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Effects of blinded acute and subacute gluten challenge on extraintestinal and gastrointestinal symptoms in patients with non-celiac gluten sensitivity *versus* healthy controls

Iven J[1], Geeraerts A[1], Vanuytsel T[1], Tack J[1], Van Oudenhove L[1], Biesiekierski JR[1,2]
1. Translational Research Center for Gastrointestinal Disorders, KU Leuven, Leuven, Belgium
2. School of Allied Health, La Trobe University, Melbourne, Victoria, Australia

Introduction: Non-celiac gluten sensitivity (NCGS) is characterized by gastrointestinal (e.g. bloating) and extraintestinal (e.g. fatigue) symptoms that subjectively disappear after dietary exclusion of gluten, in the absence of celiac disease. Previous research has shown that a 3-day exposure to gluten increases depression scores in self-reported NCGS patients; however, acute effects of gluten were not investigated.[1] We aimed to investigate the effect of single-blind acute and sub-acute administration of 16 g of gluten on psychological and gastrointestinal symptoms in healthy volunteers (HVs) and NCGS patients.

Methods: We mixed 16 g of gluten or whey protein (placebo) in 250 mL of low-fat, unsweetened yoghurt, which was consumed as an acute challenge. Gastrointestinal symptoms (bloating, cramps) were assessed using a 100 mm Visual Analogue Scale (VAS) every 15 min until 180 min after administration. At the same time points, extraintestinal symptoms (fatigue, tension, depression) were assessed using a VAS derived from the Profile of Mood States Questionnaire. Participants then consumed two gluten-free or gluten-containing (8 g) muffins at different time points per day for the following 5 days, as a sub-acute challenge. Gastrointestinal symptoms (ordinal values, 0 to 7) and extraintestinal symptoms were scored at the end of each day. After a 2-week washout period, participants crossed over to the alternative dietary arm. Responses over time (compared with pre-administration for the acute challenge and compared with the mean of the 2 days before the intervention period for the sub-acute challenge) were analyzed using (generalized) linear mixed models.

Results: Twenty HVs (three men; age, 29.7 ± 2.6 years) and 10 NCGS patients (four men; 32.6 ± 3.1 years) completed the study. After acute administration of gluten compared with placebo, fatigue scores increased in NCGS patients (P=0.015) but not in HVs (P=0.74). Similarly, NCGS patients had higher tension scores after gluten compared with placebo (P=0.043), contrary to HVs (P=0.31). Acute challenge of gluten did not alter depression scores compared with placebo (P=0.41). After 5 days of sub-acute administration, no significant differences in fatigue scores were observed between HVs and NCGS patients (P=0.70) nor between conditions (P=0.48), but tension and depression scores were higher in both groups after gluten compared with placebo (P=0.053 and 0.076, respectively). Immediately after the acute challenge, NCGS patients showed more bloating (P<0.0001) and pain (P=0.019) compared with HVs, regardless of whether gluten or placebo was ingested. This continued during the sub-acute challenge where gastrointestinal symptoms increased in the NCGS patients compared with HVs (abdominal pain, P=0.038; bloating, P=0.015), regardless of gluten *versus* placebo intake.

Conclusions: These findings provide new insights into NCGS, which might be characterized by acute gluten-induced increases in extraintestinal symptoms such as fatigue, rather than gastrointestinal symptoms. During a subacute challenge using the same dose spread over two different time points per

day for 5 consecutive days, gastrointestinal symptoms were elevated in the patient group regardless of gluten *versus* placebo intake. Further, there was a tendency towards higher levels of tension and depression after gluten intake, regardless of patient *versus* control status. Further research on the mechanisms underlying these effects, as well as other (dietary) factors involved in symptom generation in NCGS, is warranted.

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Refeeding electrolyte derangement in an adult inpatient population with anorexia nervosa: A retrospective analysis

MR Braude, D Con, E Newnham

Departments of General Medicine and Gastroenterology and Hepatology, Eastern Health Clinical School, Monash University, Melbourne, Victoria, Australia

Introduction: Patients with anorexia nervosa (AN) are considered at very high risk of refeeding syndrome (RFS), which is a rare and potentially devastating complication of dietary reconstitution in the malnourished patient. Early identification of RFS is essential, and an important surrogate marker for RFS is hypophosphatemia. Less well-recognized, but of equal importance, is the identification of hypomagnesemia, hypokalemia, and vitamin deficiencies associated with refeeding.

Aim: To review electrolyte dynamics associated with refeeding in medical inpatients with AN, and to explore potential predictive risks.

Methods: Data were derived retrospectively from 95 inpatients with moderate-to-severe AN admitted to an acute setting for medical stabilization within our adult eating disorders unit between November 2011 and August 2017. Patients were assessed by a senior dietitian, placed on a step-up dietary restoration program tailored to their individual RFS risk profile, and closely monitored using hemodynamic, biochemical, and anthropometric measurements. Univariable logistic regression was used to analyze categorical data.

Results: During the audit period, 95 patients were admitted with AN (85 [89.5%] female; median age, 21 years [IQR, 18–28]; 61 [64.9%] restrictive AN phenotype; median length of stay, 9.6 days [IQR, 5.8–19.7]). We identified a statistically significant decrease in refeeding electrolytes during inpatient refeeding. This occurred between Day 1 and Day 3 of admission. Overt refeeding electrolyte derangement was seen in 22 patients (23.2%), 12 (12.6%) of whom were found to have refeeding hypophosphatemia. Refeeding hypophosphatemia was associated with older age (odds ratio [OR], 1.05 per year; 95% CI, 1.01–1.10, P=0.018), and Code Grey (OR, 9.0; 95% CI, 2.0–41.5; P=0.005). Age was additionally associated with refeeding hypomagnesemia (OR, 1.06 per year; 95% CI, 1.02–1.10; P=0.006) and hypokalemia (OR, 1.06; 95% CI, 1.01–1.11; P=0.019), while Code Grey was additionally associated with hypomagnesemia (OR, 4.9; 95% CI, 1.2–21.0; P=0.031) but not hypokalemia. Nasogastric feeding was associated with refeeding hypokalemia (OR, 9.4; 95% CI, 1.8–50.3; P=0.009). Bradycardia was protective against refeeding hypophosphatemia (OR, 0.22; 95% CI, 0.05–0.89; P=0.034). No other hemodynamic changes were significant. Body mass index (BMI) (range, 10.0–24.9 kg/m^2) was not associated with refeeding electrolyte derangement. Refeeding electrolyte derangement did not predict

increased length of stay. Intravenous electrolyte replacement was required for 23 patients (26.3%) during their acute admission.

Conclusion: We found significant decreases in refeeding electrolytes at time points consistent with previous studies.[1] We identified nasogastric feeding, Code Grey, and older age as potentially predictive factors for refeeding electrolyte dysfunction. Bradycardia was possibly protective and has been shown to normalize more quickly than other hemodynamic parameters during refeeding.[2] Higher calories associated with nasogastric feeding are unlikely to explain the refeeding electrolyte shifts in isolation.[3] Moreover, BMI has borne out as a variable predictor but, importantly, has not been positively correlated in a cohort of patients with severe AN.[4] Similar to our study, older age has previously been identified as an independent risk factor for refeeding hypophopshatemia in a retrospective analysis.[5] Our data highlight the importance of vigilant electrolyte monitoring in all patients admitted for medical management of AN, particularly during the early days of an acute admission with AN.

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Intervening with an intragastric balloon to induce weight loss and reverse type 2 diabetes

Brett A, Fourlanos S, Fetterplace K

Royal Melbourne Hospital, Melbourne, Victoria, Australia

Introduction: Obesity is a major factor in type 2 diabetes becoming one of the most common non-communicable diseases in both the developed and developing world. The Australian Diabetes, Obesity and Lifestyle (AusDiab) study reported that people with obesity are at up to four times greater risk for developing diabetes than those with normal weight. A pilot study showed that 1 week of restricted energy intake (600 kcal/day) in patients with diabetes resulted in normalization of beta-cell function and hepatic insulin sensitivity.[1] The reversal of diabetes and its pathophysiology might best be achieved by a combination of restricting energy intake and inducing weight loss acutely. The intragastric balloon (Orbera, Apollo Endosurgery) offers a non-permanent intervention that can induce acute weight loss (mean, 15 kg) over 6 months.[2] We hypothesized that restricting energy intake and inducing weight loss using an intragastric balloon can reverse type 2 diabetes.

Aim: Our aim was to determine the efficacy of an intragastric balloon in reducing weight and reversing type 2 diabetes in patients.

Methods: An intragastric balloon was endoscopically inserted in 20 participants with or without diabetes (diagnosed within the past 3 years and taking oral hypoglycaemic therapy alone) with a body mass index (BMI) $\geq$27 kg/m^2. The procedures were performed at Epworth Hospital Richmond and approved by its human research and ethics committee. Following the procedure, the participants were reviewed by the gastroenterologist after 1 week and then every 4 weeks or more frequently if necessary. The intragastric balloon was removed after 6 months, and participants were reviewed at 9 and 12 months. All patients were offered a multidisciplinary rehabilitation program including a dietician, physiotherapist, and psychologist.

Results: The study was continued to include a total of 55 patients. Anthropology and remission of diabetes were assessed at enrolment and after removal of the intragastric balloon. All participants were included in the analysis. Mean weight and BMI at insertion were 101 kg (range, 66–229 kg) and 36 kg/m^2 (range, 29–51), respectively. Five patients had type 2 diabetes at enrolment. Mean weight loss on extraction of the balloon was 10.1 kg, mean change in BMI was 3.8 kg/m^2. Mean percentage of total weight loss was 10.8%. Three patients had early removal of the balloon because of intolerance. None of the five patients with diabetes had reversal of diabetes or a statistically significant change in HbA_{1c} level after balloon insertion. There were no major complications.

Conclusion: Intragastric balloon insertion achieves clinically significant weight loss at 6 months, but longer-term data are necessary to assess health benefits. More studies are required to assess efficacy in the treatment and reversal of type 2 diabetes. Further data will be reported on long-term weight loss after balloon removal.

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Continuous terlipressin infusion improves dietary intake and functional muscle strength in patients awaiting liver transplantation: An observational study

Chapman B[1], Gow P[2], Sinclair M[2], Angus P[2], McClure T[2], Mills C[2] and Testro A[2]

[1]Nutrition and Dietetics Department, Austin Health, and [2]Liver Transplant Unit, Austin Health, Melbourne, Victoria, Australia

Introduction: Malnutrition and sarcopenia are highly prevalent in patients with end-stage liver disease. Portal hypertension contributes to their development with multiple negative effects on gastrointestinal function, including the development of ascites, reduced gastric reserve, slowed intestinal transit, malabsorption and bacterial translocation. Terlipressin is a vasopressin agonist widely used in hospitalized patients with portal hypertensive complications. Our center offers outpatient continuous terlipressin infusion as a bridge to transplantation in patients with hepatorenal syndrome or refractory ascites. We describe for the first time the effect of terlipressin on nutritional and functional muscle parameters in this novel cohort.

Methods: Nutritional (subjective global assessment) and functional muscle assessment (handgrip strength), dietary intake (energy and protein), volume and frequency of paracentesis, severity of liver disease (MELD, MELD-Na scores), and complications of therapy were prospectively recorded at commencement of terlipressin and again at follow-up (transplantation, cessation of therapy or census date). Those with incomplete nutritional data and/or with an infusion duration less than 2 weeks were excluded.

Results: Nineteen patients treated with continuous terlipressin infusion met inclusion criteria (89% male; mean age, 58.1±7.8 years; hepatorenal syndrome, n=14; refractory ascites, n=5). All patients were malnourished at start of therapy, 63% (n=12) had poor muscle strength (grip strength below sex-specific cut-off), and the mean frequency of paracentesis was 3.02 per 30 days (range, 0.67–5.0) before starting terlipressin. The median duration of treatment was 51 days (range, 24–376), with a total of 2379 patient-days of terlipressin. Energy and protein intake improved from 55% to 80% and 50% to 91% of estimated requirements, respectively, during terlipressin treatment (both P<0.001). Handgrip strength increased from 24.7 kg of force to 29.5 kg (P=0.001). Terlipressin therapy resulted in a significant reduction in median creatinine level (from 178 µmol/L to 118 µmol/L, P<0.001), which was the primary driver in reducing MELD (from 24 to 19, P=0.001) and Na-MELD (27 to 20, P<0.001) scores. No significant change in liver function was observed with terlipressin. The frequency of large-volume paracentesis reduced by 48% across the entire cohort, to a mean of 1.56 paracentesis drains per 30 days (P<0.001). Fourteen patients (74%) were transplanted, two were delisted (10%) and three (16%) continue receiving terlipressin while awaiting liver transplant. There have been no clinical complications attributed directly to terlipressin therapy.

Conclusion: Continuous terlipressin infusion significantly improves both nutritional and functional muscle parameters in patients with cirrhosis on the liver transplant waitlist, in whom such parameters

usually demonstrate a progressive decline. Through sustained reduction in portal hypertension, we postulate that continuous terlipressin infusion reduces ascites and its associated protein losses, increases calorie and protein intake by improving gastric reserve and may improve enteral absorption, with subsequent net gain of muscle strength.

Ultrarapid iron polymaltose infusion for iron deficiency anemia (UltraRIIPH): A pilot safety study

JK Chin, I Banakh, M Turek, T Churchill

Peninsula Health, Melbourne, Victoria, Australia

Background and Aim: Iron deficiency anemia is a common diagnosis among hospitalized patients and can be treated with iron replacement. Currently available intravenous iron formulations in Australia include ferric carboxymaltose and iron polymaltose. Previous studies have demonstrated the safety of up to 1500 mg of iron polymaltose administered as a rapid 1-hour infusion.[1,2] The vastly more expensive ferric carboxymaltose is commonly preferentially prescribed, due to its shorter administration time of 15 minutes. Unfortunately, this benefit is lost when average doses for total body iron replacement of 1200 mg to 1300 mg are required, as ferric carboxymaltose is capped at a maximum dose of 1000 mg per week.[2,3] In order to improve patient outcomes and offer significant resource savings, we conducted this safety study of iron polymaltose at comparable ultrarapid rates of administration.

Methods: This was an open-label, non-randomized, double-arm pilot study conducted at a tertiary hospital from November 2017 to January 2018. It was approved by the Human Research Ethics Committee (HREC) and the Drugs and Therapeutics Committee (DTC). The initial 10 patients were consented to receive iron polymaltose infusions over 30 minutes and, after a safety evaluation by the HREC and DTC, a subsequent group of 10 patients were infused over 15 minutes. Patients were monitored for adverse effects and vital signs were recorded by medical staff before the infusion and at 5-minute intervals until completion of the infusion, with continued monitoring at 15-minute intervals during the hour after infusion. All adverse effects were recorded and graded for severity. Delayed adverse reactions were investigated by scanning through digitized medical records, as well as by directly contacting all patients a week after the infusion.

Results: The mean dose of iron polymaltose administered in the 30-minute infusion group was 1090 mg, compared with 1190 mg for the 15-minute infusion group. Three patients in each group experienced mild adverse effects during the infusion, which did not interfere with infusion completion. Reported adverse effects were a warm sensation in both arms, feeling cold, palpitations, dizziness, and pain in the contralateral wrist. These adverse reactions were transient and did not require any intervention or treatment. Two patients in each group reported delayed adverse effects during the following week. In the 30-minute infusion group, one patient reported feeling mild nausea and headache, while a second patient reported moderate headache. In the 15-minute infusion group, one patient reported moderate arthralgia and another patient reported mild headache with influenza-like symptoms. These adverse effects were effectively controlled with paracetamol without needing medical attention. No severe adverse reactions

were reported. The safety profile of ultrarapid iron polymaltose infusions was found to be comparable to that of slower infusions and to the reported adverse effects of ferric carboxymaltose infusions.

Conclusion: This pilot study demonstrated the safety profile of ultrarapid infusions of iron polymaltose up to 1500 mg, which was similar to that of slower infusion rates and ferric carboxymaltose. A prospective study with larger patient numbers is required to further validate current findings, with significant potential to improve patient convenience, as well as offering substantial resource savings through reduced nursing time and direct medication costs for hospitals and infusion centers.

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The effect of a Mediterranean diet and low-fat diet on intrahepatic fat, liver stiffness and insulin resistance in patients with non-alcoholic fatty liver disease: Preliminary findings from the MEDINA Trial

George ES[1,2], Reddy AJ[1], Nicoll AJ[3], Sood S[4], Ryan M[5], Johnson NA[6], Itsiopoulos C[1], Roberts SK[7], Tierney, AC[1,8]

1. Department of Rehabilitation, Nutrition and Sport, La Trobe University, Melbourne, Victoria, Australia
2. School of Exercise Science and Nutrition, Deakin University, Geelong, Victoria, Australia
3. Department of Gastroenterology, Eastern Health, Melbourne, Victoria, Australia
4. Department of Gastroenterology, Melbourne Health, Melbourne, Victoria, Australia
5. Department of Gastroenterology, St Vincent's Hospital, Melbourne, Victoria, Australia
6. Faculty of Health Sciences, University of Sydney, Sydney, New South Wales, Australia
7. Department of Gastroenterology, The Alfred Hospital, Melbourne, Victoria, Australia
8. School of Allied Health, University of Limerick, Limerick, Ireland

Introduction: Currently, the cornerstone of therapy for non-alcoholic fatty liver disease (NAFLD) is lifestyle modification, including diet modification to achieve weight loss. While the Mediterranean diet (MD) has been widely researched in the context of cardiovascular disease, there are limited data evaluating its impact in patients with NAFLD. The low-fat diet (LFD) represents the current dietary recommendation for chronic disease management, including NAFLD, in Australia. This aim of this study was to explore the

effect of an MD compared with an LFD on intrahepatic lipids, liver stiffness measure and insulin resistance in patients with NAFLD.

Methods: Patients with proven NAFLD recruited from three major metropolitan hospitals were randomized to either an MD or LFD for a 3-month intervention period. Liver fat concentration was quantified using proton magnetic resonance spectroscopy; insulin resistance was measured using homeostatic model assessment; and liver stiffness was measured with transient elastography (Fibroscan). Both study arms consisted of three face-to-face and three telephone call follow-up consultations delivered by an accredited practising dietitian. Anthropometrical, clinical, dietary and biochemical assessments were measured at each face-to-face appointment.

Results: In total, 25 patients (mean age, 49.6 ± 15.9 years; BMI, 32.7 ± 7.1 kg/m^2; 44% male; 48% with diagnosed diabetes) were randomized to an MD (*n*=12) or LFD (*n*=13) arm. The MD group showed a clinically meaningful reduction in liver fats (–12%, NS) compared with no change in the LFD group (0.2%, NS). The LFD group reduced energy consumption (–800kJ), resulting in significant weight loss (–6.6 kg, *P*=0.045), while there was no significant weight change in the MD group (0.8 kg, *P*=0.213). There was a small but significant improvement in liver stiffness (–0.9 kPa, *P*=0.022) in the LFD group but not in the MD group (0.1 kPa, *P*=0.65). Insulin resistance improved equally across both groups (–0.6 mmol/L, NS). Alanine aminotransferase and aspartate aminotransferase levels increased non-significantly in the MD group and reduced non-significantly in the LFD group.

Conclusions: Diet is an effective management strategy for patients with NAFLD. The MD has not previously been studied in free-living Australians with NAFLD and may be superior to an LFD in reducing liver fat *ad libitum*. The LFD may elicit more favorable weight loss outcomes. Larger cohorts are required to confirm these findings and longer-term outcomes.

Dietary patterns and the development of Crohn's disease

Christine Chapman-Kiddell[1], Lynda Ross[1,2], Paula MacDermott[1], Katherine Hanigan[3], Anita Pelecanos[4], Graham Radford-Smith[3]

[1]Nutrition and Dietetics, Royal Brisbane and Women's Hospital, Brisbane, Queensland, Australia

[2]Menzies Health Institute Queensland, Griffith University, Gold Coast, Queensland, Australia

[3]Inflammatory Bowel Disease Research Group, QIMR Berghofer Medical Research Institute, Brisbane, Queensland, Australia

[4]QIMR Berghofer Medical Research Institute, Brisbane, Queensland, Australia

Introduction: A case–controlled study was undertaken as part of a larger population-based study conducted by the Brisbane Inflammatory Bowel Disease (IBD) Research Group.

Methods: Patients with incident Crohn's disease (CD) living within the greater Brisbane area who were diagnosed after the commencement of 2004 were included as cases. Healthy controls were identified through the Australian electoral roll and invited to participate in the study. Participants completed a questionnaire to provide personal and health information. Information on usual diet before development of disease was acquired using a self-administered semi-quantitative food frequency questionnaire.

Results: Initial analysis revealed a large disparity in ages between cases and controls. It was decided to restrict data analysis to patients aged <35 years at the time of onset of disease and age-matched controls. Data were available for 146 participants: 44 cases and 102 controls. Diet patterns were created, with negative scores representing a Western Diet pattern and positive scores a Prudent Diet pattern. This continuous variable was then recoded into a categorical variable. The crude odds ratio (OR) suggests that the odds of having CD are 2.3 times higher with the Western Diet than the Prudent Diet (OR, 2.31; 95% CI, 1.13–4.75). However, after adjustment for age, sex, and smoking status, the effect was diminished (OR, 1.37; 95% CI, 0.6–3.6).

Conclusion: Although crude estimates suggest that there is an association between Western Diet type with the development of CD, these effects are diminished after adjustment for potential confounders. This highlights the challenges of identifying dietary factors independently from other factors.

Implementation and impact of a dietitian-led gastroenterology clinic in a tertiary hospital

RN Mutsekwa[1], R Canavan[2], A Spencer[1], R Angus[1]

[1]Nutrition and Food Services , Gold Coast Health, and [2]Gastroenterology, Gold Coast Health, Gold Coast, Queensland, Australia

Introduction: Models of care that use allied health practitioners working in an extended scope of practice (ESP) as the first point of contact for patients have proven effective in managing waitlist demand in a range of specialties. The dietitian-led gastroenterology clinic (DLGC) was one of a number of initiatives undertaken in our hospital and health service (HHS) to address growing demand for gastroenterology services.

Methods: An audit of gastroenterology waitlists was performed before the clinic was established, and DLGC-eligible patients were identified based on the 2016 Queensland Gastroenterology Clinical Prioritization Criteria. A business case for service implementation was developed, and DLGC-eligible patients were offered appointments in the clinic from June 2016. After clearance of the initial backlog, ongoing triaging and reallocation to the DLGC was conducted by the gastroenterology consultant. A mixed-methods approach was used to evaluate service activity and waitlists, DLGC patient characteristics and patient satisfaction between June 2016 and March 2018.

Results: The DLGC eligibility criteria included category 2 patients; patients <50 years of age; patients presenting with dyspepsia or heart burn, reflux, abdominal pain, constipation, diarrhoea, or altered bowel habits, and with no alarm symptoms. A comparison of patient wait times before and after clinic establishment was conducted against a background of rising service demand, with a 20% annual increase in gastroenterology referrals to the HHS. Over the first 21 months of operation, 827 patients met the inclusion criteria and were triaged to the DLGC. This represented 6.8% of all gastroenterology referrals and 20.1% of all category 2 gastroenterology patients. A total of 561 new patients (72% female) and 518 review patients were seen in the DLGC clinic. There were 154 patients who were removed from the gastroenterology waitlists after failing to respond to appointment offers. The remainder had future appointments booked (*n*=47) or were on the waitlist (*n*=65). The dietitian organised screening pathology under ESP and provided lifestyle management strategies. In March 2018, 396 patients (70%) had been discharged to the care of their general practitioners with satisfactory resolution of symptoms. Fifty-three patients (9.4%) were identified as requiring medical review during assessment in the DLGC and were expedited to the gastroenterologist. Since establishment of the service, the average wait times for DLGC-eligible patients reduced from 160 to 61 days. The number of patients in breach of clinically recommended wait times reduced from 74.6% (median breach days, 92) to zero. The average time from referral to discharge in the DLGC was 110 days, with an average treatment time of 50 days. Patients

received an average of 2.3 occasions of service within the DLGC. Patient surveys indicated a high level of satisfaction with the service. Enablers for successful establishment of the DLGC included alignment with broader HHS strategic objectives, positive relationships between stakeholders, strong support from management, and an opt-out process.

Conclusions: A model for the formation of a DLGC that has improved patient flow, along with enablers for successful implementation, has been established. This may be used elsewhere to address outpatient gastroenterology service demand pressures.

Oral taurine supplementation reduces muscle cramps in patients with chronic liver disease

Vidot H,[1,2] Cvejic E,[3] Carey S,[1] Strasser S,[4,5] McCaughan G,[2,5] Allman-Farinelli M,[6] Shackel N[7]

1 Department Nutrition and Dietetics, Royal Prince Alfred Hospital, Sydney, New South Wales, Australia

2 Liver Injury and Cancer, Centenary Research Institute, Sydney, New South Wales, Australia

3 School of Public Health, University of Sydney, Sydney, New South Wales, Australia

4 Sydney Medical School, University of Sydney, Sydney, New South Wales, Australia

5 A. W. Morrow Gastroenterology and Liver Centre, Royal Prince Alfred Hospital, Sydney, New South Wales, Australia

6 School of Life and Environmental Sciences, Charles Perkins Centre, University of Sydney, Sydney, New South Wales, Australia

7 Medicine, University of New South Wales, Sydney, New South Wales, Australia

Introduction: Painful muscle cramps occur in most patients with cirrhosis, significantly affecting their quality of life and sleep patterns. These cramps are frequently unrecognized or overlooked. Current management is based on anecdotal evidence or case study reports.

Aim: This study investigates the effect of oral taurine supplementation on frequency, duration, and intensity of muscle cramps in patients with chronic liver disease (CLD).

Methods: Patients with CLD who experienced three or more muscle cramps per week were enrolled in a double-blinded, randomized, controlled, crossover, taurine dose-variable study. Each participant received either taurine supplementation or placebo for 4 weeks, then crossed to the alternative study arm. Participants recorded frequency, duration, and location of muscle cramps. Biochemical parameters, including serum taurine and methionine levels, were measured at each time point. Linear mixed models were used to analyze outcomes.

Results: Forty-nine patients were enrolled in the study and 30 patients completed the protocol. The mean age of participants was 54.7 years, and 70% were male. Oral taurine supplementation increased serum taurine levels ($P<0.001$). There were no adverse side effects associated with taurine supplementation. Participants receiving 2 g/day of taurine experienced a reduction in cramp frequency (seven cramps per fortnight, $P=0.03$), duration (89 minutes per fortnight, $P=0.03$), and severity (1.4 on visual analogue scale, $P=0.004$) compared with those receiving placebo.

Conclusion: Oral supplementation with 2 g/day of taurine results in a clinically significant reduction in the frequency, duration, and intensity of muscle cramps in patients with CLD. Taurine should be considered a safe and effective intervention in the management of muscle cramps in people with CLD.