospirosis are known to occur in 5–15% of those affected.⁵ It occurs primarily as two distinct syndromes. Weil's syndrome, a triad of jaundice, haemorrhage and acute renal failure, which has a case fatality rate of 15%. Severe pulmonary haemorrhage syndrome (SPHS), which may present as acute respiratory distress and has a mortality rate of around 50%.^{6–8} Many investigators have emphasized the importance of intensive care and admission to the ICU as a life-saving measure in severe leptospirosis.^{9,10} Delay in admittance to the ICU has been linked to mortality.¹¹

Leptospirosis in intensive care settings

Reported mortality rates of patients admitted to the ICU with leptospirosis is varied. Previous studies performed in Sri Lanka, conducted in ICUs found a significantly high mortality rates of 65%¹² It was also demonstrated that mortality rate increased with higher number of system involvement. Renal involvement, hypotension and pulmonary involvement were noted to be the most frequent complications with central nervous system involvement associated with a poor overall prognosis. The study was done presumptive cases of leptospirosis including those included on clinical suspicion, hence definitive conclusions cannot be drawn.¹³ Chawla *et al.*⁹ also described a high mortality of 52% in a single unit in India. European experience on dealing with leptospirosis in the ICU revealed a mortality rate of 16.7%¹⁴ and yet a case series of 15 cases from New Zealand had a zero mortality rate.¹⁰ It can be argued that ICU mortality rates are varied depending on the presentation of the patient, severity of the disease and availability of facilities.

Admission to ICU is predominantly of males in the forties.^{9,10} High number admission to the ICU was linked with monsoon seasons due to epidemics of the disease in an Indian population.¹¹ Increased liver enzymes, renal failure, thrombocytopenia and ARDS were the main complications seen in this group of patients¹¹ The usual clinical manifestation of fever, jaundice, sub-conjunctival haemorrhages and altered sensorium⁹ was seen in a similar cohort from India. Renal failure and hypotension were common reasons for seeking ICU admission in prior investigations.¹⁰ Mechanical ventilation, vasoactive support and haemodialysis was required in most patients who developed complications.^{9–11} A high proportion of patients (76.67%) suffered from MODs in one such study.⁹ Patients presenting late to the ICU were also shown to have a higher mortality and delayed treatment with antibiotics was associated with development of MODs.¹¹

Factors associated with mortality

Even though data exclusive to critical care settings are sparse other studies have highlighted a multitude of factors to be associated with mortality. Advanced age was found to be associated with mortality by Chawla *et al.*⁹ and Spichler *et al.*¹⁵ Chawla *et al.* in the same study also

found chronic alcoholism⁹ to be associated with the same. Although male sex has been found to be associated with mortality by Chawla *et al.*⁹, other studies have challenged such assumption. Pulmonary involvement has been found to be consistently associated with mortality in multiple studies conducted. Perusitat,¹⁶ Budiono¹⁷ and Dupont¹⁸ report that radiographical evidence of pulmonary involvement was associated with mortality. Budiono¹⁷ found that pulmonary involvement was the strongest risk factor associated with mortality. Multiple studies have demonstrated association of pulmonary complications with mortality.^{19–22}

Degree of renal involvement and the association to mortality has been documented in the past.²³ Similarly multiple studies have concluded development of oliguria to be prognostic factor in mortality.^{15,24} Furthermore, significant association has been shown between established renal failure and death,^{19,25} altered mental status,²⁵ multi-organ dysfunction syndrome (MODS)^{9,21} and altered aminotransferase alanine transaminase ratio,²⁶ delayed antibiotic therapy,²⁶ platelet count⁹ less 70,000/ μ l and leukocytosis¹⁸ have all been demonstrated to be associated with mortality by various studies.

Despite the fact that multiple potential indicators of mortality have been described in the literature, there is extensive variation between studies. This may be explained in part by variations in sample size, selection criteria and differences in disease severity. However, it is also possible that differing management options and facilities, characteristics of organ involvement and characteristics of the organism may play a role.

Even though Sri Lanka is regarded to be a high prevalence area for leptospirosis, there is a dire paucity on research into mortality predictors and patients admitted to critical care settings. Research in this area is important as it may identify unique predictors in Sri Lankan patients with leptospirosis.

Materials and Methods

Study population and selection of participants

The study was performed utilizing a descriptive cross-sectional design. All patients with suspected leptospirosis according to the World Health Organization (WHO) surveillance criteria admitted to the intensive care unit of the General Hospital, Kalutara, Sri Lanka encompassing a three year period from 2011 and 2014 were included. A suspected case of leptospirosis was defined based on the World Health Organization surveillance criteria (acute febrile illness with headache, myalgia and prostration, with any of the following – conjunctival suffusion, jaundice, oliguria/haematuria, cardiac arrhythmia or failure, cough, haemoptysis and breathlessness, bleeding, features of meningeal irritation, skin rash and history of exposure to potentially contaminated water or soil). This hospital is responsible for the management of a large burden of clinical cases of leptospirosis in Sri Lanka as evidenced

by a total number of 1250 cases of leptospirosis during the selected study period.

The diagnosis of leptospirosis was qualified based on fulfilment of the following criteria.²⁷ MAT was the reference standard test for diagnosis of leptospirosis in Sri Lanka, at the time of the study, and was performed only at the Leptospirosis Reference Laboratory, Medical Research Institute, Colombo. The MAT used detected both agglutinating IgM and IgG antibodies against *L. biflexa* serovar Patoc strain Patoc I.

A MAT titre of 400 or greater in single or paired samples or a fourfold increase in MAT titre between acute and convalescent serum sample was defined as a positive MAT. It is important to highlight that even though this study is limited based on limited MAT, a locally optimized panel of serovars for MAT was not available during the three years encompassing the study. A recent study by our group shows MAT for the patoc serovar > 400 in the acute phase to have high specificity (95.7%) for the diagnosis of leptospirosis.

The above inclusion criteria are based on retrospective data based on documentation in clinical records and through perusal of relevant investigations. Accuracy was ensured based on a standard case definition checklist at the point of ICU admission which was in place before the study period.

Data collection

The clinical records of patients fulfilling the above entry criteria were obtained from unit medical records. Data were extracted using a customized data entry tool. Variables regarding sociodemographic data, clinical presentations and temporal clinical progression of the illness, extent of organ involvement, temporal progression of clinical parameters and investigations including – full blood count, serum creatinine, blood urea, serum electrolytes, coagulation profile, blood picture, CRP and arterial blood gas, management used including antibiotic therapy and organ support – inotropes, mechanical ventilation and renal replacement therapy were extracted for further analysis. All data were extracted from the point of initial medical care observations and followed up throughout the hospital and ICU stay until the endpoints of death or discharge.

Definitions of organ dysfunction

AKI was defined as increase in serum creatinine > 0.3 mg/dl over 48 h or increase in serum creatinine > 1.5 times baseline within the last 7 days, or a decrease in urine output < 0.5 ml/kg/hr for > 6 consecutive hours. Pulmonary involvement was defined as the presence of frank blood in the sputum or endotracheal tube and unilateral or bilateral alveolar infiltration with normal cardiothoracic ratio on chest radiograph, or features of ARDS. Congestive heart failure was defined by the presence of two or more of the following characteristics: clinical signs of left-side

ventricular dysfunction (jugular venous pulsation of > 6 cm above the sternal angle, pulmonary rales and hepatic pulsation or third heart sound [S3] galloping), central venous pressure of > 15 cm (if indicated to perform central venous pressure monitoring), chest radiograph showing features of cardiac failure and increased cardiothoracic ratio and echocardiographic evidence of cardiac dysfunction. Acute liver injury was defined as evidence of hepatic encephalopathy and impaired synthetic function (prothrombin time-international normalized ratio ≥ 1.5) in a patient without cirrhosis or pre-existing liver disease. Shock was defined as systolic blood pressure < 90 mm Hg or mean arterial pressure < 70 mm Hg or requirement of vasopressors.

MODS was defined as a clinical syndrome characterized by the development of progressive and potentially reversible physiologic dysfunction in two or more organs or organ systems that is induced by a variety of acute insults, including sepsis

Procedure for statistical analysis

Descriptive data were described using measures of central tendency and dispersion. Association between epidemiological characteristics, clinical manifestations, laboratory features and disease severity/mortality were examined with chi square testing. Non-parametric data were analysed using relevant statistical methods where applicable. Logistic regression models for outcome were generated using the findings of the above univariate associations and adjusted odds ratios were calculated for mortality outcomes. Cox regression modelling and hazard ratios were utilized for expression of mortality. $p < 0.05$ will be selected as the cut-off level for statistical significance. All data entry and analysis was performed using SPSS version 18.

Ethical considerations

All data were extracted from existing data sources. Anonymity of data was ensured at all stages. Ethical approval for the study was obtained from the ethics review committee of the National Institute of Health Sciences, Kalutara, Sri Lanka

Results

Forty-five patients were included encompassing the study period extending from 2011 to 2014. The mean age of the study population was 49.11 (SD = 16.95) and 41 individuals (91.1%) were male. The mean duration of hospital stay was 17 days (SD = 4.5). Fourteen (31.1%) were paddy farmers by profession. Seasonal clustering was noted with 40 cases (88.9%) reported from September to February of each year from 2011 to 2014. Clinical presentations of the study population on presentation are given in Table 1. Fever, 44(97.8%), headache, 35(77.8%), arthralgia, 33 (73.3%) and myalgia, 44(97.8%) were common presentations. Six patients (13.3%) demonstrated central nervous

system manifestations including meningism and encephalopathy. Hepatomegaly and evidence of pulmonary edema were noted in the clinical examination in 29 (64.4%) and 42 (93.3%) patients, respectively. The patterns of organ involvement are summarized in Table 2.

The most common indication for admission to intensive care was with hypotension requiring inotropic support [40 (88.9%)]. Five patients were admitted for mechanical ventilation with two patients with evidence of ARDS and three patients with refractory pulmonary edema.

Cardiac failure secondary to myocarditis was the commonest organ complication. The diagnosis of myocarditis was qualified based on diffuse ST/T segment abnormalities and evidence of global cardiac dysfunction on echocardiography. MODS was also noted in 21 patients (46.7%). The combination of AKI and ARDS was also observed in 17 patients (37.8%). A total of 55.6% patients developed

AKI in isolation or as part of a spectrum of organ dysfunction shock with requirement of inotropes was noted in 42 (93.3%) patients. The percentage mortality for this cohort is noted at 44.4%.

Laboratory features of the study population on presentation to the intensive care unit are presented in Table 3.

Neutrophil leukocytosis and thrombocytopenia were noted in 42 (93.3%). Chest x-ray infiltrates were seen in 39 (86.7%). Mean CRP was 134.2 (SD = 93.4). Mean maximum serum creatinine was 3.9 mg/dL (SD = 2.1). Significant acidosis with a pH < 7.2 was noted in 34 (75.6%) patients.

Univariate analysis was performed with respect to mortality outcomes. The results are presented in Table 4 with absolute numbers presented with percentages demonstrated within brackets.

Table 1 Clinical features in the study sample

Clinical feature	Frequency (N)	Percentage
Fever	44	97.8%
Headache	35	77.8%
Arthralgia	33	73.3%
Myalgia	44	97.8%
Presence of neck stiffness/evidence of encephalopathy	6	13.3%
Bleeding manifestations	10	22.2%
Uremia	38	84.4%
Hepatomegaly	29	64.4%
Pulmonary oedema	42	93.3%

Table 2 Organ involvement

Organ involvement	Frequency (N)	Percentage
Cardiac failure	37	82.2%
Acute kidney injury	4	8.9%
ARDS	1	2.2%
Shock with requirement of inotropes	42	93.3%
ALI and ARDS	2	4.4%
AKI and ARDS	17	37.8%
MODS	21	46.7%
Coagulopathy and DIC	10	22.2%

Table 3 Descriptive data of laboratory parameters (average)

Parameter	Mean (+/- SD)
Full blood count	
White cell count	14,040 (+/- 4896)
Neutrophil leukocytosis	80.2 (+/- 5.6)
Platelet count	47,930 (+/- 15,000)
Haemoglobin concentration	10.46 (+/- 2.04)
Serum creatinine	3.9 (+/- 2.1)
Blood urea	135 (+/- 85.54)
Serum electrolytes	
Sodium	138.54 (+/- 6.32)
Potassium	4.38 (+/- 0.71)
Liver function tests	
AST	125 (+/- 30.3)
ALT	110 (+/- 34)
Serum bilirubin	80 (+/- 3.46)
PT/INR	1.7 (+/- 0.854)
CRP	134.3 (+/- 92.4)
Arterial blood gas	
pH	7.224 (+/- 0.332)
PO ₂	96 (+/- 49.82)
PCO ₂	37.81 (+/- 11.24)
Bicarbonate	16 (+/- 4.92)

Table 4 Univariate associations of mortality (in percentages)

	Group 1 – deaths%	Group 2 – Survival%	P value
Age > 40	90	56	0.012*
Symptoms of uremia	70	96	0.254
CNS involvement	35	28	0.039*
Icterus	60	50	0.854
Oliguria	95	52	0.002*
Anuria	50	16	0.014*
MODS	80	20	0.000*
CRP > 96	65	20	0.025*
White cell count > 12,000	30	40	0.486
Platelet count < 20,000	15	12	0.786
Acidosis (pH < 7.2)	40	12	0.030*
Potassium > 5.0	15	12	0.045*
Serum creatinine > 2	42.1	40	0.952
Blood urea > 90	36.8	56	0.208
INR > 2	15.8	1	0.040*
AST > 150	22	25	0.582
Bilirubin > 90	30	28	0.582
Requirement of mechanical ventilation	95	36	0.000*

* $p < 0.05$ **Table 5 Descriptive data on therapeutics**

Antibiotic therapy		
Penicillin alone	2	4.4
Cephalosporin	16	35.6
Penicillin and Cephalosporin	25	55.6
Doxycycline	1	2.2
Penicillin and other	1	2.2
Renal replacement therapy	6	13.3
peritoneal dialysis		
Haemodialysis/haemofiltration	0	0.0
Mechanical ventilation	29	64.4

As noted in the above table, CNS involvement, oliguria, anuria, MODS, CRP > 96, acidosis with a pH < 7.2, potassium > 5.0, INR > 2 and requirement of mechanical ventilation were significantly associated with a mortality outcome on univariate analysis at a p value of < 0.05.

Covariates independently associated with the outcome of death was examined with Cox regression modelling with an analysis of data with the included time period for analysis encompassing the complete hospital stay, including intensive care up to an end point of death or discharge. Cox regression analysis was performed with inclusion of variables with a p value of < 0.2 on univariate analysis, namely age > 40, oliguria/anuria, presence of CNS involvement, elevated CRP > 96, platelets < 20,000, pH < 7.2, PT/INR > 2, MODS, potassium concentration > 5.0 and requirement of mechanical ventilation as independent variables. Presence of MODS (adjusted hazard ratio = 4.457; $p = 0.024$, 95% CI = 1.042–27.571) and potassium concentration > 5 adjusted hazard ratio = 10.350; $p = 0.026$, 95% CI = 1.614–45.574) were independently associated with mortality in this cohort. The likelihood ratio in the above model was noted at 24.56 with a statistical significance of 0.034.

The treatment modalities instituted in the study population are presented in Table 5. It is notable that 25 (55.56%) patients received combination therapy with benzyl penicillin and a third-generation cephalosporin and 16 patients

(35.56%) were treated with a combination of a penicillin and cephalosporin. Mechanical ventilation was required in 29 (64.4%) patients. Six patients underwent peritoneal dialysis.

There was no significant difference noted with proportions of survival in patients receiving penicillin monotherapy compared with combination therapy with penicillin and cephalosporin ($p = 0.456$) on chi square analysis.

Discussion

The findings of this study give insight into the demographic, clinical, mortality associations and outcome of patients with confirmed leptospirosis requiring intensive care in a region of high prevalence.

The epidemiological surveillance unit of Sri Lanka reports a total number of 1310 reported cases of confirmed leptospirosis from the district of Kalutara during the above study period, making it a major prevalence region for leptospirosis within Sri Lanka. The indoor hospital records at the general hospital Kalutara show a total number of 1250 cases of confirmed leptospirosis during the above period of which 45 were admitted for intensive care. It is notable that the percentage of patients requiring critical care is 3.6% at this unit.

Mortality rates in leptospirosis vary in different studies. Previous studies have shown that mortality rates associated with severe disease, especially those requiring

mechanical ventilation, to be unacceptably high as 55%.²⁸ In a study from Brazil by Vieira *et al.*²⁹ where all 35 patients presented with ARF required mechanical ventilation and developed multi-organ failure, mortality was 51%. In another study from India,⁹ all 60 leptospirosis patients who were admitted to the ICU had evidence of severe sepsis, 46 of 60 had multiple organ dysfunction and reported mortality was 52%. The mortality rate of these critical care admissions (44.4%) falls within these ranges, given the fact that a significant percentage developed MODS(46.7%) and ARDS(44.4%).

This is higher than the previously reported 16.7% in case series from Europe¹⁴ and 3.8%(in seropositive group) by Ittyachen *et al.*¹¹ Consequently, the percentage suffering from ARDS was notably lower in their cohort as opposed to ours (12.8% vs 44.4%). In a Sri Lankan context, as previously mentioned a study done in ICU did reveal significantly higher mortality rate(65%) with regard to probable leptospirosis.¹²

It is important to delineate the causes for the above variation. It is possible that genetic and virulence or serotype related factors may contribute towards high mortality noted in both studies from Sri Lanka in comparison with similar studies from Asian, South American and European series. The *L. interrogans* serovars Icterohaemorrhagiae, Canicola and Australis have been linked to severity and multi-organ failure^{6,30} in prior studies, but other studies did not confirm any link between serovar and outcome.^{9,18,33} In a study carried out by Everard *et al.*,³⁴ *L.interrogans* serovar icterohaemorrhagiae was clearly linked to severity in patients with leptospirosis.

This requires further investigation. It is also possible that delays from diagnosis to admission to a critical care service due limited ICU services in a Sri Lankan health care context may also contribute to mortality. The variation in case mix and severity profiles should also be taken into account.

The presence of AKI was high among our cohort of patients (55.56%) and noted to be associated with ARDS as well. It is important to note that none of the patients in our series underwent haemodialysis/filtration due to the lack of access to facilities and only underwent peritoneal dialysis. Consequently, it had been shown that mortality in patients treated with peritoneal dialysis to be higher than those treated with haemofiltration.³⁵ Furthermore, the resolution of acidosis and decline in serum creatinine was much faster in patients treated haemofiltration. It is therefore possible that this may have contributed towards the high noted mortality in our case series. It has been recommended to undergo haemodialysis earlier³⁶ in the disease and on a daily basis,³⁷ as it was found to improve mortality.

It is believed that myocardial involvement is underestimated in studies.²⁴ Myocarditis causing cardiac failure was the commonest organ involvement in this study population. Myocardial involvement in leptospirosis notably

carries a poor prognosis³⁸ as it precedes the development of severe disease. It has a mortality rate of 56% reported in previous case series.³⁹ It is possible that there is preferential myocardial involvement in certain pathogenic serovars is more prominent than others. However, further analysis was not possible as extended serovar testing was not available in this study

Age > 40 was associated with mortality in this series of patients. This is consistent with previous findings.²⁵ CNS involvement in leptospirosis is also noted to be associated with mortality in the above series, consistent with previous findings as well.²⁵ CRP > 96 was noted to be associated with mortality in this group of patients. The association of CRP with mortality in patients with leptospirosis has not been consistently demonstrated in previous studies. Wagenaar *et al.* report that the CRP was not associated with mortality in patients with leptospirosis but propose long pentraxin PTX3 as a mortality indicator.⁴⁰ In contrast to PTX3, CRP is readily available as an investigation in clinical settings. Further examination of the role of CRP in risk stratification and mortality estimation is required.

We did not demonstrate any associations with the full blood count parameters and mortality. This is contrary to findings by Dupont *et al.*¹⁸ and Spichler *et al.*¹⁵

It is important to note that the renal parameters serum creatinine > 2 and blood urea were not associated with mortality. However, oliguria and anuria were associated with mortality outcomes. Furthermore, potassium > 5 was independently associated with mortality. These findings are consistent with previous findings^{41–43} and reaffirms the fact that life-threatening significant renal damage is reflected by the urine output and potassium values.

Coagulopathy with PT/INR > 2 was associated with mortality on univariate analysis.⁴⁴ Bleeding diathesis in leptospirosis has previously been associated with mortality. It has been previously demonstrated that the coagulation system is strongly activated in leptospirosis and this change more evident in the deceased and patients with severe bleeding as opposed to survivors and those without severe bleeding.⁴⁵

The findings of this study indicate no mortality difference between penicillin, cephalosporin and combination therapy in an intensive care setting. This fact has significant implications even though based on retrospective data. It is notable that the antibiotic choice or duration was not associated with survival in this series of patients. It is important to therefore explore other alternative therapeutic options in comparison to the currently recommended antibiotic regimens.

Though mechanical ventilation has been the preferred treatment modality in ARDS,⁴⁶ its use in leptospirosis has been met with mixed results. A case series revealed 100% mortality despite being treated with mechanical ventilation in leptospirosis.⁴⁷ A subgroup analysis using the data of this study does not have adequate statistical power to make firm recommendations. Yet methyl prednisolone

and non-invasive ventilation have been demonstrated to improve mortality, especially in the low-resource setting.⁴⁸ Hence these findings should be taken into consideration along with causes of death in such cohorts of patients. More extensive studies should be done on this regard and novel therapeutic options should be investigated as well. We could not examine the role of RRT/haemofiltration on overall outcome due to lack of availability but it was evident that peritoneal dialysis was not associated with significantly improved mortality.

Limitations of this study include a low sample size. However, on the contrary, the total time duration under investigation was 3 years. Furthermore, it is retrospective data which were examined. Prospective data are required to make stronger recommendations. The diagnosis of leptospirosis made on patoc serovar MAT is also limited and may underestimate the burden of the disease in the analysed population and further investigations with a locally optimized panel of MAT is currently being performed.

Outcome and recommendations

The presence of MODS and serum potassium concentration > 5.0 was independently associated with mortality in this retrospective study of patients with confirmed leptospirosis in a critical care setting. Lack of access to dialysis/haemofiltration in resource-limited settings such as Sri Lanka creates restraints to optimum care through renal replacement therapy despite patients being treated in intensive care settings and may contribute towards high mortality.

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