Dr. Sulaiman Al Habib Medical Journal
Vol. **1**(**3-4**); December (2019), *pp.* 88–94
DOI: https://doi.org/10.2991/dsahmj.k.191004.001; eISSN 2590-3349
https://www.atlantis-press.com/journals/dsahmj

Research Article

Outcomes of Guillain–Barré Syndrome Patients Admitted to Intensive Care Unit in Tertiary Care Hospital

Muhammad Ijaz[1], Faheemullah Khan[2,*], Muhammad Jaffar Khan[3], Asadullah Khan[4], Wiqar Ahmad[5], Iftikhar Ali[6]

[1]*Department of Medicine, Gajju Khan Medical College, Swabi, Khyber Pakhtunkhwa, Pakistan*
[2]*Department of Medicine, Hayatabad Medical Complex, Peshawar, Khyber Pakhtunkhwa, Pakistan*
[3]*Institute of Basic Medical Sciences, Khyber Medical University Peshawar, Khyber Pakhtunkhwa, Pakistan*
[4]*Department of General Surgery, Khyber Teaching Hospital, Peshawar, Khyber Pakhtunkhwa, Pakistan*
[5]*Department of Medicine, Northwest General hospital and Research Centre, Peshawar, Khyber Pakhtunkhwa, Pakistan*
[6]*Pharmacy Unit, Paraplegic Centre, Hayatabad, Peshawar, Khyber Pakhtunkhwa, Pakistan*

ARTICLE INFO

Article History

Received 03 July 2019
Accepted 30 September 2019

Keywords

Guillain–Barré syndrome
mortality
plasmapheresis

ABSTRACT

Despite the availability of plasmapheresis and intravenous immunoglobulin, the mortality and long-term morbidity from Guillain–Barré Syndrome (GBS) remains significant. This study aimed to determine the short-term outcomes in patients with GBS admitted to an intensive care unit. A total of 27 patients with a mean age of 31.67 ± 15.88 years were prospectively followed for 4 weeks after admission. Overall muscle power was graded using Medical Research Council (MRC) score 0–5, GBS disability was graded according to the Hughes scale, and tendon reflexes and features of dysautonomia were also noted. Plasma and cerebrospinal fluid biochemical parameters were analysed. Plasmapheresis sessions were done in all except one patient. Seven patients (26%) who died during follow-up showed a significantly higher proportion of dysautonomia features compared to those who survived. However, muscle power and plasma and cerebrospinal fluid biochemical features were similar between the two groups. Increasing age was associated with poor outcome [Unadjusted odds ratio (OR) 0.9270, 95% confidence interval (CI) 0.8598–0.9995, $p = 0.027$]. Plasmapheresis had no impact on the improvement of overall MRC score. Platelet count reduced significantly with plasmapheresis sessions ($p = 0.014$). Survival rate of patients decreased with prolonged preceding illness, hospital stay, and duration of mechanical ventilation >10 days. Only three patients were capable of independent survival at the end of 4 weeks' follow-up. Plasmapheresis-only treatment does not improve overall MRC score in the short term in patients presenting with low MRC score.

1. INTRODUCTION

Guillain–Barré Syndrome (GBS) is an immune-mediated acute inflammatory demyelinating polyneuropathy. It is the most common acute flaccid paralysis disorder manifesting as ascending motor weakness [1,2]. Worldwide reported incidence is one or two cases per 100,000, with a male preponderance [3]. In most but not all cases, onset of GBS is associated with preceding viral (cytomegalovirus or Epstein–Barr virus) or bacterial (*Campylobacter jejuni* or *Mycoplasma pneumoniae*) infections [4]. Among the known electrophysiological variants, acute motor axonal neuropathy is commonly reported in Asian countries [5–7] including Pakistan [8].

Various clinical, aetiological, electrophysiological, and immunological factors contribute to the prognosis of GBS both in adult [9] and paediatric [10] populations. Despite improvement in treatment, the mortality and long-term morbidity from GBS remain significant and have not changed in the past decade [11]. Among the known long-term predictors of poor prognosis, the most common include old age, previous diarrhoea, disability and weakness at admission, short interval between onset of symptoms and admission, mechanical ventilation, and absent or weak compound muscle action potentials [12].

Predictors of short-term outcome in GBS vary; some authors reporting absence of previous infections and lower Medical Research Council (MRC) score at presentation as predictors of poor prognosis in mechanically ventilated patients [13]; while others reporting old age and lower MRC score at nadir as risk factors for poor short-term prognosis [9]. However, this was studied in patients requiring mechanical ventilation [13] or in elderly age groups with severe GBS [9]. Other studies involved a cohort of patients whose mean MRC score was >30 and hence carried a better chance of resuming optimal muscle power over the treatment period [14]. Studies looking at the short-term outcome of disease with lower MRC score and its impact on mortality are therefore needed. Plasma exchange is generally offered in five sessions [15]. Whether plasmapheresis in patients presenting with lower mean MRC score improves overall muscle power is not known. Furthermore, the

*Corresponding author. Email: islamianfellow@hotmail.com
Data availability statement: The datasets generated and/or analyzed during the current study are not publicly available due to patient privacy but are available from the Corresponding author on reasonable request.
Peer review under responsibility of the Dr. Sulaiman Al Habib Medical Services Group Company

effect of lower MRC score at presentation, duration of mechanical ventilation, duration of hospital stay, and number of plasmapheresis sessions on mortality in the short term needs to be investigated. This study was aimed at determining the short-term outcomes in patients with GBS admitted to an intensive care unit of Khyber Teaching Hospital, Peshawar Pakistan.

2. MATERIALS AND METHODS

A prospective longitudinal study was conducted between January and December 2015 in the Intensive Care Unit, Khyber Teaching Hospital, Peshawar, Pakistan. Twenty-seven patients with GBS, age >15 years were recruited. National Institute of Neurological Communicative Disorders and Stroke (NINCDS) criteria were used to diagnose GBS [16]. Patients with hypo or hyperkalaemic paralysis, poliomyelitis, diabetic neuropathy, and history of potential toxic exposure were excluded.

Before being recruited, written informed consent was obtained from each patient or their relatives. The study protocol was approved by the Hospital Review Board (Ref. No. 25-8/05/19). History of respiratory tract infections, diarrhoea, recent surgery, or vaccination was obtained. Complete clinical nervous system assessment was done for all patients. Muscle power was assessed using summary scores for muscle power of six bilateral muscles in arms and legs according to the MRC scale from 0 to 5 [17]. Tendon reflexes were graded as absent, reduced, normal, or brisk. In addition, patients were also assessed for dysautonomia. GBS disability score was graded as 0–6 according to the Hughes scale [18]. Complete blood count, random blood glucose, blood urea nitrogen, serum electrolytes, creatinine, alanine aminotransferase, platelet count, prothrombin time, electrocardiogram, and chest radiograph were taken for each patient. Nerve conduction study was performed in all patients for whom it was logistically feasible. Cerebrospinal Fluid (CSF) examination was done in all patients.

Plasmapheresis was done for patients presenting within 14 days after the onset of illness. Fresh frozen plasma (1 L) was used as replacement fluid. Patients who were unable to maintain partial pressure of O_2 > 60 mmHg and developing hypercarbia (partial pressure of CO_2 > 50 mmHg) or abnormal pH on arterial blood gas analysis were mechanically ventilated [19]. Outcome at 4 weeks was categorized as (1) complete (independent for activities of daily living); (2) partial (needing help for activity of daily living); or (3) poor (bedridden or wheelchair bound) [20]. Death during this period and the causes of death were noted.

2.1. Statistical Analysis

Minitab version 17 (State College, PA, USA) was used for data analysis. Categorical variables were expressed as frequency and percentage, while numerical data were presented as mean and standard deviation. Two-sample *t*-test was used to determine differences in biochemical parameters between the outcome (alive versus dead) by the end of follow-up. The χ^2 test or Fisher's exact test was used to compare categorical variables. One-way analysis of variance was applied to determine the difference in biochemical parameters between different plasmapheresis sessions. Binary logistic regression (Unadjusted OR) was applied to estimate the association of disease outcome with different parameters. Kaplan–Meier curves were plotted to estimate percentage survival of patients, and the effect of preceding illness, duration of hospital stay, duration of mechanical ventilation, and number of plasmapheresis sessions.

3. RESULTS

Mean age of all participants was 31.67 ± 15.88 years, with no significant difference between women (n = 9, 29.11 ± 12.90 years) and men (n = 18, 32.94 ± 17.39 years) (p = 0.526). Except for serum alanine aminotransferase (male; 50.5 ± 35 IU versus female; 24.85 ± 9.89 IU, p = 0.011), no significant difference was found in any of the biochemical parameters, muscle power, and CSF between male and female patients.

During 4 weeks' follow-up, seven (26%) patients died. Significant differences were found in the frequency of signs and symptoms at the time of presentation such as the presence of arrhythmia (p = 0.009), labile blood pressure (p = 0.0315), and increased sweating (p = 0.004) between those who were alive versus those who died during this period (Table 1). At presentation, prior nerve

Table 1 | Clinical features of Gullain–Barré syndrome patients who were alive at the end of 4 weeks' follow-up versus those who died

Parameter	Alive (n = 20)		Died (n = 7)		p
	No	Yes	No	Yes	
Preceding diarrhoea	6 (46.15)	7 (53.85)	2 (50)	2 (50)	0.893
Preceding respiratory disease	7 (43.75)	9 (56.25)	2 (40)	3 (60)	0.882
Neck flexion	12 (75)	4 (25)	2 (50)	2 (50)	0.344
Respiratory muscle involvement	15 (83.33)	3 (16.67)	3 (50)	3 (50)	0.102
Bulbar/cranial nerve involvement	16 (80)	4 (20)	4 (57.14)	3 (42.86)	0.249
Tachy/bradyarrhythmia	18 (100)	0 (0)	3 (50)	3 (50)	0.009
Labile blood pressure	16 (100)	2 (10)	2 (50)	2 (50)	0.032
Increased sweating	19 (95)	1 (5)	3 (42.86)	4 (57.14)	0.004
Urinary retention/incontinence	14 (100)	0 (0)	5 (83.33)	1 (16.67)	0.300
Mechanical ventilation required	13 (72.22)	5 (27.78)	1 (16.67)	5 (83.33)	0.015
CMV mode ventilator used	5 (25)	15 (75)	5 (75)	2 (25)	NC
SIMV mode ventilator used	5 (25)	15 (75)	2 (25)	5 (75)	NC
Tracheostomy needed	4 (50)	4 (50)	2 (33.33)	4 (66.667)	0.531
Ventilator associated pneumonia	1 (20)	4 (80)	1 (25)	3 (75)	NC

CMV, continuous mechanical ventilation; NC, not calculable; SIMV, spontaneous intermittent mechanical ventilation.

conduction studies were performed in only 10 patients who were reported to have motor axonal (n = 7), axonal (n =1), or mixed (n = 2) neuropathies. A significantly higher percentage of patients who died during follow-up required mechanical ventilation compared to those who survived (p = 0.015). Ventilator-associated pneumonia was found in seven patients. Culture and sensitivity aspirate (cultured for 48 h) yielded growth of *Pseudomonas aeruginosa* in four aspirates (three samples from patients who were alive at the end of follow-up and one from the patient who died). Of those who survived (n = 17), only three (17.6%) patients could live independently at the end of follow-up.

Blood pressure, number of plasmapheresis sessions, duration of mechanical ventilation, haematological parameters, and parameters of CSF were not significantly different between those who were alive until the end of follow-up versus those who died in this period (Table 2).

Binary logistic regression analysis showed a significant association of age with disease outcome (death considered as an event) (Unadjusted OR 0.9270, 95% CI 0.8598–0.9995, p = 0.027) and a tendency toward total MRC score (Unadjusted OR 1.0931, 95% CI 0.9783–1.2214, p = 0.086) (Table 3).

Plasmapheresis sessions (n = 1–4) were done for all except one patient. Total MRC score remained similar throughout all these sessions (Figure 1). Compared to baseline measurements, significant differences were observed only in platelet count (p = 0.014) (Table 4 and Figure 2).

Table 2 | Clinical and biochemical parameters of participants who were alive at the end of follow-up versus those who died during the study period

Variable	All patients (n = 27)		Alive (n = 20)		Died (n = 7)		p
	Mean	SD	Mean	SD	Mean	SD	
Age (years)	31.67	15.88	28.40	14.03	41.00	18.25	0.135
Duration of illness before admission (days)	5.222	4.635	4.85	4.58	6.29	4.99	0.520
Heart rate (per min)	95.48	15.72	96.6	17.81	92.67	9.35	0.519
Systolic blood pressure (mmHg)	125.87	22.19	121.88	14.24	135.0	34.0	0.363
Diastolic blood pressure (mmHg)	77.39	12.87	75.00	10.95	82.86	16.04	0.271
Plasmapheresis total sessions (n)	3.769	1.142	3.895	0.875	3.429	1.718	0.515
Ventilation required on day	2.455	2.252	1.800	0.837	3.00	2.97	0.387
Duration on CMV mode (days)	19.22	18.03	16.20	18.09	23.00	19.92	0.615
Duration on SIMV mode (days)	25.7	26.0	18.00	20.15	64.000	*	NC
Total duration on MV (days)	33.8	42.1	25.20	19.56	48.0	70.3	0.638
Hospital stay (days)	15.13	11.63	15.56	10.10	14.57	14.19	0.880
Power of muscles – MRC score							
Deltoid – right	1.852	1.262	2.000	1.170	1.429	1.512	0.390
Deltoid – left	1.778	1.251	1.900	1.165	1.429	1.512	0.474
Biceps – right	2.037	1.224	2.150	1.040	1.714	1.704	0.545
Biceps – left	2.000	1.271	2.050	1.099	1.857	1.773	0.795
Wrist extensors – right	1.815	1.111	2.000	1.076	1.286	1.113	0.171
Wrist extensors – left	1.815	1.145	1.950	1.099	1.429	1.272	0.360
Illeopsoas – right	1.222	0.974	1.350	0.998	0.857	0.900	0.250
Illeopsoas – left	1.148	0.949	1.250	1.250	0.857	0.900	0.351
Quadricep femoris – right	1.222	0.892	1.300	0.923	1.000	0.816	0.436
Quadricep femoris – left	1.148	0.949	1.200	1.005	1.000	0.816	0.610
Tibialis anterior – right	1.296	0.869	1.300	0.979	1.286	0.488	0.961
Tibialis anterior – left	1.296	0.823	1.300	0.923	1.286	0.488	0.959
Total MRC score	18.59	10.32	19.70	9.740	15.43	12.04	0.422
Biochemical parameters							
Haemoglobin (g/dL)	13.49	2.396	13.38	2.502	13.829	2.207	0.664
Total leukocyte count	20368	36891	16291	23829	32015	62334	0.539
Platelet count	219762	95022	212781	92014	237714	107731	0.602
PT – patient	16.60	3.440	16.556	3.854	16.714	2.289	0.901
PT – control	13.36	0.907	13.278	1.018	13.571	0.535	0.360
APTT – patient	33.72	7.88	32.17	5.93	37.71	11.07	0.249
APTT – control	30.52	3.177	30.00	2.951	31.86	3.58	0.253
RBS (mg/dL)	140.2	64.1	145.9	68.8	120.8	44.9	0.314
Na^+ (mmol/L)	137.67	3.32	137.6	2.74	137.86	4.88	0.898
K^+ (mmol/L)	3.990	0.373	4.001	0.353	3.957	0.454	0.822
SGPT/ALT (IU)	42.31	31.55	37.46	24.39	57.7	47.6	0.363
CSF R/E – cell count	5.864	3.895	5.47	3.125	7.20	6.14	0.577
CSF R/E – lymphocytes (%)	83.75	33.47	80.63	36.82	96.25	7.50	0.134
CSF R/E – protein (mg/100 mL)	96.16	40.97	94.39	37.51	102.2	55.9	0.781
CSF R/E – calcium	8.617	1.002	8.511	0.930	8.933	1.232	0.467
CSF R/E – albumin	4.073	0.798	4.032	0.804	4.186	0.834	0.682

*Duration on SIMV mode (days) is constant for died patients. APTT, activated partial thromboplastin time; CSF R/E, cerebrospinal fluid routine examination; MRC, Medical Research Council; NC, not calculable; PT, prothrombin time; RBS, random blood sugar; SD, standard deviation; SGPT/ALT, serum glutamate phosphotransferase/alanine aminotransferase; CMV, continuous mechanical ventilation; SIMV, spontaneous intermittent mechanical ventilation.

3.1. Survival Analysis of Outcome Predictors

Survival analysis showed mean survival of 15.56 days (95% Cl 8.95644–22.1547). A significant decrease in the survival of patients was observed with prolonged hospital stay (survival at day 3 was 88.89% versus 33.33% at day 14) and prolonged preceding illness (survival for duration of preceding illness at day 1 was 85% versus 15% at day 7). However, this was not affected by preceding illness such as diarrhoea and respiratory disorders (p = 0.99 and 0.253, log-rank test). Percentage survival of patients was 84.2% after three plasmapheresis sessions that decreased to 15.7% after four sessions. There was a tendency toward a significant difference in the survival of patients with and without mechanical ventilation (p = 0.085, log-rank test). When applied, the percentage survival of patients on mechanical ventilation decreased with increase in duration of mechanical ventilation (100% on day 10 versus 20% on day 19) (Figure 3a–d).

Table 3 | Binary logistic regression analysis for the association of outcome of disease with blood pressure, total MRC score, and plasma and CSF parameters

Parameter	R^2(%)	Unadjusted OR (95% CI)	p
Age	9.65	1.0508 (0.9891–1.1164)	0.027
Total MRC score	3.11	0.9583 (0.8789–1.0449)	0.086
Diastolic BP	6.01	1.0478 (0.9739–1.1273)	0.198
Systolic BP	5.42	1.0260 (0.9834–1.0704)	0.222
Haemoglobin (mg/dL)	0.39	1.0654 (0.7449–1.5239)	0.730
Total leukocyte count	2.79	1.0000 (1.0000–1.0000)	0.358
Platelet count	1.42	1.0000 (1.0000–1.0000)	0.521
RBS	4.60	0.9893 (0.9683–1.0108)	0.260
Serum Na^+	0.05	1.0160 (0.7813–1.3211)	0.906
Serum K^+	0.54	0.6138 (0.0569–6.6219)	0.687
ALT/SGPT	5.77	1.0178 (0.9892–1.0472)	0.212
CSF cell count	4.24	1.1329 (0.8836–1.4524)	0.323
CSF lymphocytes	4.28	1.0227 (0.9594–1.0903)	0.360
CSF protein	0.65	1.0049 (0.9802–1.0302)	0.699
CSF calcium	2.62	1.5113 (0.5544–4.1198)	0.405
CSF albumin	0.46	1.2315 (0.4059–3.7366)	0.712

ALT/SGPT, alanine aminotransferase/serum glutamate phosphotransferase; BP, blood pressure; CI, confidence interval; CSF, cerebrospinal fluid; MRC, Medical Research Council; OR, odds ratio; RBS, random blood sugar.

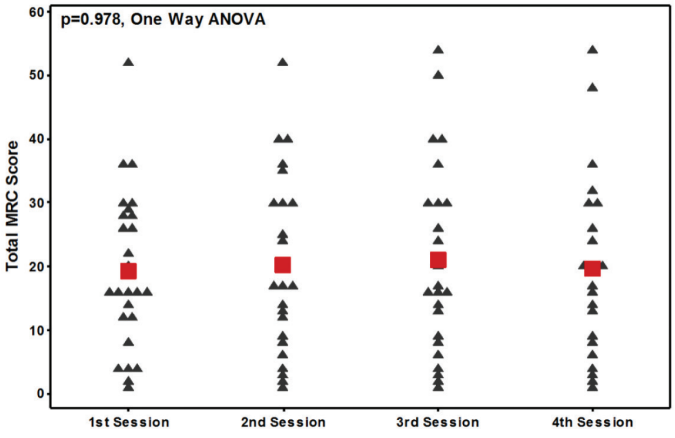

Figure 1 | Trends in MRC scores in all plasmapheresis sessions. ANOVA, analysis of variance; MRC, Medical Research Council.

4. DISCUSSION

With improvement in treatment support for GBS patients, mortality has reduced over time; however, it remains significant in patients presenting with poor prognostic signs. This was also seen in our study, which indicated 26% mortality by the end of 4 weeks. This is high given the overall mortality of 2–15% in GBS [21]. However, previous studies have reported high mortality particularly in patients requiring mechanical ventilation, older people, and those admitted to intensive care [22].

A significantly higher percentage of patients who died during follow-up had abnormal heart rhythm (tachy/bradyarrhythmia) and increased sweating at nadir, which are the features of

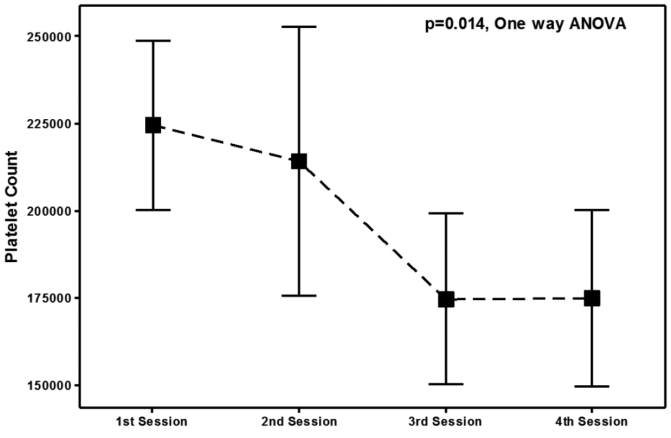

Figure 2 | Interval plot for changes in platelet count with plasmapheresis sessions in all patients. Bars are based on 95% confidence interval calculated from standard deviation scores; small square boxes represent mean value. ANOVA, analysis of variance.

Table 4 | One-way analysis of variance for comparison of biochemical parameters and MRC score after four sessions of plasmapheresis

Parameter	1st Session			2nd Session			3rd Session			4th Session			p
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	
Platelets	24	224417	57659	18	214111	77412	19	174579	50769	16	174813	47326	0.014
PT	21	17.3	4.231	18	19.033	3.169	16	17.762	3.393	10	16.75	3.29	0.352
Albumin	21	4.105	1.024	19	3.716	1.01	18	3.622	1.072	14	3.15	0.997	0.070
Calcium	23	8.074	1.069	20	7.525	1.095	18	7.461	0.889	16	7.531	0.962	0.174
MRC score	26	19.38	12.41	24	20.21	14.01	24	21.04	15.14	22	19.68	14.46	0.978

MRC, Medical Research Council; PT, prothrombin time; SD, standard deviation.

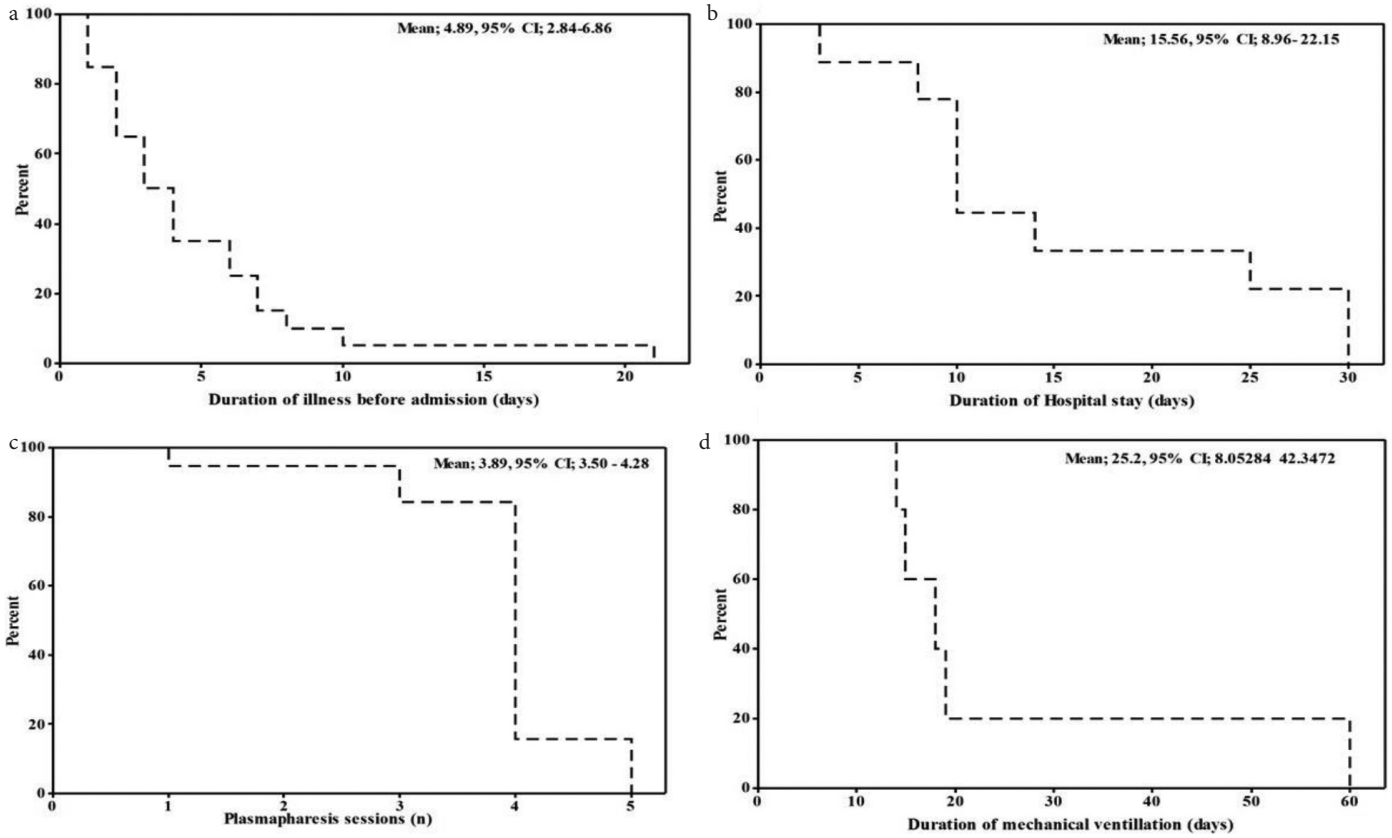

Figure 3 | Kaplan–Meier plots for survival analysis of outcome predictors. CI, confidence interval.

autonomic dysfunction due to demyelination of neurons in the somatic and autonomic nervous systems. Autonomic function including heart rate, vasomotor stability, sweating, continence, and blood pressure are generally affected more commonly in children [23]. This may explain the severity of the disease status in patients leading to complications and ultimately death within 1 month. This was supported by the data indicating that cause of death in these patients was cardiac asystole ($n = 4$), pneumonia due to respiratory muscles paralysis ($n = 2$), and hypotension ($n = 1$).

Although GBS affects peripheral nerves, CSF being in close contact with the proximal nerve roots, may potentially reflect biochemical changes related to the disease. Accordingly, changes in the expression, post-translational modifications or turnover of proteins may be reflected as changes in CSF protein content [24]. Abnormalities in CSF protein concentration most frequently seen as isolated blood–CSF barrier dysfunction, as measured by elevated CSF protein concentration or elevated CSF/serum albumin quotient, without an elevated cell count, or intrathecally produced immunoglobulins, are characteristic of GBS and considered as initial evidence of biomarkers present in CSF [25]. In our study, although CSF proteins, calcium, and proportion of lymphocytes were significantly higher than upper-normal range, their levels were not significantly different between the two groups. This indicates a breach in the immune-mediated blood–CSF barrier function, irrespective of the disease outcome. Although evidence suggests that CSF protein may be normal within the first week after disease onset, and that severe increase in CSF protein and albumin may be seen after 2–3 weeks, there are randomized control trials showing that 50% of CSF samples within 1 week and 80% of CSF samples within 2 weeks showed an increase in protein and albumin content [26]. However, this lack of consistency in terms of its appearance makes CSF protein a poor diagnostic marker for GBS in the early days of the disease.

Mean MRC score at baseline is a measure of muscle power in limbs and is a proxy for the extent of peripheral nerve damage by disease process. There is plenty of evidence showing the association of low MRC score with poor disease prognosis. Our data indicate that although there was no difference in baseline MRC score between the two groups, MRC score at baseline had a tendency toward poor disease outcome. A nonsignificant likelihood in this study may be due to low patient numbers. It was however interesting to observe that mean MRC score at baseline did not improve with plasmapheresis sessions, indicating little improvement in the functional status of the patients. This might indicate that treatment with plasmapheresis alone is not sufficient to improve muscle power and hence independent survival in the short term, and that the overall benefit of plasmapheresis sessions and survival of patients depends on other factors [27]. This has been reported by Lin et al. [27] who found that although overall disability score of the patient improves with plasmapheresis sessions, the recovery was poor in patients with poor prognosis. Use of Intravenous Immunoglobulin (IVIG) apart from plasmapheresis is a standard practice and is associated with better survival and functional status of the patients [1]. However, the cost of IVIG prevents its application in resource-poor settings such as in the present study. We observed a significant reduction in

platelet count with subsequent plasmapheresis sessions. Since plasmapheresis leads to separation and loss of plasma, it also results in unintentional loss of platelets. This has also been previously observed during plasmapheresis sessions for other diseases such as thrombotic thrombocytopenic purpura [28], and this loss varied with different makes of equipment.

Prolonged preceding illness was associated with reduced survival in our study. This was expected as previous evidence suggests that a delay of >2 days in the initiation of treatment in these patients leads to a poor outcome in terms of morbidity and mortality compared to those who present early [22]. Moreover, patients who present late are likely to require more aggressive and prolonged hospitalization and exhibit delayed recovery. This was supported by finding that percentage survival decreased with prolonged hospital stay.

Although mechanical ventilation has played a key role in improving the survival of patients presenting with respiratory muscle paralysis, our study shows that patients requiring mechanical ventilation for >10 days show a drastic decrease in percentage survival from 100% down to 20%. Patients requiring prolonged mechanical ventilation are at increased risk of poor outcome, decreased independent survival, slow recovery, and ventilator-associated respiratory complications [14,22,29]. Prolonged duration of mechanical ventilation may therefore indicate poor muscle potential and advanced disease state. In a study by Dhar et al., prolonged mechanical ventilation for >60 days was associated with complications. Moreover, pneumonia and sepsis were highly associated with duration of mechanical ventilation for >14 days [29]. However, the strongest predictors of mortality were age and significant comorbidity but not mechanical ventilation (only 8.5% mortality at 1 year) [29]. In another study, older age, increased ventilation time (>4 months), and upper limb paralysis were predictors associated with poor outcome at maximum recovery [22].

Despite some promising results, our study had some limitations. This was a single centre study with a small patient cohort, which might have resulted in some nonstatistical results. Furthermore, patients were not treated with IVIG due to poor resource availability in the study setting, which might have obscured the improvement in mean MRC score at the end of 4 weeks, despite plasmapheresis. Patients were referred to this tertiary care centre from far-flung areas that resulted in delayed onset of treatment tailored for GBS. Detailed data on the clinical and plasma biochemical parameters at the onset of symptoms would therefore have helped to explain the high mortality rate in this small cohort.

In conclusion, this study suggests that mortality in the short term is related to prolonged preceding illness, hospital stay, duration of mechanical ventilation, and increasing number of plasmapheresis sessions. Furthermore, overall MRC score does not improve with subsequent plasmapheresis sessions. It is recommended to carry out larger multicentre studies based on intensive care settings to validate these results.

CONFLICTS OF INTEREST

The authors declare they have no conflicts of interest.

AUTHORS' CONTRIBUTION

MI and FK contributed in study conception and design. AK contributed in acquisition of data. MJK contributed in analysis and interpretation of data. MI and FK contributed in drafting/write-up. WA and IA contributed in critical revision. All authors read and approved the final version of the paper.

REFERENCES

[1] Willison HJ, Jacobs BC, van Doorn PA. Guillain-Barré syndrome. Lancet 2016;388;717–27.

[2] Walling AD, Dickson G. Guillain-Barré syndrome. Am Fam Physician 2013;87;191–7.

[3] Hauck LJ, White C, Feasby TE, Zochodne DW, Svenson LW, Hill MD. Incidence of Guillain-Barré syndrome in Alberta, Canada: an administrative data study. J Neurol Neurosurg Psychiatry 2008;79;318–20.

[4] Yuki N, Hartung HP. Guillain-Barré syndrome. N Engl J Med 2012;366;2294–304.

[5] Liou LS, Chung CH, Wu YT, Tsao CH, Wu YF, Wu-Chien C, et al. Epidemiology and prognostic factors of inpatient mortality of Guillain-Barré syndrome: a nationwide population study over 14 years in Asian country. J Neurol Sci 2016;369;159–64.

[6] Islam Z, Jacobs BC, van Belkum A, Mohammad QD, Islam MB, Herbrink P, et al. Axonal variant of Guillain-Barré syndrome associated with *Campylobacter* infection in Bangladesh. Neurology 2010;74;581–7.

[7] Ogawara K, Kuwabara S, Mori M, Hattori T, Koga M, Yuki N. Axonal Guillain-Barré syndrome: relation to anti-ganglioside antibodies and *Campylobacter jejuni* infection in Japan. Ann Neurol 2000;48;624–31.

[8] Shafqat S, Khealani BA, Awan F, Abedin SE. Guillain-Barré syndrome in Pakistan: similarity of demyelinating and axonal variants. Eur J Neurol 2006;13;662–5.

[9] Zhang B, Wu X, Shen D, Li T, Li C, Mao M, et al. The clinical characteristics and short-term prognosis in elderly patients with Guillain-Barré syndrome. Medicine (Baltimore) 2017;96;e5848.

[10] Kalra V, Sankhyan N, Sharma S, Gulati S, Choudhry R, Dhawan B. Outcome in childhood Guillain-Barré syndrome. Indian J Pediatr 2009;76;795–9.

[11] Alshekhlee A, Hussain Z, Sultan B, Katirji B. Guillain-Barré syndrome: incidence and mortality rates in US hospitals. Neurology 2008;70;1608–13.

[12] Rajabally YA, Uncini A. Outcome and its predictors in Guillain-Barré syndrome. J Neurol Neurosurg Psychiatry 2012;83;711–8.

[13] Wu X, Li C, Zhang B, Shen D, Li T, Liu K, et al. Predictors for mechanical ventilation and short-term prognosis in patients with Guillain-Barré syndrome. Crit Care 2015;19;310.

[14] Kiphuth IC, Schellinger PD, Köhrmann M, Bardutzky J, Lücking H, Kloska S, et al. Predictors for good functional outcome after neurocritical care. Crit Care 2010;14;R136.

[15] Verboon C, van Doorn PA, Jacobs BC. Treatment dilemmas in Guillain-Barré syndrome. J Neurol Neurosurg Psychiatry 2017;88;346–52.

[16] Asbury AK, Cornblath DR. Assessment of current diagnostic criteria for Guillain-Barré syndrome. Ann Neurol 1990;27;S21–S4.

[17] Medical Research Council. Aids to the examination of the peripheral nervous system. London: Her Majesty's Stationery Office; 1943.
[18] Hughes RA, Brassington R, Gunn AA, van Doorn PA. Corticosteroids for Guillain-Barré syndrome. Cochrane Database Syst Rev 2016;10;CD001446.
[19] Tharakan J, Jayaprakash PA, Iyer VP. Small volume plasma exchange in Guillain-Barré syndrome: experience in 25 patients. J Assoc Physicians India 1990;38;550–3.
[20] Kalita J, Misra UK, Das M. Neurophysiological criteria in the diagnosis of different clinical types of Guillain-Barré syndrome. J Neurol Neurosurg Psychiatry 2008;79;289–93.
[21] Witsch J, Galldiks N, Bender A, Kollmar R, Bösel J, Hobohm C, et al. Long-term outcome in patients with Guillain-Barré syndrome requiring mechanical ventilation. J Neurol 2013;260;1367–74.
[22] Fletcher DD, Lawn ND, Wolter TD, Wijdicks EF. Long-term outcome in patients with Guillain-Barré syndrome requiring mechanical ventilation. Neurology 2000;54;2311–5.
[23] Dimario FJ Jr, Edwards C. Autonomic dysfunction in childhood Guillain-Barré syndrome. J Child Neurol 2012;27;581–6.
[24] Brettschneider J, Petzold A, Süssmuth S, Tumani H. Cerebrospinal fluid biomarkers in Guillain-Barré syndrome – where do we stand? J Neurol 2009;256;3–12.
[25] Brettschneider J, Claus A, Kassubek J, Tumani H. Isolated blood-cerebrospinal fluid barrier dysfunction: prevalence and associated diseases. J Neurol 2005;252;1067–73.
[26] Van der Meché FG, Van Doorn PA, Meulstee J, Jennekens FG. Diagnostic and classification criteria for the Guillain-Barré syndrome. Eur Neurol 2001;45;133–9.
[27] Lin JH, Tu KH, Chang CH, Chen YC, Tian YC, Yu CC, et al. Prognostic factors and complication rates for double-filtration plasmapheresis in patients with Guillain-Barré syndrome. Transfus Apher Sci 2015;52;78–83.
[28] Perdue JJ, Chandler LK, Vesely SK, Duvall DS, Gilcher RO, Smith JW, et al. Unintentional platelet removal by plasmapheresis. J Clin Apher 2001;16;55–60.
[29] Dhar R, Stitt L, Hahn AF. The morbidity and outcome of patients with Guillain-Barré syndrome admitted to the intensive care unit. J Neurol Sci 2008;264;121–8.