

Preoperative and postoperative optimisation of patients undergoing thyroid surgery: a multicentre quality improvement project at Barts Health NHS Trust

Matt Lechner,¹ Gulwish Moghul,² Deepak Chandrasekharan,^{2,3} Salman Ashraf,³ Oscar Emanuel,² Tiarnan Magos,² Zi Wei Liu,⁴ Margaret Crutchlow,⁵ Stephen Kinghorn,⁵ Gayle McDonnell,⁶ Harry McArdle,⁶ Amr Salem,³ Mike Papesch,^{3,7} Kalpita Majumdar,⁸ Abdulfattah Lakhdar,⁸ Safina Ali,² Jahangir Ahmed,² Ghassan Alusi,² Paul Stimpson,⁹ Mona Waterhouse,¹⁰ Khalid Ghufoor²

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ML, GM and DC contributed equally.

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For numbered affiliations see end of article.

Correspondence to
Mr Matt Lechner;
m.lechner@ucl.ac.uk

Mr Khalid Ghufoor;
k.ghufoor@nhs.net

ABSTRACT

Hypocalcaemia following thyroid surgery can occur in up to 38% of patients. With over 7100 thyroid surgeries performed in 2018 in the UK, this is a common postoperative complication. Undertreated hypocalcaemia can result in cardiac arrhythmias and death. Preventing adverse events from hypocalcaemia requires preoperative identification and treatment of at-risk patients with vitamin D deficiency, timely recognition of postoperative hypocalcaemia and prompt appropriate treatment with calcium supplementation. This project aimed to design and implement a perioperative protocol for prevention, detection and management of post-thyroidectomy hypocalcaemia. A retrospective audit of thyroid surgeries (n=67; October 2017 to June 2018) was undertaken to establish baseline practice of (1) preoperative vitamin D levels assessment, (2) postoperative calcium checks and incidence of postoperative hypocalcaemia and (3) management of postoperative hypocalcaemia. A multidisciplinary team approach following quality improvement principles was then used to design a perioperative management protocol with all relevant stakeholders involved. After dissemination and implementation, the above measures were reassessed prospectively (n=23; April–July 2019). The percentage of patients having their preoperative vitamin D measured increased from 40.3% to 65.2%. Postoperative day-of-surgery calcium checks increased from 76.1% to 87.0%. Hypocalcaemia was detected in 26.8% of patients before and 30.43% of patients after protocol implementation. The postoperative component of the protocol was followed in 78.3% of patients. Limitations include low number of patients which precluded from analysis of the impact of the protocol on length of stay. Our protocol provides a foundation for preoperative risk stratification and prevention, early detection and subsequent management of hypocalcaemia in thyroidectomy patients. This aligns with enhanced recovery protocols. Moreover, we offer suggestions for others to build on this quality improvement project with the aim to further advance the perioperative care of thyroidectomy patients.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Hypocalcaemia is a major postoperative complication following a total or completion thyroidectomy and can lead to significant morbidity and prolonged hospital stay. It can rarely lead to life-threatening complications if poorly managed. The incidence of postoperative hypocalcaemia is variable, occurring in up to 38% of patients, and is likely to increase with the rising number of thyroidectomy procedures being performed annually in the UK and globally. Several studies have looked into preventing postoperative hypocalcaemia by focusing on preoperative risk factors such as a low serum vitamin D level. Vitamin D deficiency is widespread within the UK, with many 'at-risk groups' residents within East London.

WHAT THIS STUDY ADDS

⇒ The primary objective of this quality improvement project was to design and implement a perioperative protocol for prevention, detection and management of post-thyroidectomy hypocalcaemia. Specific aims were to increase preoperative vitamin D testing and day-0 calcium testing and combine these with treatment protocols to prevent and manage hypocalcaemia. This took place in Barts Health NHS Trust. The trust consists of four hospitals within the City of London and East London: St. Bartholomew's Hospital, Royal London Hospital, Whipps Cross University Hospital, and Newham University Hospital. Following introduction of the new protocol within the Trust, we assessed compliance and impact by carrying out a prospective audit (PA) of perioperative thyroidectomy patient care.

BACKGROUND

Post-thyroidectomy hypocalcaemia is often due to hypoparathyroidism, which can

**HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY**

⇒ Our protocol provides a foundation for preoperative risk stratification and prevention, early detection and subsequent management of hypocalcaemia in thyroidectomy patients. This aligns with enhanced recovery protocols. Moreover, we offer suggestions for others to build on our quality improvement work in the perioperative care of thyroidectomy patients.

occur secondary to inadvertent removal of the parathyroid gland(s) intraoperatively, parathyroid devascularisation, haematoma formation or temporary stunning following manipulation.^{1 2} The estimated incidence of transient and permanent hypocalcaemia post thyroidectomy ranges from 19% to 38% and 0% to 3%, respectively.² Most patients suffer from transient hypocalcaemia which is defined as having low serum calcium levels requiring supplementation in the acute postoperative period, with resolution within 6 months once the parathyroid glands have recovered.³ Patients may be asymptomatic or may develop neurological or cardiac symptoms, which can include perioral or digital paraesthesia, carpopedal spasms, tetany or rarely cardiac arrhythmias.³ Thus, symptomatic acute hypocalcaemia should be considered a medical emergency and rapidly treated with oral calcium and vitamin D supplementation, with severe cases requiring additional intravenous calcium supplementation. Permanent hypocalcaemia can lead to the development of cataracts, renal impairment and psychiatric illness, and requires long-term treatment with oral calcium and vitamin D.^{2 3} Along with considerable morbidity, hypocalcaemia can lead to a prolonged hospital stay in the acute setting, patient dissatisfaction, an increased use of resources and NHS costs.³

Multiple predictors and risk factors for developing postoperative hypocalcaemia have been identified.¹ Certain factors, such as preoperative vitamin D levels, are amenable to optimisation. Studies have shown that prophylactic supplementation of vitamin D and calcium can reduce the rates of transient hypocalcaemia post thyroidectomy, including symptoms and length of hospital stay. However, routine prophylactic supplementation can lead to inappropriate treatment and toxicity in patients not at risk.⁴ The optimal treatment strategy is unclear, with different guidelines followed by ear, nose and throat (ENT), general and endocrine surgeons within the UK.

In the UK, the British Association of Endocrine and Thyroid Surgeons (BAETS) has provided guidelines on the management of post-thyroidectomy hypocalcaemia. It has recommended that these guidelines are used as an aid to produce local guidelines in conjunction with local endocrinology and pharmacy colleagues.⁵ The guidelines recommend early treatment of hypocalcaemia, suggesting that the serum corrected calcium levels are checked within 12 hours postoperatively. A normal calcium level is indicated as more than 2.10 mmol/L. If the patient has 'severe symptoms' or a corrected calcium

level of less than 1.80 mmol/L, treatment with a bolus of calcium gluconate followed by an intravenous infusion is recommended, with oral supplementation of a vitamin D and calcium combination (Calcichew-D3 Forte). This oral combination was also recommended on its own for asymptomatic patients with corrected calcium levels between 1.81 and 2.00 mmol/L or symptomatic patients with levels of 2.01–2.10 mmol/L. Asymptomatic patients with levels between 2.01 and 2.10 can be reassured, with a recheck of serum calcium levels within 24 hours. A Cochrane review on this guideline suggested that these recommendations were based on low-level evidence.² These guidelines also do not include any recommendations on preoperative optimisation of our patients despite it being extensively studied in the literature, nor are there recommendations on how to manage patients with oral calcium and/or vitamin D treatment on discharge.^{2 5}

The European Society of Endocrinology (ESE) guidelines advise only on the management of patients with long-term hypoparathyroidism with active vitamin D and calcium supplements. This guideline does not address the preoperative optimisation of patients with transient postsurgical hypoparathyroidism, nor the management of acute postoperative hypocalcaemia.²

The American Thyroid Association (ATA) does not have a dedicated guideline, but provides a detailed appraisal of the heterogeneity in the study and management of post-thyroidectomy hypocalcaemia.⁶ Unlike the BAETS and the ESE guidelines, the ATA statement emphasises the importance of surgeons employing strategies preoperatively to prevent postoperative hypocalcaemia. In particular, in patients listed for a total or completion thyroidectomy, clinicians are recommended to test baseline serum calcium, parathyroid and 25-hydroxy vitamin D levels preoperatively. If the baseline calcium or vitamin D levels are low, the ATA states that it may be appropriate to commence oral calcium or vitamin D, respectively, preoperatively.⁶ The ATA also recommends that it would be prudent to diagnose vitamin D deficiency preoperatively and initiate appropriate treatment. They have also suggested that vitamin D deficiency should be corrected preoperatively, even if this leads to delaying an elective total or completion thyroidectomy.

Although there are several studies that found that preoperative vitamin D deficiency is a significant risk factor for post-thyroidectomy hypocalcaemia and should be treated preoperatively, a study by Lang *et al* found that the presence of mild-to-severe vitamin D deficiency did not affect the rate of postoperative hypocalcaemia.^{1 7–9} However, treating vitamin D deficiency preoperatively has been supported by large systematic reviews and meta-analyses of predictors of post-thyroidectomy hypocalcaemia. These report that preoperative serum vitamin D levels are a biochemical predictor of postoperative hypocalcaemia and supplementation preoperatively reduced the rates of transient post-thyroidectomy hypocalcaemia.^{10 11}

In a regional population with a high percentage of vitamin D deficiency, it would appear that diagnosing

vitamin D deficiency preoperatively and treating this appropriately should reduce the rate of significant hypocalcaemia post thyroidectomy. We may consider delaying elective surgery in patients with severe vitamin D deficiency in order to prevent patients from the morbidity associated with significant hypocalcaemia postoperatively. Preoperative and postoperative magnesium monitoring and Parathyroid hormone (PTH) levels in recalcitrant hypocalcaemia (in our institution PTH levels take up to 2 days) should also be taken into account.

MEASUREMENT

During the first part of the project, we collected data retrospectively on all patients who underwent a total or completion thyroidectomy across all four hospitals. This included procedures carried out by ENT, endocrine and general surgeons. We collected data over a 9-month period (October 2017 to June 2018) to analyse the incidence and management of postoperative hypocalcaemia within our Trust.

A pro forma was used to document the following: location of surgery; operating surgeon; type of surgery (total or completion); demographics (sex, age); histology; whether preoperative bloods were taken and their results (full blood count, urea and electrolytes, adjusted calcium, coagulation profile, group and save, vitamin D, thyroid profile and magnesium); whether postoperative bloods were taken and their results (calcium, parathyroid hormone and magnesium); development of hypocalcaemia postoperatively and whether patients were symptomatic; management of hypocalcaemia acutely and on discharge (including guideline followed if documented); involvement of other teams (endocrine if patient under ENT or general surgery teams); and length of hospital stay. This data was collected using the shared electronic health record system between all hospitals.

Following the retrospective audit (RA), a trust-wide protocol was developed in conjunction with the endocrine team and introduced in October 2018 across all four hospital sites. This was based on current evidence on preoperative optimisation and the management of postoperative hypocalcaemia. We then conducted a PA 6 months later, from April to July 2019, to analyse compliance with the new guideline. For our PA, data was measured in all areas collected for the RA as detailed above.

In order to establish whether the observed outcomes in the RA were secondary to our interventions, we asked whether the guideline/protocol was used to be documented.

DESIGN

Both retrospective and PAs were registered with the Barts Health NHS Trust (Quality Improvement Project registration number 9566).

From the RA, it was clear that there was no general consensus on patient risk stratification, early identification and the management of hypocalcaemia in terms

of guidelines followed and when to request endocrine input. Thus, in order to improve the quality of care we deliver, the intervention implemented following the initial retrospective analysis was a guideline on preoperative optimisation of patients undergoing total or completion thyroidectomy and a guideline on the postoperative management of patients with hypocalcaemia.

The guidelines were developed with input from the endocrine team and the preoperative clinic nurse leads at two sites, thus expected to be followed across teams. The guideline was then discussed in detail at a clinical governance meeting to ensure all doctors involved in managing post-thyroidectomy patients were familiar with the new trust guidelines. At the initial stage, we did not anticipate any problems with compliance. We planned on making our intervention sustainable by reauditing at 6–12 monthly intervals to assess our compliance, to ensure that staff continued to use the protocol and to troubleshoot should there be any issues with compliance.

STRATEGY

Our Specific, Measurable, Attainable, Relevant, and Time-based (SMART) aim was to optimise the management of patients undergoing total or completion thyroidectomy surgery. We aim to reduce the incidence of hypocalcaemia by preoperative optimisation of patients and by improving the management of hypocalcaemia in those who developed it. We undertook a RA to assess the situation prior to the intervention, introduced the guidelines and then reaudited the changes prospectively.

Cycle 1

We performed a RA on the management of patients undergoing a total or completion thyroidectomy. From this audit it was clear that there was no general consensus on the management of hypocalcaemia in terms of guidelines followed and when to request endocrine input. Thus, in order to improve the quality of care we deliver, the interventions implemented following the initial retrospective analysis were as follows.

The first intervention introduced was a standardised guideline on preoperative optimisation of patients, and another intervention introduced was on postoperative management of hypocalcaemia. This was publicised at the ENT clinical governance meetings, digital copies were sent to all ENT and endocrine clinicians and all preoperative assessment nursing staff. Paper copies were displayed on the wards where our post-thyroidectomy patients would be based. Copies of alternative guidelines on the management of hypocalcaemia were removed from the wards to avoid confusion on which guideline to follow.

Furthermore, it was noted that patients were not being optimised preoperatively, with 0% compliance with the preoperative optimisation guidelines. Preoperative optimisation guidelines were thus publicised at the ENT clinical governance meetings, digital copies were sent to all

ENT and endocrine clinicians and all preoperative assessment nursing staff.

Cycle 2

The PA was carried out between April and July 2019, 6 months after the guidelines were initially disseminated, with the improvement cycles occurring during this time period. The compliance with the new postoperative hypocalcaemia guidelines was 78.3%, the preoperative optimisation guideline increased the number of patients being tested for preoperative vitamin D testing, but compliance with consequent treatment of the deficiency was limited due to doctors not readily available in the preassessment clinics.

A group meeting with all members of the preoperative assessment was conducted to discuss issues regarding compliance. The team were finding it difficult to engage with the guidelines, as it was thought to be extra work in an already busy clinic—with similar issues regarding prescribing and chasing results for the additional blood tests requested. An additional method to contact the junior ENT doctors was provided through a group email address that could be used to alert all junior doctors of abnormal blood results. A patient information leaflet was also suggested so that the preoperative nurses could inform patients of the possibility of requiring vitamin D supplementation preoperatively if they were deficient. This could be incorporated into the standard preoperative instructions leaflet provided to all patients attending clinic.

RESULTS

Retrospective audit (RA)

Over a 9-month period from October 2017 to June 2018, data was collected retrospectively for 67 patients undergoing completion or total thyroidectomy across the four hospital sites. This included 17 (25.4%) male and 50 (74.6%) female patients, with a mean age of 52 years. Total thyroidectomy was performed in 51 (76.1%) patients and a completion hemithyroidectomy in 16 (23.9%) patients. The most common histology being a multinodular goitre (n=37; 55.2%) and papillary carcinoma (n=17; 25.4%).

Prospective audit (PA)

This was carried out over 3 months between April and July 2019, with 23 patients in total—4 male (17.4%) and 19 female (82.6%) patients. The mean age was 51 years. A total thyroidectomy was performed in 18 (78.2%) patients and a completion thyroidectomy in 5 (21.7%). The most common histology was a multinodular goitre (n=11; 47.8%) and Graves' disease (n=4; 17.4%).

Comparative results (RA vs PA)

Risk stratification

There was an improvement in the percentage of patients who had the following preoperative bloods taken: full blood count (FBC) (98.5% vs 100%); urea & electrolytes (U&Es) (98.5% vs 100%); corrected calcium (55.2% vs 78.3%); coagulation profile (59.7% vs 82.6%); group and save (91% vs 91.3%); vitamin D (40.3% vs 65.2%);

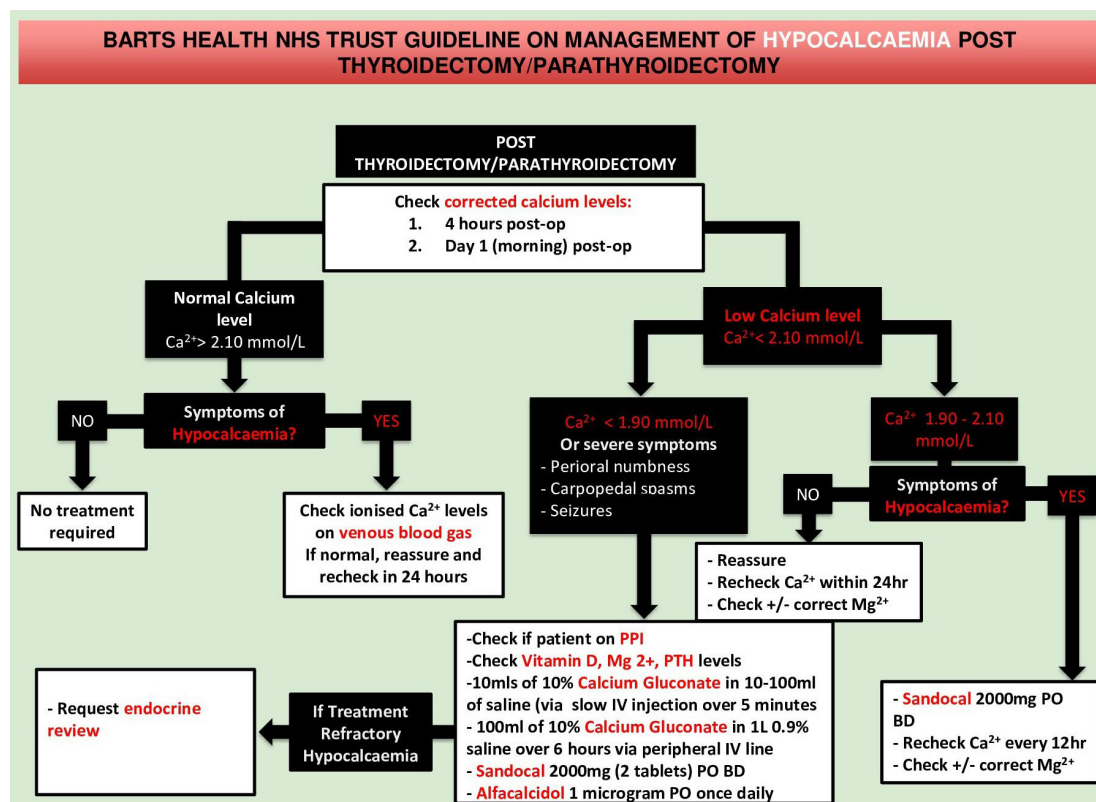


Figure 1 Guideline on management of hypocalcaemia post total or completion thyroidectomy. BD, twice daily; PO, orally.

thyroid profile (98.5% vs 100%); and magnesium (17.9% vs 34.8%).

In the PA, 65.2% of patients had their vitamin D levels checked preoperatively with 26.7% found to have a deficiency and 73.3% with normal levels. In the 26.7% of patients requiring preoperative vitamin D supplementation, only 25% went on to develop postoperative hypocalcaemia and another 25% were placed on vitamin D supplementation on discharge.

Early identification and management

There was an improvement in the corrected calcium being checked 4 hours postoperatively (76.1% vs 87%) and on day 1 (100% vs 100%). Postoperative hypocalcaemia developed in 26.9% versus 30.4% of patients. Intravenous and oral treatment was required in 27.8% versus 42.9% of patients, with only oral supplementation required in 50% versus 57.1%. Oral supplementation was provided on discharge for 71.6% versus 65.2% of patients.

Protocol impact

The compliance with the new postoperative hypocalcaemia guidelines was 78.3%, the preoperative optimisation guideline increased the number of patients being tested for preoperative vitamin D testing, but compliance with consequent treatment of the deficiency was limited due to doctors not readily available in the preassessment clinics. However, a detailed breakdown of the preoperative guideline compliance is paramount here. In terms of taking additional blood tests preoperatively, there was in fact a 65.2% compliance with checking vitamin D levels and a 34.8% compliance with checking magnesium

levels. Compliance with prescribing vitamin D to those with low levels was 0%. However, this may reflect a lack of documentation as it does not align with the increase in preoperative vitamin D checks.

LESSONS AND LIMITATIONS

This project was successful in providing a regional guideline on how to manage postoperative hypocalcaemia. We were able to develop this guideline (figure 1) in agreement with multiple disciplines including endocrine and pharmacy, which was a major achievement in a time when different hospitals within our trust, and even different consultant teams within a hospital, were following different guidelines which had undoubtedly led to confusion in the optimal management pathway for patients previously.

As suggested by the BAETS guidelines, we were able to develop a regional guideline based on the BAETS guidelines for our local patient population with a higher population of patients at 'high risk' of vitamin D deficiency. Thus, we were able to incorporate vitamin D testing preoperatively with the aim to reduce the rates of hypocalcaemia and the postoperative length of stay (figure 2). These guidelines were based on suggestions from the BAETS and ESE guidelines and the ATA statement, thus incorporating guidance from all three major associations.

However, our audit was underpowered to detect a significant difference in the rate of hypocalcaemia postoperatively in our PA. However, with time, we may begin to see an effect on the rates of hypocalcaemia, aiming for a 100% compliance with patients having their vitamin D

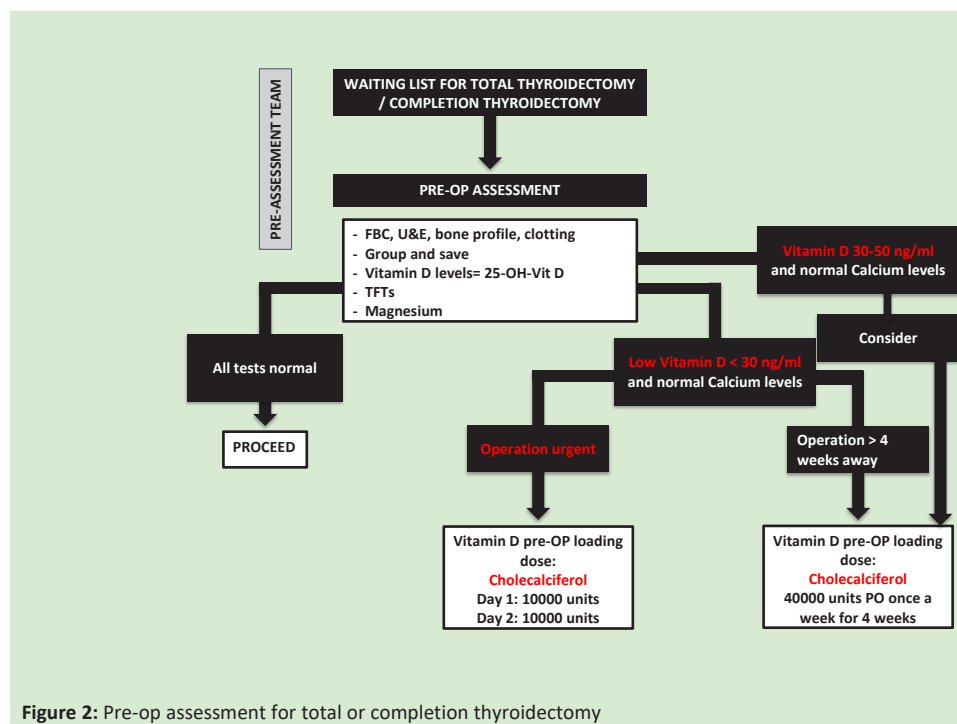


Figure 2: Pre-op assessment for total or completion thyroidectomy

Figure 2 Preoperative assessment for total or completion thyroidectomy. FBC, full blood count; OP, operative; U&Es, urea & electrolytes.



levels checked preoperatively and a 100% compliance with patients being prescribed vitamin D if levels are low. The increase in day-of-surgery postoperative checks and better liaison with endocrinology resulting from this work may help facilitate early identification of hypocalcaemia and prevention of serious consequences.

We did, nonetheless, see a significant compliance with the new postoperative hypocalcaemia guidelines at 78.3%. A clear and concise postoperative management pathway for hypocalcaemia made it easier for junior doctors to follow these guidelines, particularly since it included trust-approved oral and intravenous medication with dosages, when to contact the endocrine team for complex patients, and follow-up plans with endocrine and ENT and at what levels patients can be discharged with oral supplements.

Another limitation was engagement with the nursing team regarding the preoperative guidelines. We presented the guidelines in our governance meeting, but these meetings are usually more difficult to attend for our nursing staff. We will work on engaging with them further, as we would like to overcome difficulties they may have had with engaging with the guidelines.

CONCLUSION

We have been successful in developing a region-specific guideline, based the BAETS, ESE and ATA guidance. Our main addition to the guidelines is checking and correcting vitamin D levels preoperatively when deficient and considering replacing it if below normal, as evidence suggests that vitamin D deficiency is a predictor for postoperative hypocalcaemia. This is an important predictor amenable to intervention, particularly since our East London patient population has a high rate of vitamin D deficiency.

Due to the limitations of our study as discussed, we are unable to make valid conclusions on whether optimising patients with vitamin D deficiency preoperatively leads to reduced rates of postoperative hypocalcaemia. However, this project was useful in introducing a new trust-wide postoperative hypocalcaemia guideline with compliance at 78.3% in our PA, having been developed with input from multiple teams, including head and neck surgeons, endocrine physicians, nurses and other healthcare professionals. Having introduced these new guidelines, this made it easier for junior doctors to follow a clear algorithm, particularly since it included trust-approved oral and intravenous medication with dosages, when to contact the endocrine team for complex patients, and follow-up plans with endocrine and ENT and at what levels patients can be discharged with oral supplements.

In summary, this quality improvement project has brought together teams from multiple sites and disciplines, including pharmacy and endocrinology, to develop readily usable guidelines that are suited to our specific regional population. To ensure results are sustainable, we have placed the guidelines in paper format in easy view

in the ward and clinics and are working on having the guidelines added to the intranet guidelines directory for our Trust. We also hope that our project will encourage other trusts to consider whether the guidelines they are currently using can be amended based on evidence on hypocalcaemia predictors and based on their population characteristics. This can lead to better care for our patients and by also reducing length of stay, will lead to reduced NHS costs.

Author affiliations

- ¹Division of Surgery and Interventional Science & Cancer Institute, University College London, London, UK
- ²Department of Otolaryngology - Head and Neck Surgery, Royal London Hospital, Barts Health NHS Trust, London, UK
- ³Department of Otolaryngology - Head and Neck Surgery, Whipps Cross University Hospitals, Barts Health NHS Trust, London, UK
- ⁴Department of Otolaryngology-Head and Neck Surgery, Northwick Park Hospital, London North West Healthcare NHS Trust, London, UK
- ⁵Pre-assessment Clinic, Whipps Cross University Hospital, Barts Health NHS Trust, London, UK
- ⁶Pre-assessment Clinic, Royal London Hospital, Barts Health NHS Trust, London, UK
- ⁷Department of Otorhinolaryngology and Maxillofacial Surgery, Zealand University Hospital, Køge, Denmark
- ⁸Division of Endocrinology, Department of Medicine, Whipps Cross University Hospital, Barts Health NHS Trust, London, UK
- ⁹Head and Neck Centre, University College London Hospitals NHS Trust, London, UK
- ¹⁰Department of Endocrinology, St Bartholomew's Hospital, Barts Health NHS Trust, London, UK

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