HHS Public Access

Author manuscript

Psychooncology. Author manuscript; available in PMC 2018 September 01.

Published in final edited form as:

Psychooncology. 2017 September ; 26(9): 1384–1389. doi:10.1002/pon.4155.

High Rate of Thiamine Deficiency among Inpatients with Cancer Referred for Psychiatric Consultation: Results of A Single Site Prevalence Study

Elie Isenberg-Grzeda, MD, CM, FRCPC,
Department of Psychiatry, Sunnybrook Health Sciences Center, 2075 Bayview Avenue, TG-230, Toronto, Ontario, M4N 3M5, Canada

Megan Johnson Shen, Ph.D.,
Weill-Cornell Medical College

Yesne Alici, MD,
Department of Psychiatry and Behavioral Sciences, Memorial Sloan Kettering Cancer Center

Jonathan Wills, BA,
Department of Information Systems, Memorial Sloan Kettering Cancer Center

Christian Nelson, PhD, and
Department of Psychiatry and Behavioral Sciences, Memorial Sloan Kettering Cancer Center

William Breitbart, MD
Department of Psychiatry and Behavioral Sciences, Memorial Sloan Kettering Cancer Center

Abstract

Objective—Thiamine deficiency (TD) is increasingly recognized in medically ill patients. The prevalence of TD among cancer patients is unknown. This study aims to characterize the prevalence of TD among inpatients with cancer.

Methods—Retrospective chart review of patients admitted to a large cancer center who were referred for psychiatric consultation and whose serum thiamine concentration was measured. Patients with alcohol use were excluded.

Results—Among 217 patients with various cancer types, TD was found in 55.3%. Risk factors included fluorouracil-based chemotherapy, significant weight loss, and undergoing active cancer treatment. Almost all patients were normal weight, overweight, or obese, and few had concomitant vitamin B12 or folate deficiency. A total of 17.5% were receiving multivitamin supplementation. Nearly half (49.8%) did not receive empiric treatment with thiamine and among those who did, treatment delay occurred in the majority of cases (59.6%). Measurement of serum thiamine concentration preceded psychiatric consultation in only 10.6% of cases.

Corresponding Author: Elie Isenberg-Grzeda, MD CM, FRCPC; Sunnybrook Health Sciences Center, 2075 Bayview Avenue, TG-230, Toronto, Ontario, M4N 3M5, Canada. Telephone: +1-416-480-5000. eisenberggrzeda@sunnybrook.ca.

Author Statements: No conflicts of Interest were declared by any authors.

Conclusions—Our findings suggest that TD is highly prevalent among inpatients with cancer, even among normal and overweight individuals, in the absence of other vitamin deficiencies, and while receiving multivitamin supplements. Several potential risk factors were identified, including active cancer treatment. Evaluation of TD was most commonly not initiated by oncologists. Failure to treat and treatment delay were common. Given these findings, oncologists must be vigilant about detecting TD among inpatients with cancer.

MeSH Keywords

Thiamine; Thiamine deficiency; Neoplasms; Nutritional status; Prevalence

Introduction

Thiamine (vitamin B1) is a water-soluble B-vitamin involved in energy production[1]. Like all essential nutrients, thiamine cannot be produced by the body and must be acquired from the diet[2]. Typically, foods fortified with thiamine contain sufficient quantities for healthy individuals to meet recommended dietary allowances[2]. Thiamine is a co-factor for several enzymes in the Krebs cycle and the pentose phosphate pathway[1]. Thus, it is a critical player in the conversion of carbohydrates and amino acids into energy throughout the body. For every 1000 Kcal consumed, an estimated 0.33 mg of thiamine is required[2]. Because of its rapid rate of turnover, daily intake is required and excess thiamine is readily excreted in the urine[2, 3]. Healthy individuals can maintain two to three weeks' worth of thiamine stores in the liver and skeletal muscle in order to buffer against brief periods of thiamine deficiency (TD)[2].

Classically, TD has been associated with alcoholism [4]; however, various pathophysiologic mechanisms in cancer may increase the risk of absolute, relative, and functional thiamine deficiency [5, 6]. Absolute TD is caused by malnutrition, malabsorption, starvation, or vomiting [2]. In cancer patients, this can result from tumour obstruction within the gastrointestinal (GI) tract [6], reduced absorptive area following GI surgery [7], adverse effects of chemotherapy and radiation on appetite and weight [8], and malnutrition caused by prolonged parenteral nutrition [7]. Relative TD can occur with increased metabolic demands and energy requirements, particularly when thiamine supplementation is not administered in proportion to the increase. In cancer patients, clinical examples might include states of infection [6], sepsis [9], or other forms of critical illness [10], fast growing tumors and hematologic malignancies [11], and intravenous carbohydrate loading [12]. Because the stress response causes a net catabolic state and hyperglycemia [13], it is conceivable that exogenous steroid use predisposes to relative TD in a manner similar to carbohydrate loading. Finally, functional TD can occur when thiamine-dependent enzyme activity is reduced. In cancer patients, this can occur following fluorouracil-based chemotherapy [14], which has been proposed to directly inactivate thiamine-dependent enzymes through its metabolite fluoroacetate[15].

Various assays have been used to detect thiamine deficiency. Historically, the indirect tests of thiamine status were considered sensitive [16] and were once the most common tests used to measure TD [17]. One such indirect measure was of erythrocyte transketolase (ETK)

activity (a thiamine-dependent enzyme found in red blood cells), whereby low ETK activity was presumed to reflect a TD state [17]. Similarly indirect, thiamine pyrophosphate (TPP) effect measured the percentage of increase in ETK activity after TPP is added to the sample, such that a greater increase in ETK activity was presumed to reflect a more profound state of thiamine deficiency [17]. Other indirect measures of thiamine status have been noted in the literature [16]. A newer biochemical method for detecting thiamine by high-performance liquid chromatography (HPLC) has replaced indirect measurement of thiamine [18] and is noted in several TD prevalence studies [19, 20]. HPLC can measure free thiamine, which exists in serum or plasma, as well as mono- and di-phosphorylated thiamine, which exist in red and white blood cells. Because most of the blood's thiamine exists within red blood cells, measuring whole blood or red blood cell concentration of TPP is thought to be the most sensitive and precise method to determine thiamine status [21]. Still, and despite their limitations, serum and plasma concentrations of thiamine have been used in many studies of TD in various medically ill patient populations [22-25].

Very few studies have characterized the prevalence of TD in cancer. To our knowledge, only three such studies exist. In one pilot study, TPP effect was greater among a sample of 14 patients with untreated chronic lymphocytic leukemia versus controls [5]. In a longitudinal study of a heterogeneous group of cancer patients, TPP effect increased over the course of treatment among 26 patients receiving fluorouracil-based chemotherapy versus non-fluorouracil controls [14]. In a third prospective study of 40 patients with liver cancer, statistically significant TD, as measured by HPLC in samples of both red blood cells and whole-blood, was greater among liver cancer patients compared to healthy controls [19].

TD can lead to clinically relevant pathology, including the neuropsychiatric syndrome known as the Wernicke-Korsakoff Syndrome (WKS) or thiamine-related encephalopathy (TRE) [27]. Recent systematic reviews suggested that WKS is under-recognized among non-alcoholic medically ill patients in general [26] and among non-alcoholic cancer patients, specifically (Isenberg-Grzeda et al., Lancet-Oncology, in press). Both reviews argued that clinicians may be less apt to recognize WKS among non-alcoholic patients. Given that thiamine supplementation is considered safe and effective at both preventing and treating TD-related syndromes, several national guidelines recommend that the suspicion of TD should warrant empiric thiamine supplementation [18, 28], and many experts recommend collecting blood for measurement of thiamine concentration prior to empiric treatment [2, 18, 29, 30].

Aims

Given that inpatients with cancer may have multiple risk factors for TD and that TD-related syndromes appear to be missed among non-alcoholic cancer patients, we aimed to estimate the prevalence of TD among a heterogenous, real-life sample of cancer patients admitted to an acute care cancer hospital. Our secondary aims were to identify risk factors for TD and to report on diagnostic and treatment delay among inpatients with cancer. We believe this will help highlight an area in need of further examination by clinicians and researchers alike.

Methods

Design

This is an exploratory study with a retrospective chart review design. The study was approved by the hospital's institutional review board.

Setting

Convenience sample of patients referred for psychiatry consultation while admitted to a large academic cancer hospital in an urban center. Our psychiatry consultation service sees 10% of all inpatients at our hospital.

Patients

All adult patients admitted to our hospital between July 2013 and December 2014 were identified for possible inclusion if they were referred for inpatient consultation by our psychiatry service and had serum thiamine concentration measured during that admission. Patients were identified by querying two electronic databases for: (a) patients referred for psychiatric consultation and (b) patients who had serum thiamine concentration ordered during the admission. The results were combined and duplicate cases were deleted. For patients receiving multiple consultations or blood tests during the study period, only the first was included. All cases were cross-referenced with the electronic medical record (EMR) to ensure that psychiatric consultation had occurred. Patients were excluded if they had no diagnosis of cancer, if the blood test had been cancelled or the test could not be performed, or if the patient was already receiving thiamine supplementation (oral and/or parenteral) at the time of the blood test. Patients were excluded if they met DSM-IV or DSM-5 criteria for alcohol use disorder [31], as determined by the psychiatric evaluation.

Data Abstraction

All data were abstracted from the EMR by one of the authors (EIG) and entered into a spreadsheet. Data elements included the following: demographic information (patient age, gender, length of stay, date of consultation, cancer diagnosis and treatment); treatment status (active treatment was defined as receiving either chemotherapy within the past 8 weeks, surgery during the current admission, or radiation therapy within the past month); psychiatric diagnosis and symptomatology (abstracted from the psychiatric consultation notes); one or more cognitive symptoms (disturbance of alertness, attention, orientation, short-term memory, or other unspecified cognitive symptom) as determined clinically during psychiatric assessment; Nutrition risk as assessed by nutritionists based on an institutional protocol (patients were categorized into low, moderate, or high risk); body mass index (BMI) was abstracted from nutrition assessments, or, when BMI was not documented in the note, it was calculated manually at the time of chart review by one of the authors (EIG) whenever sufficient information was available (BMI was categorized as follows: BMI < 18.5 is underweight; BMI 18.5 – 24.9 is normal; BMI 25 – 29.9 is overweight; BMI ≥ 30 is obese); Significant weight loss, defined as weighing ≤ 90% usual body weight.

Data pertaining to laboratory investigations included: serum thiamine concentration, which is measured at an outside lab (Quest Diagnostics Nichols Institute, San Juan Capistrano,

California; reference range is 8-30 nmol/l; for the purpose of this study, TD refers to serum thiamine concentration < 8 nmol/l); serum vitamin B12 concentration, measured at our hospital laboratory (reference range is 211-911 pg/ml, and because vitamin B12 levels below 400 pg/ml are considered "borderline" [32], the current study defined normal B12 concentration as > 400 pg/ml; serum folate concentration was measured at our hospital's laboratory (concentration >5.4 ng/ml is considered normal, <3.4 ng/ml is considered deficiency, and 3.4-5.4 ng/ml is considered intermediate), and for this study, any concentration < 5.4 ng/ml was considered abnormal. All laboratory and other investigations were ordered as part of routine clinical care based on the judgment of the treating physicians. Therefore, vitamin b12 and folate concentrations had not necessarily been ordered for every patient, and data on vitamin B12 and folate concentration was only reported if the test had been ordered.

Treatment delay was calculated as the number of days between ordering serum thiamine concentration and initiating thiamine supplementation. To infer whether measurement of serum thiamine concentration resulted from psychiatry consultants' recommendations (versus the primary team), the date of consultation was compared to the date of the blood test. When the blood test followed the consult, psychiatry was presumed to have recommended the test. When the date preceded the consult, the primary team was presumed to have ordered the test. Blood tests ordered on the same day as the consult were considered equivocal. Mortality rate was calculated based on the number of patients who died at any point following consultation until the start date of chart review (January 1st 2015).

Data Analysis

Data was re-coded by one of the authors (EIG) and analyzed by two authors (EIG and MS) using IBM SPSS statistics v22 (SPSS, Inc., Chicago, IL, USA). Missing data were excluded from individual analyses. Descriptive statistics including frequencies, percentages, means, standard deviations, medians and ranges were performed. We tested statistical significance between all groups by using Pearson chi-square analyses.

Results

Two hundred thirty nine patients were identified for possible inclusion. Twenty-two were excluded due to already receiving thiamine or no cancer diagnosis, leaving a total sample of 217 patients. Baseline characteristics are listed in Table 1.

Prevalence and Risk Factors for Thiamine Deficiency

Within the total sample, TD was found in 120 patients (55.29%). Patients receiving fluorouracil-based chemotherapy, patients with significant weight loss, and patients receiving active treatment were each significantly more likely to have TD ($p<0.05$; see Figure 1). Serum thiamine concentration had been ordered prior to requesting psychiatry consult in only 23 cases (10.6%).

Associated Features

Only few had vitamin B12 deficiency (n=9;13.2%) or folate abnormality (n=7; 15.6%). Almost all patients with TD were normal weight (n=43; 37.1%), overweight (n=40; 34.5%), or obese (n=25; 21.6%). Twenty-one patients with TD (17.5%) were receiving daily multivitamins. Among those with TD, a diagnosis of delirium or cognitive disorder not otherwise specified was given to 71 patients (59.2%) and at least one cognitive symptom was documented in 83 patients (69.2%).

Treatment Delay

In nearly half of the total sample, thiamine supplementation was never prescribed (n=108; 49.8%) during the hospital admission. Of those who received thiamine supplementation, treatment delay occurred in 65 cases (59.6%) with median treatment delay of seven days (range 1-109).

Discussion

Our findings suggest that TD is highly prevalent among inpatients with cancer referred for psychiatric consultation. Our sample represents a medically-ill inpatient population with heterogeneous cancers, nearly half of whom died within a year of consultation. Given that patients were admitted to medical, surgical, intensive care, and neurology services, our findings may have wide implications for many clinicians treating cancer patients.

Our study highlighted several potential risk factors for TD: Receiving chemotherapy containing fluorouracil, floxuridine, or capecitabine; weight loss of at least 10% of usual body weight; and receiving at least one form of active cancer treatment. The prevalence of TD was so high in the fluorouracil-based chemotherapy group that it calls for the urgent need to study the risks and benefits of empiric thiamine supplementation in this patient group. Given the severity of illness, partially reflected by the high rate of death in our sample, it is tempting to expect that patients would generally have multiple vitamin deficiencies and appear significantly underweight. Interestingly, patients with TD in our sample did not typically have concomitant vitamin B12 or folate deficiencies, and low BMI was also not common. While these findings should be confirmed in future studies, our study suggests that the presence of adequate concentrations of other vitamins and the presence of normal (or greater than normal) body weight must not be used as proxies for adequate thiamine status and should not reassure clinicians with regards to underlying thiamine status.

While guidelines for the use of long-term thiamine supplementation among cancer patients is lacking, the literature strongly favours empiric treatment with thiamine (immediately following blood draw) when acute TD syndromes are suspected. Our findings suggest that hospitalized cancer patients may represent a particularly high-risk group of cancer patients for whom prophylactic treatment is warranted in order to prevent or mitigate the impact of TD-related syndromes. Given the long wait time for thiamine concentration blood test results if hospitals do not test this in-house, the risks of delaying treatment in these patients clearly outweighs the fact that excess thiamine is safe and readily excreted. We recommend that if clinicians have enough of a suspicion of TD or TD-related syndromes, empiric

thiamine supplementation should begin for prophylaxis or treatment immediately after drawing a blood sample. The results of the blood test, once resulted, may help guide the need for further supplementation. Further studies are warranted to test the safety and efficacy of prophylactic thiamine administration to all hospitalized cancer patients.

Our findings also confirmed that problems with detection and treatment delay exist. In the majority of cases, thiamine concentration was not ordered prior to requesting psychiatry consult, implying that clinicians may not be vigilant about detecting TD in this patient population. In our sample, treatment was delayed in the majority of patients who received thiamine supplementation, and nearly half the sample received no supplementation at all. While our study was not designed to explore the reasons why clinicians fail to treat TD, the literature on nonalocholic WKS suggests that clinicians are less apt to diagnose WKS among nonalcoholic patient populations. It is possible that clinicians are less apt to detect and/or treat TD among nonalocholic medically ill patients, including cancer patients, and this should be explored in future studies. Educational initiatives to increase clinicians' awareness of these recommendations may be a strategy to address this problem.

Limitations

Our study has several limitations that should be considered when interpreting results. First, because we did not design a prospective study, the thiamine concentrations reported were those that had been drawn during routine clinical care. In our hospital, serum is used to measure thiamine concentration, which has limitations in accuracy. Second, because we used a non-randomized inpatient sample of patients referred for psychiatric consultation, our results may not be applicable to all cancer patients. Additionally, given that TD-related syndromes can cause neuropsychiatric symptoms, it is possible that a sampling bias may have led to an overestimate of prevalence. Because of our study design, we were not able to conclude whether TD-related symptoms were part of the reason for consultation. Third, our retrospective design may have also conferred bias and limited our ability to establish causal relationships among the associations we found. Finally, the retrospective design implied that serum thiamine concentrations were not ordered systematically as part of a research study and therefore the indication for ordering the test was not known. As a result, the indication may have varied based on patients' clinical presentation as well as clinician background and training. This may have introduced bias resulting in an overestimate of the prevalence.

Future studies should prospectively evaluate prevalence and risk factors for TD in other samples of cancer patients. The method of choice for measuring thiamine concentration should be direct measurement of thiamine diphosphate in samples of whole blood or red blood cells, rather than serum or plasma.

Conclusions

In conclusion, our study suggests that TD is highly prevalent and clinically relevant among inpatients with a variety of cancer types and receiving a variety of cancer treatments. Delays in detection and treatment seem to be the rule, rather than the exception. While there is hardly a question of empirically treating symptomatic patients (after first measuring thiamine concentration), virtually no literature exists on thiamine deficiency among

inpatients with cancer. Our study sheds light on this understudied area and the need for prospectively designed studies aimed specifically at replicating these findings, identifying more risk factors for TD, and assessing the cost-effectiveness of routine screening for TD among inpatients with cancer. Our findings also make a compelling case for empiric prophylaxis for asymptomatic inpatients with cancer receiving 5-FU, significant weight loss, or undergoing treatment. If laboratory measurement of thiamine concentration is performed, we recommend direct measurement of thiamine diphosphate in whole blood or RBCs.

Acknowledgments

This study was funded in part through the National Institutes of Health/ National Cancer Institute Cancer Center Support Grant P30 CA008748. The study was approved by the Memorial Sloan Kettering Cancer Center Institutional Review Board.

References

1. Manzetti S, Zhang J, van der Spoel D. Thiamin function, metabolism, uptake, and transport. Biochemistry. 2014; 53:821–35. [PubMed: 24460461]
2. Isenberg-Grzeda E, Kutner HE, Nicolson SE. Wernicke-Korsakoff-syndrome: under-recognized and under-treated. Psychosomatics. 2012; 53:507–16. [PubMed: 23157990]
3. Institute of Medicine. (US) Standing Committee on the Scientific Evaluation of Dietary Reference Intakes and its Panel on Folate. Other B Vitamins, and Choline. 1998
4. Isenberg-Grzeda E, Chabon B, Nicolson SE. Prescribing thiamine to inpatients with alcohol use disorders: how well are we doing? J Addict Med. 2014; 8:1–5. [PubMed: 24343128]
5. Seligmann H, Levi R, Konijn AM, Prokocimer M. Thiamine deficiency in patients with B-chronic lymphocytic leukaemia: a pilot study. Postgrad Med J. 2001; 77:582–5. [PubMed: 11524517]
6. Isenberg-Grzeda E, Hsu AJ, Hatzoglou V, Nelso C, Breitbart W. Palliative treatment of thiamine-related encephalopathy (Wernicke's encephalopathy) in cancer: A case series and review of the literature. Palliat Support Care. 2014:1–9. [PubMed: 23915975]
7. Rufa A, Rosini F, Cerase A, Giannini F, Pretegiani E, Buccoliero R, Dotti MT, Federico A. Wernicke encephalopathy after gastrointestinal surgery for cancer: causes of diagnostic failure or delay. Int J Neurosci. 2011; 121:201–8. [PubMed: 21244301]
8. Fikhman G, Berger JR, Gal TJ. Wernicke's encephalopathy in the course of chemoradiotherapy for head and neck cancer. Am J Otolaryngol. 2011; 32:250–2. [PubMed: 20434810]
9. Kuo SH, Debnam JM, Fuller GN, de Groot J. Wernicke's encephalopathy: an underrecognized and reversible cause of confusional state in cancer patients. Oncology. 2009; 76:10–8. [PubMed: 19018150]
10. Chadda K, Raynard B, Antoun S, Thyrault M, Nitenberg G. Acute lactic acidosis with Wernicke's encephalopathy due to acute thiamine deficiency. Intensive Care Med. 2002; 28:1499. [PubMed: 12373478]
11. Boniol S, Boyd M, Koreth R, Burton GV. Wernicke encephalopathy complicating lymphoma therapy: case report and literature review. South Med J. 2007; 100:717–9. [PubMed: 17639753]
12. Law HL, Tan S, Sedi R. Wernicke's Encephalopathy in a Patient with Nasopharyngeal Carcinoma: Magnetic Resonance Imaging Findings. Malays J Med Sci. 2011; 18:71–4. [PubMed: 22135604]
13. Desborough JP. The stress response to trauma and surgery. Br J Anaesth. 2000; 85:109–17. [PubMed: 10927999]
14. Aksoy M, Basu TK, Brient J, Dickerson JW. Thiamin status of patients treated with drug combinations containing 5-fluorouracil. Eur J Cancer. 1980; 16:1041–5. [PubMed: 7439220]
15. Yeh KH, Cheng AL. Acute confusion induced by a high-dose infusion of 5-fluorouracil and folinic acid. J Formos Med Assoc. 1994; 93:721–3. [PubMed: 7858459]
16. World Health Organization (WHO). Thiamine deficiency and its prevention and control in major emergencies. 1999; 2016

17. Talwar D, Davidson H, Cooney J, St JO'Reilly D. Vitamin B(1) status assessed by direct measurement of thiamin pyrophosphate in erythrocytes or whole blood by HPLC: comparison with erythrocyte transketolase activation assay. Clin Chem. 2000; 46:704–10. [PubMed: 10794754]
18. Galvin R, Brathen G, Ivashynka A, Hillbom M, Tanasescu R, Leone MA, EFNS. EFNS guidelines for diagnosis, therapy and prevention of Wernicke encephalopathy. Eur J Neurol. 2010; 17:1408–18. [PubMed: 20642790]
19. Lin CC, Yin MC. B vitamins deficiency and decreased anti-oxidative state in patients with liver cancer. Eur J Nutr. 2007; 46:293–9. [PubMed: 17571208]
20. Hanninen SA, Darling PB, Sole MJ, Barr A, Keith ME. The prevalence of thiamin deficiency in hospitalized patients with congestive heart failure. J Am Coll Cardiol. 2006; 47:354–61. [PubMed: 16412860]
21. Mayo Foundation For Medical Education And Research. Thiamine (Vitamin B1). Whole Blood. 2016; 2016
22. Falder S, Silla R, Phillips M, Rea S, Gurfinkel R, Baur E, Bartley A, Wood FM, Fear MW. Thiamine supplementation increases serum thiamine and reduces pyruvate and lactate levels in burn patients. Burns. 2010; 36:261–9. [PubMed: 19501976]
23. Frank T, Czeche K, Bitsch R, Stein G. Assessment of thiamin status in chronic renal failure patients, transplant recipients and hemodialysis patients receiving a multivitamin supplementation. Int J Vitam Nutr Res. 2000; 70:159–66. [PubMed: 10989764]
24. Donnino MW, Carney E, Cocchi MN, Barbash I, Chase M, Joyce N, Chou PP, Ngo L. Thiamine deficiency in critically ill patients with sepsis. J Crit Care. 2010; 25:576–81. [PubMed: 20646908]
25. Donnino MW, Cocchi MN, Smithline H, Carney E, Chou PP, Salciccioli J. Coronary artery bypass graft surgery depletes plasma thiamine levels. Nutrition. 2010; 26:133–6. [PubMed: 20005469]
26. Scalzo SJ, Bowden SC, Ambrose ML, Whelan G, Cook MJ. Wernicke-Korsakoff syndrome not related to alcohol use: a systematic review. J Neurol Neurosurg Psychiatry. 2015
27. Isenberg-Grzeda E, Alici Y, Hatzoglou V, Nelson C, Breitbart W. Nonalcoholic Thiamine-Related Encephalopathy (Wernicke-Korsakoff Syndrome) Among Inpatients With Cancer: A Series of 18 Cases. Psychosomatics. 2016; 57:71–81. [PubMed: 26791514]
28. Thomson AD, Cook CC, Touquet R, Henry JA, Royal College of Physicians, London. The Royal College of Physicians report on alcohol: guidelines for managing Wernicke's encephalopathy in the accident and Emergency Department. Alcohol Alcohol. 2002; 37:513–21. [PubMed: 12414541]
29. Donnino MW, Vega J, Miller J, Walsh M. Myths and misconceptions of Wernicke's encephalopathy: what every emergency physician should know. Ann Emerg Med. 2007; 50:715–21. [PubMed: 17681641]
30. Sechi G, Serra A. Wernicke's encephalopathy: new clinical settings and recent advances in diagnosis and management. Lancet Neurol. 2007; 6:442–55. [PubMed: 17434099]
31. Bartoli F, Carra G, Crocamo C, Clerici M. From DSM-IV to DSM-5 alcohol use disorder: an overview of epidemiological data. Addict Behav. 2015; 41:46–50. [PubMed: 25305657]
32. Mayo Foundation For Medical Education And Research. Vitamin B12 Assay. Serum. 2015; 2015

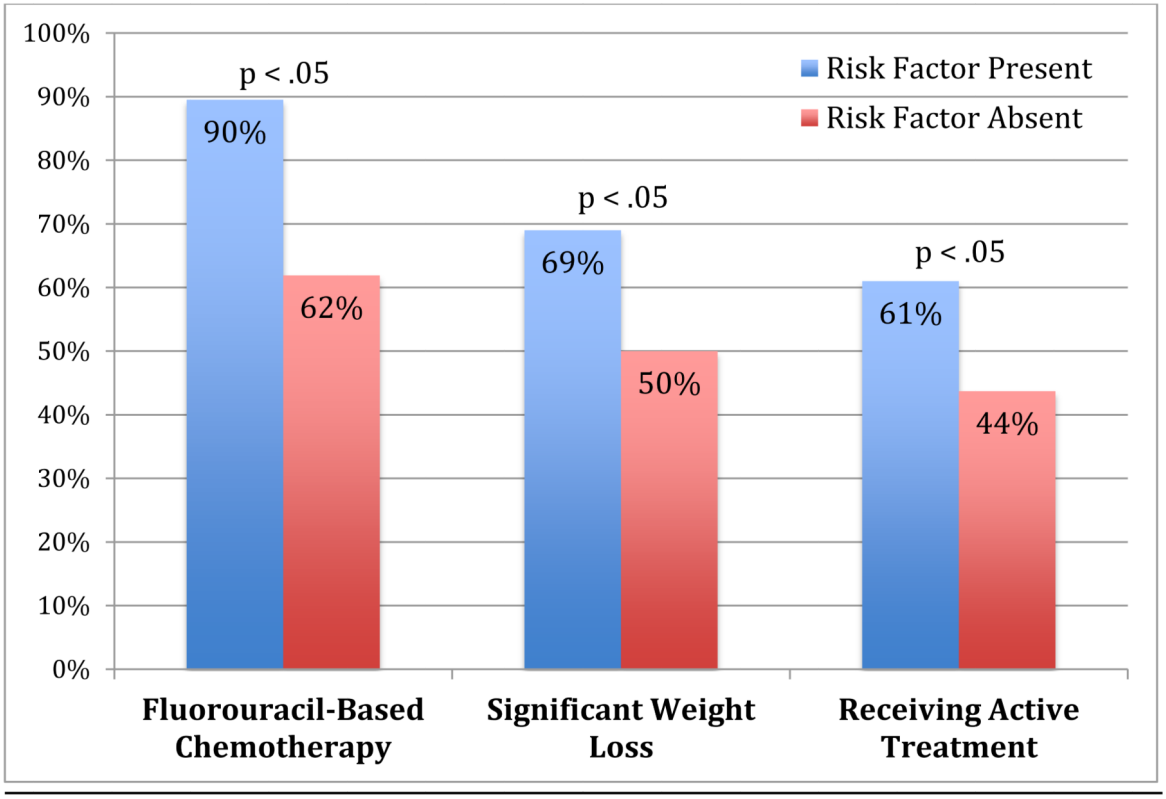

Figure 1. Prevalence of TD Based on Presence or Absence of Risk Factors

Left: Prevalence of TD among patients receiving fluorouracil-based chemotherapy (blue, n=17;90%) versus patients receiving non-fluorouracil-based chemotherapy (red, n=52;62%), $\chi^2(1)=5.326$ (p = .021). Middle: Prevalence of TD among patients with significant weight loss (blue, n=49;69%) versus patients without significant weight loss (red, n=58;50%), $\chi^2(1)=6.505$ (p = .011). Right: Prevalence of TD among patients receiving active treatment (blue, n=89;61%) versus patients not receiving active treatment (red, n=31;71%), $\chi^2(1)=5.782$ (p = .016).

Table 1
Patient Demographics and Baseline Characteristics

Variable	Frequency *n* (%)
Age, Mean (SD)	63.2 years (14.7)
Gender	
Male	119 (54.8%)
Female	98 (45.2%)
Cancer Type / Site	
Hematologic	72 (33.2%)
Genitourinary	19 (8.8%)
Lung	19 (8.8%)
Gastrointestinal	18 (8.3%)
Hepatopancreatobiliary	16 (7.4%)
Sarcoma	15 (6.9%)
Head and Neck	14 (6.5%)
Gynecologic	14 (6.5%)
Breast	13 (6%)
Other	17 (7.8%)
Mortality	
Rate	99 (45.6%)
Median Time from Consult (range)	36 days (3-372)
Nutrition Screening *	
Low Risk	4 (1.8%)
Moderate Risk	25 (11.5%)
High Risk	179 (82.5%)
Admitting Service	
Medicine	143 (65.9%)
Surgery	48 (22.1%)
Intensive Care Unit	14 (6.5%)
Neurology	12 (5.5%)
Psychiatric Consult Diagnosis	
Delirium/Cognitive Disorder	131 (60.4%)
Mood or Anxiety Disorder	45 (20.7%)
Adjustment Disorder	35 (16.1%)
Other	6 (2.8%)
Cancer Treatment **	
Surgery ***	42 (19.4%)
Chemotherapy	103 (47.5%)
Radiation	30 (13.8%)
No Active Treatment	71 (32.7%)

SD = Standard deviation

*Indicates that the sum is less than 100% due to missing data.

**Sum is greater than 100% since patients may have received more than one type of treatment.

***All surgeries were performed during the current admission and the median time from surgery to measurement of serum thiamine concentration was 8 days (range 1-43 days).