

ORIGINAL ARTICLE

A Point-Prevalence Study of Serum Phosphorus Levels in Burn Patients at Admission in Kirtipur Hospital

Animesh Kharel¹, Mangal G. Magar¹, Bishal Karki¹, Kiran K. Nakarmi¹, Shankar M. Rai¹

ABSTRACT

Introduction: In Nepal, an estimated 55,902 burn injuries occur each year, with approximately 2,100 burn-related deaths annually. With little to no resuscitation many patients bear the risk of metabolic and electrolyte derangements during the acute phase. Studies indicate the nadir of Phosphorus occurs between days 3rd to 5th post burn days.

Methods: This observational Point-Prevalence study was conducted at a tertiary burn center in Nepal over a 12-months period. Chart review of all burn patients admitted to Burn Intensive Care Unit was done. A predesigned proforma was used to record demographic details, age and gender, and total burn surface area (TBSA). The lab values of Phosphorus, Magnesium and Calcium done at the time of presentation to the emergency Department were recorded.

Results: In total, 75 participants, 33 were female, 42 were male with mean age of 29.3 ± 26.64 years and Total Body Surface Area Burn was $25.53 \pm 14.05\%$. Phosphorus level averaged 1.14 ± 0.50 mmol/ml - with 29.3% hypophosphatemia (<0.8 mmol/L) and 13.3% hyperphosphatemia (>1.5 mmol/L), revealing moderate elevation variance. Magnesium averaged 0.80 ± 0.20 mmol/ml with 21.3% hypomagnesemia (<0.7 mmol/L), suggesting moderate depletion Calcium value averaged 1.89 ± 0.22 mmol/ml—15.5% hypocalcemia (<2.1 mmol/L) indicating widespread calcium deficiency at presentation.

Conclusion: Elderly patients with burn are particularly at high risk for hypophosphatemia. Hypocalcemia, and hypomagnesemia are also commonly noted.

Keywords: Burns, Point prevalence, electrolytes, phosphorus, calcium, magnesium.

INTRODUCTION

Approximately 11 million new burn cases are reported annually, with nearly 70% occurring in low- and middle-income countries (LMICs). In Nepal, approximately 55,000 burn injuries occur annually, resulting in around 2,100 deaths each year.^{1,2} Phosphorus, second to Calcium, is the most abundant mineral in the human body, accounting for approximately 1% of total body weight.^{3,8} In Burn patients, hypophosphatemia is commonly observed,

particularly during the early resuscitation phase.^{4,5,9} It typically decline between post-burn days 2 and 5. The incidence of hypophosphatemia from 0.2% to 2.2%, but it can rise to 21.5% or higher in patients with large Total Body Surface Area (TBSA) burns.^{6,10,11} Hyperphosphatemia (>1.5 mmol/L) is also a factor in increasing the mortality in burns.^{7,12} This study aimed to identify the serum phosphorus levels in relation to gender, TBSA burns, Calcium and Magnesium levels at the time of presentation to the hospital for cases

¹Department of Burns, Plastic and Reconstructive Surgery, Kirtipur Hospital, Nepal

*Corresponding author

Animesh Kharel, Department of Burn, Plastic and Reconstructive Surgery, Kirtipur Hospital, Nepal, Phone: 9861288292, Email : animeshkharel@gmail.com

admitted to the Burn ICU.

METHODS

Ethical approval was taken from Institutional Review Committee of pfect-NEPAL. This retrospective observational point-prevalence study was conducted over 12 months (01 Aug 2024 to 31 July 2025) under the Department of Burn, Plastic and Reconstructive Surgery at Kirtipur Hospital, a tertiary burn center in Nepal. All burns patients arriving at Kirtipur Hospital who required admission and had lab reports of Phosphorus, Calcium and Magnesium done at arrival were included for the study. Patients lacking any of the lab values at admission were excluded from study. Total of 75 patients were included in the study. Upon final evaluation Data were extracted from the medical records of 75 patients focusing on demographics (Age and Gender), Total Body Surface Area (TBSA) burn, and laboratory values for phosphorus, magnesium, and calcium at the time of initial admission.

Predesigned proforma was used to record demographic details; age gender and TBSA. The lab values of Phosphorus, along with Magnesium and Calcium were recorded at the time of initial presentation to the Emergency Department. All data were entered in SPSS v 27. The analysis employed Pearson correlation to measure linear associations between continuous variables and Spearman correlation for monotonic associations. To compare independent groups, specifically gender, the Mann-Whitney U Test was utilized. For predictive modeling, Simple Ordinary Least Squares (OLS) was applied to determine the impact of single variables, such as age, while a Multivariate Predictors test evaluated the collective predictive signal of age, sex, and TBSA simultaneously.

RESULTS

Our study included 75 burn patients. Gender Phosphorus levels averaged 1.14 mmol/L (median: 1.03, SD: 0.50), with 29.3% hypophosphatemia (<0.8 mmol/L) and 13.3% hyperphosphatemia (>1.5 mmol/L), revealing moderate elevation variance.

Serum phosphorus levels exhibit distinct age-related patterns, beginning at an average of 1.328 mmol/ml in young children (<5 years) and declining progressively to 0.902 mmol/ml in elderly patients (>60 years),

representing a 32% decrease that places the elderly at particular risk. Although the linear association (Pearson) was not statistically significant ($r = -0.14$, $p = 0.221$), a significant monotonic association (Spearman) was found ($\rho = -0.25$, $p = 0.02981$), suggesting that phosphorus levels tend to be lower at higher ages. A simple OLS model determined a slope of -0.003 mmol/L per year with a 95% confidence interval of -0.008 to 0.002 and a p -value of 0.22 . Ultimately, the model's R^2 value of 0.0201 indicates that age accounts for only about 2% of the total variability in phosphorus levels.

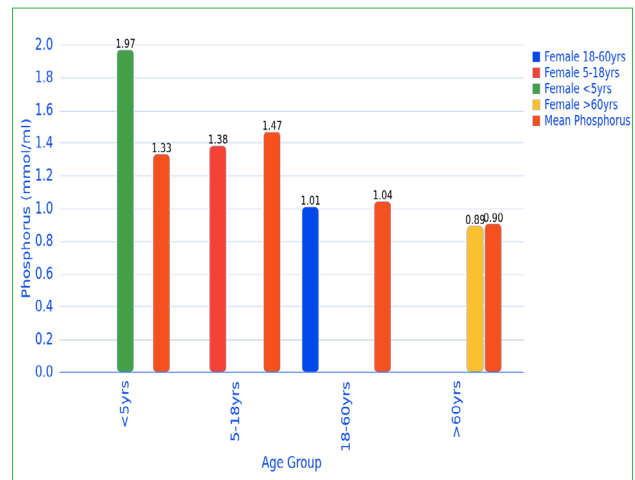


Figure 1: Mean phosphorus levels by age group in females

The linear association (Pearson correlation) was measured at $r=0.12$ ($p=0.3041$), while the monotonic association (Spearman) yielded a ρ of 0.06 ($p=0.631$). A simple OLS model determined a slope of 0.005 mmol/L per 1% TBSA, with a 95% confidence interval of -0.004 to 0.013 and a p -value of 0.304 . Ultimately, the model's R^2 value of 0.0141 demonstrates very low explanatory power, and phosphorus levels exhibited minimal variation across different burn severity groups. This indicates a low significant statistical relationship between burn severity (TBSA) and phosphorus levels.

Table 1: Relationship between burn severity (TBSA) and phosphorus levels.

Burn Severity Group (TBSA %)	Mean Phosphorus Level (mmol/ml)	Sample Size (n)
>50%	1.30	6

31-50%	1.24	15
16-30%	1.09	36
≤15%	1.19	19

ANOVA results confirm no significant differences in phosphorus levels across severity categories ($F=0.507$, $p=0.679$). Analysis of phosphorus variation based on gender shows minimal differences overall, with a sample of 42 males (mean 1.195 ± 0.509 mmol/ml; median 1.100) and 33 females (mean 1.121 ± 0.555 mmol/ml; median 0.960). Statistical testing confirms these minimal differences, as the Welch t-test yielded a p-value of 0.5541 and the Mann-Whitney U test resulted in a p-value of 0.07721, which is considered suggestive but not conventionally significant. Additionally, the Cohen's d effect size was 0.141, indicating a very small difference between the two groups. However, interaction analysis reveals significant gender disparities within specific age groups; most notably, young females exhibited 76% higher phosphorus levels (1.966 mmol/ml) compared to their male counterparts (1.115 mmol/ml)

In the multivariable Ordinary Least Squares (OLS) model used to analyze phosphorus levels in burn patients, several key predictors were evaluated simultaneously. For gender (comparing males to females), the analysis showed a coefficient of 0.014 with a 95% confidence interval ranging from -0.256 to 0.284 and a p-value of 0.9191. Regarding age, the coefficient was -0.003 with a 95% confidence interval of -0.008 to 0.003 and a p-value of 0.3231. For Total Body Surface Area (TBSA), the model produced a coefficient of 0.004 with a 95% confidence interval of -0.005 to 0.013 and a p-value of 0.3561. Ultimately, the overall fit of the model resulted in an Adjusted R^2 of -0.0081, indicating that these specific covariates provided no significant predictive signal for phosphorus levels within this patient group. In conclusion, Phosphorus shows a decrease with age detectable by Spearman correlation in association with Age, Gender, or TBSA%.

Magnesium: Mean 0.79 mmol/L (median: 0.80, SD: 0.20) with 21.3% hypomagnesemia (<0.7 mmol/L) and minimal hypermagnesemia (1.3%), suggesting moderate depletion. Calcium is markedly abnormal, with mean 1.87 mmol/L (median: 1.89, SD: 0.22)—

15.5% of patients exhibited hypocalcemia (<2.1 mmol/L), while no hypercalcemia was observed, indicating severe and widespread calcium deficiency at presentation.

DISCUSSION

Several factors influence the degree and duration of hypophosphatemia in burn patients, including burn severity, presence of inhalational injury and extent of fluid resuscitation, nutritional status, phosphate availability, and refeeding syndrome.^{13,14}

The large doses of Ringer's lactate given for initial burn resuscitation may decrease serum Phosphorus by means of several mechanisms: a) metabolic alkalosis induced by lactate infusion may lead to an increase of glycolysis, which promotes the transfer of P to the intracellular space; b) lactate is converted into glucose in the liver, a process that requires high energy phosphate availability.¹⁵⁻¹⁷

The incidence and severity of hypophosphatemia increase with increasing TBSA involvement. Serum phosphorus levels typically decline most markedly between post-burn days 2 and 5. Phosphorus levels between 2.0 and 3.0 mg/dL are generally managed with oral supplementation, whereas levels below 2.0 mg/dL often require intravenous replacement.¹⁸

Hypophosphatemia is typically categorized as: mild (serum P concentration of 2.5–2.9 mg/dL), moderate (1–2.4 mg/dL), or severe (<1 mg/dL). Although mild to moderate hypophosphatemia is usually asymptomatic, severe hypophosphatemia can be potentially associated with significant morbidity. Up to fourfold increase mortality is reported in patients with severe hypophosphatemia.¹⁹ Despite aggressive supplementation, normalization of serum phosphorus levels may be delayed, frequently requiring more than 10 days post-burn and, in some cases, up to 18–20 days.²⁰

Refeeding Syndrome and associated electrolyte abnormalities occur as a result of initiation of a high caloric diet in previously starved or severely malnourished patients when additional doses of Phosphorus is not administered.²¹ Refeeding syndrome

encompasses a constellation of metabolic disturbances, especially hypophosphatemia, along with neurological, pulmonary, cardiac, neuromuscular, and hematological complications.^{22,23} Interestingly enough, Studies show that Hyperphosphatemia (>1.5 mmol/L) is also a factor to increase the mortality in burns.^{12,24}

The study reveals that 29.3% of burn patients exhibit hypophosphatemia (<0.8 mmol/L) at the time of hospital presentation, while 13.3% show hyperphosphatemia (>1.5 mmol/L). This incidence of hypophosphatemia is notably higher than the 0.2% to 21.5% range typically reported in existing medical literature for burn patients. Additionally, the study identifies a significant age-related decline in phosphorus levels, which decrease from an average of 1.328 mmol/ml in children under five to 0.902 mmol/ml in elderly patients over sixty. This trend is statistically supported by a significant monotonic association (Spearman rho = -0.25, $p=0.02981$), although a standard linear association was not found.

Interestingly, the analysis found no significant relationship between phosphorus levels and Total Body Surface Area (TBSA) or gender in the overall models. This contrasts with some literature suggesting that hypophosphatemia rates rise significantly in patients with large TBSA burns.^{3,10} While the general gender analysis showed minimal differences, a specific interaction was noted where young females exhibited 76% higher phosphorus levels than their male counterparts. Furthermore, the study highlights that calcium dysregulation—characterized by widespread hypocalcemia (mean 1.87 mmol/L)—is the dominant electrolyte pattern in this cohort, overshadowing phosphorus and magnesium depletion.

The findings have direct clinical implications, particularly for elderly burn patients who appear to be at a higher risk due to a 32% baseline decrease in phosphorus levels compared to children. The severity of calcium deficiency at presentation suggests that targeted calcium supplementation protocols are more important, too.^{7,8} A primary strength of this study is its point-prevalence retrospective design, which provides clear descriptive data on the frequency of electrolyte imbalances in the specific burn population of Nepal at the exact moment of initial hospital presentation.

However, several limitations must be considered. The small sample size of 75 patients significantly limits the statistical power of the models, likely contributing to the high p-values and the inability to detect more subtle linear relationships. The study also lacks data on critical confounding factors, such as creatinine levels, acid-base status, lactate, albumin, and the nutritional or co-morbidity status of the patients, all of which can influence electrolyte dynamics.

CONCLUSION

Elderly patients with burn are particularly at high risk for hypophosphatemia. Hypocalcemia, and hypomagnesemia are also commonly noted. It was also noted that the tendency for phosphorus to be lower with increasing age.

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