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28-year-old with type 1 diabetes and multiple autoimmune diseases — the need for the individualization of diabetes treatment

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Abstract

The aim of this case report is to summarize the clinical picture of a patient with T1DM and other autoimmune diseases, highlighting the individualization of treatment. A 28-year-old patient was diagnosed with T1DM, followed by autoimmune thyroiditis and celiac disease. In the following years, Crohn's disease, primary sclerosing cholangitis, and autoimmune hepatitis were diagnosed. At the same time, primary adrenocortical insufficiency was excluded based on a Synacthen test. The patient has been treated with a personal insulin pump (initially insulin aspart, later insulin lispro) for 15 years. Azathioprine and methylprednisolone were prescribed for Crohn's disease. HbA1c was 8.4% in January 2017. Treatment with a single morning dose of methylprednisolone (8 mg) required a non-physiological basal insulin infusion pattern, peaking at 1.45 units/h between 12:00 and 20:00. Empagliflozin 10 mg once daily was initiated, followed by dapagliflozin 5 mg from 2019. After four weeks, the average glycemia over 14 days was 185 (± 78.3) mg/dl. From January 2023, following reimbursement for glucose monitoring in patients aged 26 and above, the patient began using FreeStyle Libre 2, leading to improved metabolic control. To our knowledge, this is the first description of a patient with T1DM and a wide range of autoimmune disorders in whom metabolic control was improved using a non-standard insulin pump regimen, a continuous glucose monitoring system, and an SGLT-2 inhibitor.

autoimmune disease; diabetes type 1; insulin pump; sodium-glucose co-transporter-2 inhibitor

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INTRODUCTION

Type 1 diabetes (T1DM) is an autoimmune disease caused by the destruction of pancreatic β-cells. Insulin therapy remains the cornerstone of T1DM management. Intensive insulin therapy can be achieved through the use of personal insulin pumps or multiple daily injections. Intensive therapy has been shown to delay the onset and progression of chronic complications such as retinopathy, nephropathy, and neuropathy in patients with T1DM. Although no significant difference in overall mortality was observed between treatment groups in the Diabe-

tes Control and Complications Trial (DCCT), the intensively treated group experienced a two – to threefold higher rate of hypoglycemia. However, after a mean follow-up of 27 years, a modest reduction in all-cause mortality was observed among patients who had initially received intensive therapy for 6.5 years. In addition, a reduction in severe hypoglycemia episodes was noted in the former intensive treatment group, while an increase was seen in the former conventional group.

Despite these findings, preventing severe hypoglycemia remains a challenge in diabetes management. Weight gain during insulin therapy is also frequently reported. It is therefore essential to balance the risks and benefits of insulin therapy intensification to optimize diabetes control.

T1DM is commonly associated with other autoimmune diseases. These include autoimmune thyroid disease (15–30%), autoimmune gastritis (15%), pernicious anemia (10%), celiac disease (4–9%), vitiligo (1–7%), rheumatoid arthritis (1.2%), systemic lupus erythematosus (1.15%), Addison's disease (0.5%), and multiple sclerosis (0.2%). T1DM patients should be regularly screened for other autoimmune conditions, as early diagnosis and management are essential. Guidelines recommend that patients without previously diagnosed autoimmune thyroid disease should undergo annual thyroid function testing. The presence of autoimmune thyroid disease or celiac disease can negatively affect glycemic control. Moreover, coexisting autoimmune conditions can accelerate atherosclerosis and increase cardiovascular risk.

Managing T1DM in the presence of comorbid autoimmune diseases poses a significant challenge, requiring an individualized approach to diabetes care. In recent years, numerous studies have evaluated the potential benefits and safety of adjunctive therapies to insulin in patients with T1DM, including sodium-glucose co-transporter 2 (SGLT-2) inhibitors. These drugs work by inhibiting glucose reabsorption in the proximal tubules of the kidneys, which are responsible for reabsorbing up to 90% of filtered glucose. Dapagliflozin was the first SGLT-2 inhibitor approved in the European Union as an adjunct to insulin therapy in adults with T1DM who have not achieved optimal glycemic control despite intensive insulin treatment.

CASE STUDY

Written informed consent for publication of clinical details and/or clinical images was obtained from the patient.

The 18-year-old patient with type 1 diabetes mellitus (T1DM) was referred from the Children's University Hospital to our Outpatient Clinic of the Department of Metabolic Diseases in Krakow for continued care upon reaching adulthood.

The diagnosis of T1DM was established at the age of 11, in May 2007, based on clinical symptoms and laboratory findings. At that time, autoimmune thyroid disease was also diagnosed. The patient presented with subclinical hyperthyroidism, positive thyroid peroxidase antibodies, and thyroid ultrasound findings consistent with Hashimoto's thyroiditis. In December 2008, the patient developed hypothyroidism and treatment with levothyroxine was initiated (Table 1).

Table 1. The list of comorbidities and the age of diagnosis

Diagnosis	Age at the time of diagnosis (years)	The basis for diagnosis
Diabetes Mellitus	11	Based on clinical symptoms and laboratory tests
autoimmune thyroid disease,Hashimoto disease	13	Positive thyroid peroxidase antibodies, thyroid ultrasound picture corresponding to autoimmune disease and laboratory tests
Celiac disease	13	positive endomysial antibodies, confirmed by duodenal biopsy

Atrioventricular nodal reentrant tachykardia	13	
Crohn disease	15	Positive cANCA antibodies, typical changes in samples of tissue (biopsy) taken during colonoscopy
Sclerosing cholangitis	15	Liver biopsy
Dermatitis atopica		Typical symptoms
Autoimmune utricaria	24?	Typical symptoms, co-existence of autoimmune diseases

In December 2007, the patient was diagnosed with celiac disease. Subsequently, atrioventricular nodal reentrant tachycardia was observed. In April 2009, the patient was hospitalized due to hypochromic anemia. During this hospitalization, both gastroscopy and colonoscopy with biopsy were performed. Gastritis, duodenitis, and Crohn's disease were diagnosed. The patient was discharged with prescriptions for mesalazine, azathioprine, and gradually tapering doses of methylprednisolone.

In June 2009, the patient was again hospitalized due to vomiting and diarrhea. Laboratory tests revealed hypoglycemia and hyponatremia. Adrenal insufficiency was suspected, and a Synacthen test was performed. Baseline cortisol was 204.8 ng/mL; at 30 minutes, 224.5 ng/mL; and at 60 minutes, 277.5 ng/mL. Adrenal insufficiency was ruled out at that time. During this hospitalization, elevated transaminases and features of cholestasis were noted during mesalazine treatment. Upon withdrawal of the drug, liver enzyme levels normalized. Additionally, urticaria observed during the hospitalization resolved after discontinuation of ursodeoxycholic acid.

In October 2009, the patient was admitted due to elevated transaminases and gamma-glutamyl transferase (GGT) levels following antibiotic therapy for a respiratory tract infection. Autoimmune hepatitis was suspected. Laboratory tests showed elevated transaminases, GGT, and total IgG, with viral hepatitis excluded (negative anti-HAV, anti-EBV, anti-CMV, anti-HCV antibodies, and negative HBs antigen). Liver biopsy confirmed the diagnosis of primary sclerosing cholangitis. The patient had a family history of autoimmune diseases—his grandmother had Graves' disease.

Since November 2009, the patient has been treated with an insulin pump (initially Accu-Chek Spirit, later MiniMed Paradigm Veo) and insulin aspart, which was later switched to insulin lispro. In April 2017, the daily insulin requirement was approximately 62 units (currently 66 units; body weight: 71 kg), with a basal-to-bolus ratio of 48.3% to 51.7%. In January 2017, the HbA1c level was 8.4%, and the average 30-day glucose level was 207 ± 88.2 mg/dL. The highest basal insulin infusion rate (1.45 units/hour) was between 12 a.m. and 8 p.m. The daily basal insulin pattern was as follows:

- 12 p.m. to 8 a.m.: 1.15 units/hour
- 8 a.m. to 12 p.m.: 1.35 units/hour
- 12 p.m. to 10 a.m.: 1.30 units/hour
- 12 a.m. to 8 p.m.: 1.45 units/hour (Figure 1)

Despite increased insulin doses, the patient did not achieve satisfactory glycemic control. Therefore, empagliflozin 10 mg once daily was introduced, which led to a reduction in HbA1c

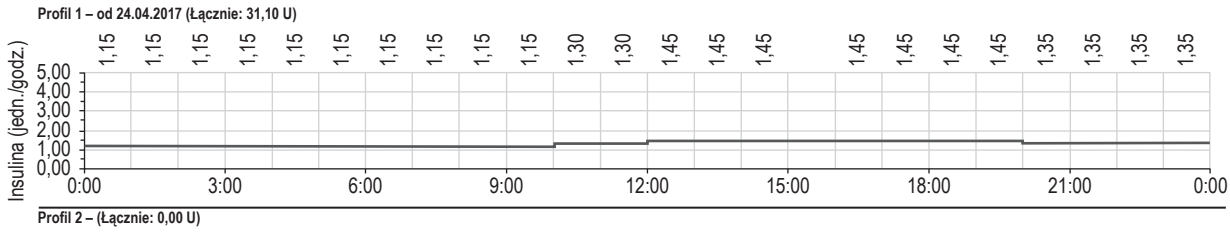


Figure 1. The pattern of basal insulin infusion.

to 8.2% within the following year. The average glucose level was 191 ± 83 mg/dL. Since 2019, the patient has been treated with dapagliflozin 5 mg daily, as approved by the manufacturer. In April 2022, the HbA1c level was 7.5%.

In January 2023, the patient started using the FreeStyle Libre 2 system continuously, following the extension of reimbursement for flash/continuous glucose monitoring (FGM/CGM) for patients aged ≥26. This led to further improvement in metabolic control. In October 2024, the HbA1c level was 7.2%; recent three-month data show an average glycemia of 164 mg/dL, with Time in Range (TIR) at 66%, Time Below Range (TBR) at 1%, and Time Above Range (TAR) at 25%, with TAR level 2 at 8% (Figures 2 and 3).

a) Basal insulin

24-Hour Total	38,500 U

TIME	U/hr
0:00	1,10
4:00	1,10
10:00	1,40
13:00	2,10
16:00	2,30
22:00	1,60

b) Carbohydrate ratio (U/ex)

TIME	Ratio
0:00	1,2
6:00	1,2
12:00	1,3
16:00	1,5

c) Insulin sensitivity (mg/dL per U)

TIME	Sensitivity
0:00	25
6:00	35
12:00	35

d) Blood glucose Target (mg/dl)

TIME	Low	High
0:00	90	110
12:00	90	100

Figure 2. Actual personal insulin pump settings.

The patient is currently treated with azathioprine 50 mg twice daily, methylprednisolone 4 mg daily, and levothyroxine (Euthyrox) 100 µg daily. He receives supplementation with potassium, calcium, and vitamin D during the winter months. He adheres to a gluten-free diet consistent with diabetes and celiac disease dietary recommendations. Further treatment intensification is necessary, primarily concerning daily insulin dosage. Insulin dose increases must be gradual due to a high risk of hypoglycemia associated with malabsorption. A promising treatment option would be the MiniMed 780G insulin pump (a hybrid closed-loop system).

Psychological assessment:

Given the co-occurrence of multiple chronic illnesses, a psychological evaluation was conducted. It included the assessment of the patient's stress coping styles and strategies, adaptation to illness, emotional regulation, and acceptance of his health condition.

Research Tools

The following standardized psychological instruments were used in the assessment:

- **Diabetes Distress Scale (DDS-17):** A 17-item scale measuring four key dimensions of diabetes-related distress: emotional burden, regimen-related distress, interpersonal distress, and physician-related distress. Total scores are calculated as the mean of item responses. Scores are interpreted as follows: < 2.0 indicates little or no distress; 2.0–2.9 indicates moderate distress; ≥ 3.0 indicates high distress [11].
- **Problem Areas in Diabetes Scale (PAID-20):** A 20-item questionnaire assessing diabetes-related psychosocial distress across four domains: negative emotions associated with diabetes, treatment-related problems, eating-related problems, and lack of social support. The total score reflects the overall level of emotional distress related to diabetes [12].

GLUCOSE STATISTICS AND TARGETS

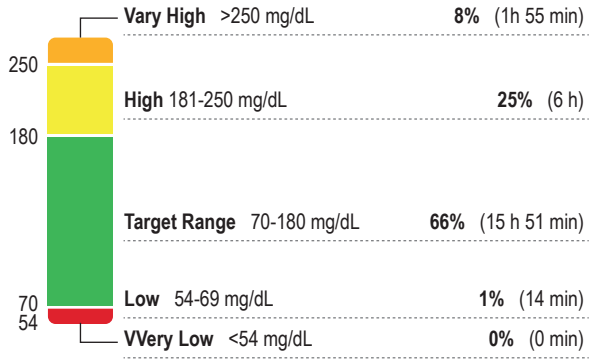
17 July 2024 – 14 October 2024	**90 Days**
Time Sensor Active:	**100%**

Ranges And Targets For	Type 1 or Type 2 Diabetes
Glucose Ranges	**Targets** % of Reading (Time/Day)
Target Range 70-180 mg/dL	Greater than 70% (16h 48 min)
Below 70 mg/dL	Less than 4% (58 min)
Below 54 mg/dL	Less than 1% (14 min)
Above 180 mg/dL	Less than 25% (6 h)
Above 250 mg/dL	Less than 5% (1 h 12 min)
Each 5% increase in time range (70-180 mg/dL) is clinically beneficial.	

Average Glucose	**164** mg/dL
Glucose Management Indicator (GMI)	**7.2% or 56 mmol/mol**
Glucose Variability	**34.2%**

Defined as percent coefficient of variation (%CV); target ≤ 36%

TIME IN RANGES



AMBULATORY GLUCOSE PROFILE (AGP)

AGP is a summary of glucose values from the report period, with median (50%) and other percentiles shown as if occurring in a single day.

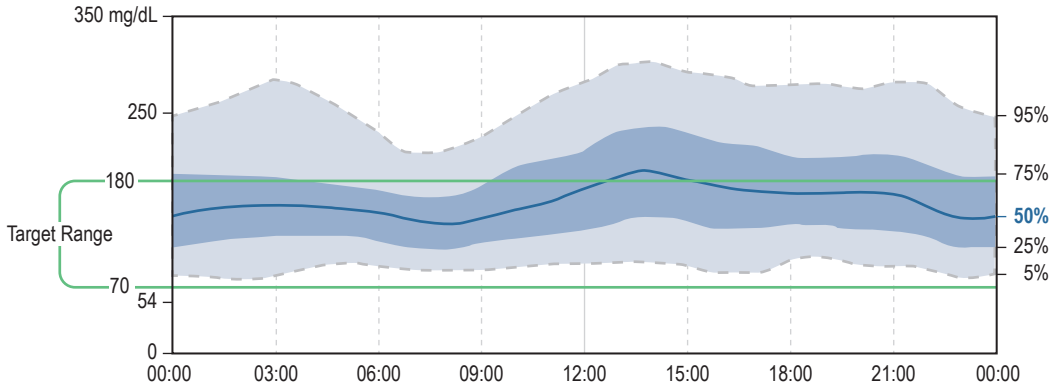


Figure 3. Report from insulin pump and continuous glucose monitoring

- **Diabetes Burnout Scale (DBS):** A 6-item instrument designed to assess diabetes burnout in adults. A total score above 2 suggests the presence of burnout symptoms [13].
- **Quick Inventory of Depressive Symptomatology – Self-Report (QIDS-SR):** A self-administered tool for evaluating the severity of depressive symptoms. Total scores range from 0 to 27 and are categorized as follows: ≤ 5 – no depression; 6–10 – mild; 11–15 – moderate; 16–20 – severe; > 21 – very severe depression [14].
- **Symptom Checklist "O":** A self-report questionnaire used to identify the presence of neurotic disorders, monitor symptom severity over time, and evaluate treatment outcomes. The cut-off score is 180 for males and 200 for females, indicating a possible anxiety disorder [15].
- **Hypoglycemia Fear Survey (HFS):** Developed by Cox et al., this instrument evaluates fear of hypoglycemia. It consists of two subscales: Behavior (HFS-B) and Worry (HFS-W). A global score above 40 indicates a clinically significant level of hypoglycemia-related fear [16].
- **Pittsburgh Sleep Quality Index (PSQI):** Developed by Buysse, Reynolds et al., this 19-item self-report questionnaire assesses sleep quality and disturbances over the past month. A global score > 5 indicates poor sleep quality [17].

- **Mini-COPE:** A 28-item inventory developed by Carver and adapted into Polish by Juczyński and Ogińska-Bulik. It measures 14 different coping strategies (two items per strategy) used in response to stress, capturing both adaptive and maladaptive coping styles [18].
- **Acceptance of Illness Scale (AIS):** An 8-item scale measuring the degree of acceptance of one's illness. Items focus on perceived limitations, dependence, and emotional impact. Total scores range from 8 to 40, with higher scores indicating greater illness acceptance [19].
- **WHO-5 Well-Being Index:** A five-item scale assessing mental well-being over the past two weeks. Each item is rated on a 6-point scale. A total score below 13 may indicate low mood or depressive symptoms [20].
- **Popular Emotional Intelligence Questionnaire (PEIQ):** This tool measures emotional intelligence across four dimensions: Acceptance of emotions, Empathy, Emotional control, and Understanding of emotions. A total emotional intelligence score is also calculated [21].
- **Perceived Stress Scale (PSS-10):** A 10-item instrument that evaluates perceived stress over the past month, focusing on the unpredictability, uncontrollability, and overload of life situations. Higher scores reflect higher levels of perceived stress [22].

The patient demonstrates a high level of psychosocial functioning and exceptional adaptability to the challenges associated with diabetes. He is characterized by a deep acceptance of his health condition and displays a notable ability to plan ahead and actively respond to emerging difficulties. His approach is marked by resilience, a proactive attitude, and a strong commitment to maintaining a balanced and fulfilling quality of life (Table 2).

Table 2. The level of the psychological parameters of patient.

Indices	Score
DDS-17 A. Emotional Burden B. Physician Distress C. Regimen Distress D. Interpersonal Distress: istress:	GLOBAL 38 2.1 1.4 1.8 1.5
PAID-20	19
DBS	2 answers „True"
QIDS-SR	5
HFS	BS: 9 WS: 6 Total: 15
PEIQ 1. AKC (Acceptance, Expression, and Utilization of One's Emotions) 2. EMP (Empathy) 3. KON (Control Over Emotions) 4. ROZ (Understanding and Awareness of Emotions)	GLOBAL RESULT 3.93 AKC: 80 points / 20 items = 4.0 EMP: 70 points / 18 items = 3.89 KON: 85 points / 22 items = 3.86 ROZ: 75 points / 19 items = 3.95
Mini-COPE	A: Acceptance P: Planning Ac: Active coping
AIS	33
WHO-5	14
PSQI	4
PSS-10	23, sten 8

Emotionally, the patient exhibits excellent self-regulation, effectively managing his emotional responses to both anticipated and unexpected stressors. This emotional stability allows him to respond thoughtfully and constructively to his circumstances, rather than react impulsively or avoidantly.

Moreover, the patient shows a significant degree of acceptance regarding his overall life situation. Instead of resisting or denying his condition, he focuses on adapting to it in a practical and meaningful manner. He consistently seeks constructive solutions and remains open to change, which enhances his capacity to navigate the complexities of chronic illness with dignity and purpose.

From a psychological standpoint, the patient presents no signs of diabetes-related distress or burnout, nor are there symptoms of other emotional disorders. Clinical evaluations revealed no evidence of sleep disturbances, anxiety, behavioral or personality disorders, or depressive symptoms — the latter being commonly observed in individuals living with chronic illnesses.

DISCUSSION

To the best of our knowledge, this is the first case report describing the use of empagliflozin as adjunctive therapy to a personal insulin pump in a patient with type 1 diabetes mellitus (T1DM) accompanied by such a broad spectrum of autoimmune comorbidities. In patients with T1DM and multiple autoimmune diseases, treatment must be highly individualized. It is essential to optimize diabetes therapy by carefully weighing the risks and benefits, while also considering the patient's quality of life.

T1DM management requires intensive insulin therapy, typically delivered via multiple daily injections or a personal insulin pump. In recent years, adjunctive therapies such as metformin and incretin-based treatments have been explored in T1DM patients [7–10, 23–24].

Of particular interest in this case is the patient's basal insulin infusion pattern. In contrast to typical profiles observed in our clinic—where basal insulin needs peak between 3 a.m. and 8 a.m. and are lowest overnight—this patient demonstrated the highest basal insulin requirements between 12 a.m. and 8 p.m., with only minor fluctuations throughout the day.

Coexisting autoimmune disorders can complicate glycemic control in T1DM [25–31]. Both untreated hypothyroidism and hyperthyroidism negatively impact glycemic management. Hypothyroidism is associated with weight gain and an increased risk of hypoglycemia [25,26], whereas Graves' disease raises insulin requirements and reduces insulin sensitivity [27]. Celiac disease contributes to more frequent hypoglycemic episodes and decreased insulin demand, particularly when gastrointestinal symptoms such as diarrhea are present [28]. Addison's disease leads to reduced insulin needs and increases hypoglycemia risk [29]. Similarly, Crohn's disease and associated gastrointestinal symptoms can further complicate diabetes management [30].

Moreover, there is evidence linking autoantibodies to cardiac arrhythmias [31], highlighting the importance of monitoring symptoms that may indicate cardiac involvement.

Given the heightened risk of additional autoimmune diseases in T1DM, routine screening is essential to ensure early diagnosis and appropriate treatment. Dittam et al. [26] found that T1DM was the initial diagnosis in 48.3% of patients with polyglandular autoimmune syndromes, with the most frequent combination being T1DM and autoimmune thyroid disease.

The use of dapagliflozin as an adjunct to insulin therapy in adult patients with T1DM who do not achieve adequate glycemic control with insulin alone was approved in the European Union in 2019 [10]; however, this indication was withdrawn by the manufacturer in 2021. Nonetheless, considering the complexity of this case and the mixed mechanisms contributing to hyperglycemia, we believe that the use of dapagliflozin was justified.

It is important to note that systematic reviews and meta-analyses have reported cases of euglycemic diabetic ketoacidosis (DKA)—defined as DKA with normal or only mildly elevated blood glucose levels (<200 mg/dL)—in T1DM patients treated with SGLT-2 inhibitors. Specifically, treatment with dapagliflozin 5 mg, empagliflozin 10 mg, and sotagliflozin at both 200 mg and 400 mg doses has been associated with a significantly increased incidence of DKA compared to placebo [32]. On average, the use of SGLT-

2 inhibitors in adults with T1DM increases the absolute risk of DKA by approximately 4% per year [33].

Ideally, the most effective therapeutic strategy for this patient would involve the use of a hybrid closed-loop insulin pump. Unfortunately, due to the high cost of such devices and the fact that the patient does not meet the current age-based reimbursement criteria in Poland, this option remains inaccessible.

This case highlights the critical role of psychological resilience, emotional intelligence, and active problem-solving in achieving favorable long-term outcomes in chronic disease management [34]. The patient's ability to maintain emotional stability and avoid common psychological complications serves as a model of holistic, integrated care for individuals living with complex chronic conditions.

CONCLUSION

We describe a comprehensive approach undertaken to improve glycemic control in a patient diagnosed with T1DM and multiple autoimmune comorbidities, achieving a reduction in HbA1c from 8.4% to 7.2%. This was accomplished through the use of a personal insulin pump, continuous glucose monitoring systems, and adjunctive therapy with an SGLT-2 inhibitor.

Type 1 diabetes is frequently associated with other autoimmune disorders, highlighting the importance of routine screening and early diagnosis. Timely identification and management of coexisting autoimmune diseases are essential for optimizing outcomes and preventing complications.

In selected cases of T1DM with suboptimal glycemic control—where increasing insulin doses heightens the risk of hypoglycemia and negatively affects quality of life—SGLT-2 inhibitors may be considered as a valuable adjunctive therapy. Their use may be particularly beneficial in patients with complex autoimmune profiles, such as those with polyglandular autoimmune syndromes.

Given the chronic and multifaceted nature of T1DM and its comorbidities, it is crucial to maintain ongoing vigilance not only in terms of metabolic control but also in monitoring patients' mental health throughout the course of their lives. Multidisciplinary care that includes psychological assessment and support remains a key component of effective long-term disease management.

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Authors contribution: *SM, BM – Conducting the patient interview and analyzing medical history; SM, BM, KC – writing the manuscript; KD, KC – psychological analysis, TK, BM, SM – Final review and approval of the case report.*

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