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Quality Indicators for the Diagnosis and Management of Primary Hyperparathyroidism

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[+ Supplemental content](#)

IMPORTANCE Primary hyperparathyroidism (pHPT) is a common endocrine disorder with many diagnostic and treatment challenges. Despite high-quality guidelines, care is variable, and there is low adherence to evidence-based treatment pathways.

OBJECTIVE To develop quality indicators (QIs) to evaluate the diagnosis and treatment of pHPT that could measure, improve, and optimize quality of care and outcomes for patients with this disease.

DESIGN, SETTING, AND PARTICIPANTS This quality improvement study used a guideline-based approach to develop QIs that were ranked by a Canadian 9-member expert panel of 3 endocrinologists, 3 otolaryngologists, and 3 endocrine surgeons. Data were analyzed between September 2020 and May 2021.

MAIN OUTCOMES AND MEASURES Candidate indicators (CIs) were extracted from published primary hyperparathyroidism guidelines and summarized with supporting evidence. The 9-member expert panel rated each CI on the validity, reliability, and feasibility of measurement. Final QIs were selected from CIs using the modified RAND–University of California, Los Angeles appropriateness methodology. All panelists were then asked to rank the top 5 QIs for primary, endocrine, and surgical care.

RESULTS Forty QIs were identified and evaluated by the expert panel. After 2 rounds of evaluations and discussion, a total of 18 QIs were selected as appropriate measures of high-quality care. The top 5 QIs for primary, endocrine, and surgical care were selected following panelist rankings.

CONCLUSIONS AND RELEVANCE This quality improvement study proposes 18 QIs for the diagnosis and management of pHPT. Furthermore, the top 5 QIs applicable to physicians commonly treating pHPT, including general physicians, internists, endocrinologists, otolaryngologists, and surgeons, are included. These QIs not only assess the quality of care to guide the process of improvement, but also can assess the implementation of evidence-based guideline recommendations. Using these indicators in clinical practice and health system registries can improve quality and cost-effectiveness of care for patients with pHPT.

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Primary hyperparathyroidism (pHPT) is a common endocrine disorder causing dysregulation of calcium homeostasis. The incidence of pHPT is estimated to be 65.5 per 100 000 person-years among women and 24.7 per 100 000 person-years among men.¹ Owing to increased incidence of routine screening since the 1970s, pHPT is diagnosed more often, increasing incidence and prevalence.²

Evaluation and treatment of pHPT involves a multidisciplinary approach, including input from family physicians, internists, endocrinologists, and surgeons. Guidelines for the management of pHPT include the recently published American Association of Endocrine Surgeons guideline³ and the international workshop on the management of asymptomatic pHPT published in 2014.⁴ However, the adherence to these practice recommendations on the management and preoperative workup of patients with pHPT is low.⁵⁻⁷ Less than 50% of patients who fulfil the criteria for surgery receive parathyroidectomy, and less than 70% of patients have adequate preoperative imaging studies.^{5,6} Because of this nonadherence, the treatment of pHPT may benefit from quality indicator (QI) development. These QIs can help physicians identify gaps in quality, thereby sparking quality-improvement initiatives to improve care delivery for optimal outcomes.

Quality of care can be defined as “the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge.”^{8(p707)} A QI provides qualitative and quantitative measures for clinicians, organizations, and planners aiming to achieve improvement in care and the processes by which patient care is provided,^{9,10} and QIs should be valid (meaning the degree to which the indicator measures what it is intended to measure), reliable, and feasible to measure.⁹

This quality improvement study aims to develop QIs for the diagnosis and treatment of pHPT with a focus on specific indicators for each health care practitioner caring for these patients. These QIs can be used to develop strategies for improving quality of care and optimizing outcomes.

Methods

This study was executed using an expert panel of internist-endocrinologists, otolaryngologists, and endocrine surgeons to rank possible QIs, known as candidate indicators (CIs). All QIs were selected using a guideline-based approach, proposed by Kötter et al.¹¹ The most commonly cited guidelines, including the American Association of Endocrine Surgeons guideline and the guideline for the management of asymptomatic pHPT, were selected for CI extraction because these guidelines bear trusted society endorsements.^{3,4} Guidelines were determined to be of high quality using the Appraisal of Guidelines for Research and Evaluation II tool.¹² The guidelines were independently reviewed by 2 authors (M.E.N. and J.D.P.) to extract CIs. All disagreement among the reviewers concerning CI extraction was settled by consensus. Because patient-level data were not used in this study, institutional review board approval was not required.

Key Points

Question What are valid quality indicators (QIs) to evaluate the diagnosis and treatment of primary hyperparathyroidism (pHPT) that could measure, improve, and optimize quality of care and outcomes?

Findings In this quality improvement study, 18 QIs for the diagnosis and management of pHPT were proposed. Through ranking by a 9-member expert panel of 3 endocrinologists, 3 otolaryngologists, and 3 endocrine surgeons, the top 5 QIs applicable to physicians commonly treating pHPT were chosen.

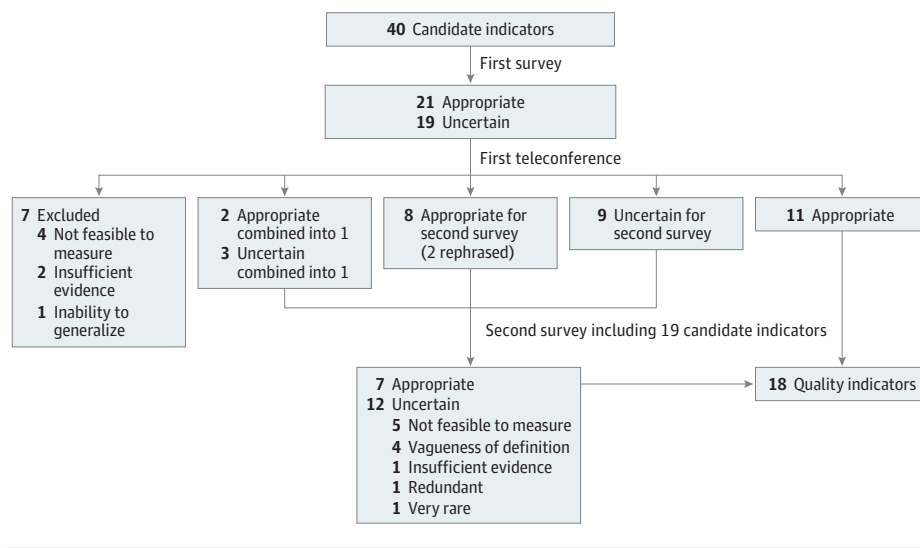
Meaning Quality indicators assess quality of care to guide the process of improvement and can assess the implementation of evidence-based guideline recommendations; using QIs in clinical practice and registries can improve quality and cost-effectiveness of care for patients with pHPT.

As described by Cottrell et al,¹³ CIs for this study had to be measurable, either practically or theoretically. Indicator name, indicator type (structure, process, or outcome¹⁴), numerator and denominator, definitions, specific exclusion criteria, and summary of evidence were collected. Structure indicators refer to the attributes of the setting in which care occurs, including facilities, human resources, and organizational structure. Process indicators refer to actions related to giving and receiving care (such as the physicians' activities in making a diagnosis, recommending, or implementing treatment) or other interactions with the patient. Lastly, outcome indicators describe the effects of care on the health status of patients and populations.⁹ The numerator describes the target process, condition, event, or outcome, and the denominator defines the population being measured.

The expert panel consisted of 3 endocrinologists (K.G.H., M.K.B., and E.M.W.), 3 otolaryngologists (E.M., D.P.G., and A.E.), and 3 endocrine surgeons (L.R., A.M., and K.D.). Panelists were selected based on criteria that were similar to other quality studies.^{13,15,16} Selection of panelists was based on academic and community representation, ensuring that panelists were involved with patient safety, quality improvement, and clinical experience, and demonstrated research interest in parathyroid disease, including academic and community physicians. Leaders from large academic institutions and provincial centers were selected warranting that panelists had a high-volume academic and community practice. The expert panel is considered to be representative of a broad range of physicians. The modified RAND-University of California, Los Angeles appropriateness methodology was used to select QIs from the CIs.¹⁷

First, the panel completed a survey containing the extracted data and level of evidence for each CI. The panel was asked to evaluate the validity (meaning the degree to which the indicator measures what it is intended to measure), reliability (meaning the extent to which repeated measurements of a stable phenomenon by different data collectors or instruments, at different times and places, get similar results), and feasibility (meaning feasible to measure) for each CI on a 9-point scale. The rating was anonymous and independent. Afterward, the results of the survey were analyzed to determine if each CI was appropriate as a QI and whether agreement had been reached among panelists (eTable 1 in the

Figure. Flow Diagram Describing the Process of Determining Candidate Indicator Appropriateness



Supplement).^{10,17} Consensus requirements to include CIs as QIs were defined as a median score of 7 to 9 and no disagreement among panelists. Disagreement was reached if at least 3 panel members rated the CI outside of the 3-point region (ranges, 1-3, 4-6, and 7-9) containing the median. Each panel member had equal weight in the rating process. After the first anonymous rating, a teleconference was held to present the initial results and discuss areas of disagreement, new insights, or potential CIs not included in the first survey.

We checked whether QIs contained statistically significant outliers using the Grubbs test ($P < .05$ was considered statistically significant). Subsequently, a second survey was disseminated and analyzed, which led to the final list of appropriate QIs. All panel members were then asked to rank the top 5 QIs for primary, endocrine, and surgical care. The ranking was based on optimizing patient safety and quality of care. The top-ranked QI received 5 points, the second-ranked QI received 4 points, the third-ranked QI received 3 points, the fourth-ranked QI received 2 points, and the fifth-ranked QI received 1 point (eTable 1 in the Supplement). Any QIs that were not listed in the top 5 received no points. Subsequently, the sum of all QIs was calculated, leading to the top 5 of the highest-ranked appropriate QIs in medical and surgical management areas. Statistical analyses were performed with Prism, version 9.0 (GraphPad).

Results

First Evaluation Round

Thirty-one process CIs and 9 outcome CIs were extracted from 2 guidelines (eTable 2 in the Supplement). No structure CIs were extracted.

The Figure depicts a flow diagram describing the process of CI appropriateness determination. Following the first round of evaluations, 21 CIs were deemed appropriate. Teleconference discussion centered on relevance, metrics,

and evidence for QI inclusion and panel disagreements. Explicit definitions of CIs and their measurability were common themes of discussion for 13 of the indicators. Numerators and denominators were modified in 4 indicators to improve validity (eTable 3 in the Supplement). Any CIs that described a practical approach to surgical strategy were discussed at length by the panel. Given that multiple CIs involved surgical approach and use of intraoperative parathyroid hormone (PTH), through a discussion of variability in resource availability, the panel merged the CIs into the supported QI: “Appropriate surgical strategies for parathyroidectomy include limited parathyroid exploration with use of intraoperative PTH or four gland parathyroid exploration” (eTable 4 in the Supplement). Owing to lack of clarity in the literature about training, volume-outcome relationships, and access to parathyroid surgeons, a unanimous QI could not be recommended regarding target parathyroidectomy volumes.

During the teleconference, new concerns arose concerning 6 appropriate CIs that were therefore extensively discussed and included in the second survey (Table 1 and Figure). Furthermore, 2 appropriate CIs were rephrased, and 2 appropriate CIs were combined into 1 and afterward included in the second survey (Table 1). Therefore, 11 CIs were deemed appropriate from the first round following the teleconference (Table 2). Seven CIs were excluded following the teleconference owing to lack of consistency or feasibility in measuring the indicator, inability to generalize across specialties, insufficient or conflicting evidence that the indicator would lead to improvement in patient outcomes, or vagueness of the CI definitions (Table 3). No new CIs were brought forward during the teleconference discussion.

Second Evaluation Round

The content of the teleconference was used to guide the panel into the second round of voting. In total, 19 CIs were included in the second round (Figure). After the second round of evalu-

Table 1. Appropriate Candidate Indicators Reintroduced in the Second Round of Evaluation

Candidate indicator	Appropriateness total score		Remarks	Definitions
	Median score ^a	Panelist agreement, %		
Concerns regarding appropriate candidate indicators				
1. In patients with suspected pHPT, a personal and family history should be taken.	8	79	Difficult to measure, will require medical record review	Personal history includes kidney manifestations, including nephrolithiasis and skeletal manifestations, including fragility fractures and osteoporosis. Family history includes history of previous neck surgery, kidney stones, pituitary tumors, peptic ulcers, hypercalcemia, or pancreatic tumor.
2. Patients undergoing parathyroidectomy should have concomitant thyroid disease assessed.	8	100	There is no definition for "assessed." Furthermore, it is redundant because another candidate indicator states, "Preoperative imaging should start with the performance of cervical ultrasonography combined with sestamibi or 4-dimensional computed tomography."	NA
3. Preoperative voice evaluation assessment is an essential component of the preoperative examination.	7	79	Vaguely defined candidate indicator. Furthermore, a vocal cord paralysis in patients with pHPT who did not have previous thyroid surgery is very rare.	Preoperative voice evaluation includes specific inquiry about subjective voice changes, with additional evaluation for considerable voice changes or a history of prior at-risk surgery.
4. Parathyroidectomy should be conducted by surgeons with adequate training and experience in pHPT management.	7	79	There is no definition for adequate training and experience.	Currently, there is no definition of adequate training and experience.
5. Intraoperative nerve monitoring should play a role in reoperative cases.	7	79	Although it is helpful, it is not standard of care and many institutions may not have this. Furthermore, sidedness and function of the nerve preoperatively matters here.	NA
6. With intraoperative suspicion of parathyroid carcinoma, the goal should be a complete resection avoiding capsular disruption and, if necessary, en bloc resection of adherent tissues.	7	89	Difficult to measure, will require surgery report review. Furthermore, parathyroid carcinoma is very rare and may therefore not be an optimal quality indicator.	The diagnosis of parathyroid carcinoma should be considered in patients with pHPT with markedly elevated parathyroid hormone levels and severe hypercalcemia, with a palpable parathyroid mass or preoperative imaging that may suggest parathyroid carcinoma.
Rephrased appropriate candidate indicators				
Initial phrasing		New phrasing		
7. Preoperative imaging should be performed after deciding to proceed with parathyroidectomy, and patients should still be referred for parathyroidectomy despite negative imaging results.	8	100	If the patient meets an indication for parathyroidectomy, negative imaging results should not preclude parathyroidectomy.	NA
8. Patients who are vitamin D deficient should receive vitamin D supplementation after apparently successful parathyroidectomy.	8	100	Patients who are vitamin D deficient should receive vitamin D supplementation before parathyroid surgery, while monitoring calcium levels.	Vitamin D deficiency is defined as 25-hydroxyvitamin D levels <20 ng/mL. The definition of successful parathyroidectomy is normocalcemia at 6 mo post surgery.
9. Postoperative recurrent laryngeal nerve paralysis rate	8	79	Postoperative complication rate: recurrent laryngeal nerve paralysis and cervical hematoma	NA
10. Postoperative cervical hematoma rate	8	89		

^aScores were measured on a 9-point scale. Abbreviations: NA, not applicable; pHPT, primary hyperparathyroidism.

ations, 7 CIs were deemed appropriate with agreement, providing a total of 18 QIs to be appropriate indicators of quality care (Table 2). In the second round, 12 CIs did not reach consensus regarding their appropriateness, totaling the exclusion of 19 CIs in both rounds (Table 3). Of the 18 QIs, 6 contained 1 outlier (1 in 9 was an outlier) (Table 2). The top 5 ranking of QIs for primary, endocrine, and surgical care is summarized in Table 4.

Discussion

Owing to nonadherence of guidelines in the management of pHPT, the treatment of pHPT could benefit greatly from QIs. These indicators can help physicians identify gaps in quality, thereby triggering quality-improvement initiatives to optimize outcomes. These QIs not only assess the quality of care

Table 2. Appropriate Candidate Indicators With Agreement Following the 2 Rounds of Evaluations

Candidate indicator	Score ^a					Definitions
	Appropriateness component		Appropriateness total		Panelist agreement, %	
	Validity	Reliability	Measurability	Median score		
First round of evaluation						
1. Primary hyperparathyroidism is diagnosed on biochemical grounds, and biochemical evaluation of suspected pHPT should include adequate calcium measurement (total calcium, corrected calcium, ionized calcium as appropriate), PTH, creatinine, and 25-hydroxyvitamin D levels.	8	8	8	8	89	In pHPT, PTH levels are high or inappropriately normal (ie, not suppressed despite hypercalcemia). Diagnosis of normocalcemic pHPT requires the exclusion of other causes of secondary elevation of PTH.
2. 24-hour urinary calcium and vitamin D serum levels should be measured in patients with pHPT, specifically those at risk for familial hypocalciuric hypercalcemia.	8	8	9	8	78	Familial hypocalciuric hypercalcemia is an autosomal dominant disorder of the kidney calcium-sensing receptor that can mimic pHPT.
3. Parathyroidectomy is indicated, and is the preferred treatment, for all patients with symptomatic pHPT. ^b	8	8	8	8	89	Patients with symptomatic pHPT have overt signs and symptoms directly attributed to the disease. The classic manifestations include nephrolithiasis, osteitis fibrosa cystica, peptic ulcers, and psychiatric/cognitive symptoms.
4. Parathyroidectomy is indicated regardless of whether objective symptoms are present or absent when the serum calcium level is >1 mg/dL (0.25 mmol/L) above normal.	8	8	8	8	100	NA
5. Parathyroidectomy is indicated regardless of whether objective symptoms are present or absent in patients with osteoporosis, fragility fracture, or evidence of vertebral compression fracture on spine imaging.	8	8	8	8	100	Osteoporosis is a T-score lower than -2.5 at lumbar spine, total hip, femoral neck, or distal 1/3 radius.
6. Parathyroidectomy is indicated regardless of whether objective symptoms are present or absent when there is objective evidence of kidney involvement, including silent nephrolithiasis on kidney imaging, nephrocalcinosis, hypercalciuria with increased stone risk, or impaired kidney function.	8	8	8	8	100	Hypercalciuria is a 24-hour urine calcium level >400 mg/dL. Impaired kidney function is a glomerular filtration rate <60 mL/min.
7. Parathyroidectomy is indicated regardless of whether objective symptoms are present or absent when pHPT is diagnosed at 50 y or younger. ^b	8	8	8	8	89	NA
8. Preoperative imaging should start with the performance of cervical ultrasonography combined with sestamibi or 4-dimensional computed tomography. ^b	8	8	8	8	89	The fourth dimension in 4-dimensional computed tomography refers to the differential pattern of contrast enhancement in parathyroid tissue over time.
9. Patients should not receive medical therapy (cinacalcet) for definitive management.	8	8	8	8	100	NA
10. Patients undergoing surgery for pHPT should have a cure rate approaching 98%.	8	8	7	8	100	Cure after parathyroidectomy is defined as the reestablishment of normal calcium homeostasis lasting a minimum of 6 mo.
11. Persistent hyperparathyroidism rate ^b	8	8	8	8	89	Persistent hyperparathyroidism is defined as failure to achieve normocalcemia within 6 mo of parathyroidectomy.
Second round of evaluation						
12. If the patient meets an indication for parathyroidectomy, negative imaging results should not preclude parathyroidectomy. ^b	8	8	8	8	89	NA
13. Postoperative complication rate: recurrent laryngeal nerve paralysis and cervical hematoma ^b	8	8	7	8	89	NA
14. In patients with asymptomatic pHPT, abdominal imaging should be performed for detection of nephrocalcinosis or nephrolithiasis because both are indications for parathyroidectomy.	7	7	7	7	79	NA
15. Dual-energy x-ray absorptiometry should be performed for all patients with pHPT.	7	7	7	7	79	Bone mineral density should be measured at the lumbar spine, hip, and distal radius.
16. Appropriate surgical strategies for parathyroidectomy include limited parathyroid exploration with use of intraoperative PTH and four gland parathyroid exploration.	8	8	7	8	100	NA
17. Length of stay	7	7	7	7	89	NA
18. Reoperative parathyroidectomy rate	7	7	7	7	89	NA

^b This candidate indicator contained 1 outlier (in all candidate indicators, the outlier was 5).

Abbreviations: NA, not applicable; pHPT, primary hyperparathyroidism; PTH, parathyroid hormone.

^a Scores were measured on a 9-point scale.

Table 3. Excluded Candidate Indicators

Candidate indicator	Appropriateness total score		Reason for exclusion			Vagueness of definition	Insufficient evidence	Additional exclusion reason provided	Definitions
	Median score ^a	Panelist agreement, %	Lack of consistency or not feasible to measure	Inability to generalize	Insufficient evidence				
Excluded from first round of evaluation									
1. Parathyroidectomy is recommended for patients with neurocognitive and/or neuropsychiatric symptoms that are attributable to pHPT.	6	33	Yes	Yes	No	No	NA	NA	Classic neuropsychiatric symptoms of pHPT include mental status changes, obtundation, and frank psychosis. Psychological and cognitive changes include fatigue, depression, anxiety, emotional lability, sleep disturbances, worsening memory, and inability to concentrate.
2. Parathyroidectomy may be offered to surgical candidates with cardiovascular disease who might benefit from mitigation of potential cardiovascular sequel other than hypertension.	4	33	Yes	No	Yes	No	NA	NA	Cardiovascular sequel may include diastolic dysfunction and left ventricular hypertrophy, left ventricular mass, systolic and diastolic function, and smooth muscle-mediated vasodilatation.
3. The nontraditional symptoms of muscle weakness, functional capacity, and abnormal sleep patterns should be considered in the decision for parathyroidectomy.	4	56	Yes	Yes	No	No	NA	NA	
4. Before parathyroidectomy, patients with pHPT who are vitamin D deficient should begin with vitamin D supplementation.	6	33	No	No	Yes	Yes	Redundant	NA	Vitamin D deficiency is defined as 25-hydroxyvitamin D levels <20 ng/mL.
5. Reoperative parathyroidectomy should only be performed if indicated and well-localized disease.	6	56	No	Yes	No	Yes	NA	NA	
6. Incision length	5	22	Yes	No	No	No	Incision length is not a surrogate for the quality of surgery. It does not consider the resultant appearance of the scar.	NA	
7. Postoperative hypocalcemia rate	5	22	No	No	Yes	No	NA	NA	
Excluded from second round of evaluation									
8. In patients with suspected pHPT, a personal and family history should be taken.	6	56	Yes	No	No	No	NA	NA	Personal history includes kidney manifestations, including nephrolithiasis and skeletal manifestations, including fragility fractures and osteoporosis. Family history includes history of previous neck surgery, kidney stones, kidney tumors, peptic ulcers, hypercalcemia, or pancreatic tumor.
9. Patients undergoing parathyroidectomy should have concomitant thyroid disease assessed.	7	56	No	No	No	Yes	Redundant	NA	

(continued)

Table 3. Excluded Candidate Indicators (continued)

Candidate indicator	Appropriateness total score			Reason for exclusion			Additional exclusion reason provided	Definitions
	Median score ^a	Panelist agreement, %	Lack of consistency or not feasible to measure	Inability to generalize	Insufficient evidence	Vagueness of definition		
10. Preoperative voice evaluation assessment is an essential component of the preoperative examination.	7	67	No	No	No	Yes	A vocal cord paralysis in patients with pHPT who did not have previous thyroid surgery is very rare.	Preoperative voice evaluation includes specific inquiry about subjective voice changes, with additional evaluation for considerable voice changes or a history of prior at-risk surgery.
11. Parathyroidectomy should be conducted by surgeons with adequate training and experience in pHPT management.	6	22	No	No	No	Yes	NA	Currently, there is no definition of adequate training and experience.
12. Intraoperative nerve monitoring should play a role in reoperative cases.	7	67	Yes	Yes	No	Yes	NA	NA
13. With intraoperative suspicion of parathyroid carcinoma, the goal should be a complete resection avoiding capsular disruption and, if necessary, en bloc resection of adherent tissues.	6	44	Yes	No	No	Yes	Very rare	The diagnosis of parathyroid carcinoma should be considered in patients with pHPT with markedly elevated parathyroid hormone levels and severe hypercalcemia, with a palpable parathyroid mass or preoperative imaging that may suggest parathyroid carcinoma.
14. Patients who are vitamin D deficient should receive vitamin D supplementation before parathyroid surgery while monitoring calcium levels.	7	67	No	No	Yes	No	NA	Vitamin D deficiency is defined as 25-hydroxyvitamin D levels <20 ng/mL. The definition of successful parathyroidectomy is normocalcemia at 6 mo post surgery.
15. Subjective symptoms, including neuropsychiatric, cognitive, musculoskeletal, and gastrointestinal complaints, should be documented and considered in treatment for pHPT.	6	44	Yes	No	No	No	NA	Classic neuropsychiatric symptoms of pHPT include mental status changes, obtundation, and frank psychosis. Psychological and cognitive changes include fatigue, depression, anxiety, emotional lability, sleep disturbances, worsening memory, and inability to concentrate. Musculoskeletal symptoms include proximal muscle weakness, musculoskeletal pain, and muscular atrophy. Gastrointestinal symptoms include anorexia, nausea, vomiting, abdominal pain, and pancreatitis.
16. Genetic testing should be performed for patients younger than 40 y with pHPT, as well as for patients with multigland disease, and should be considered for those with a family history or syndromic manifestations.	7	56	Yes	No	No	No	The age cutoff is controversial.	Familial causes investigated as appropriate and family history may include history of previous neck surgery, kidney stones, pituitary tumors, peptic ulcers, hypercalcemia, or pancreatic tumor. Syndromic manifestations may include the occurrence of parathyroid, pancreatic islet, anterior pituitary tumors, medullary thyroid cancer, pheochromocytoma, fibromas of the mandible and maxilla, kidney tumors, and uterine tumors, although patients can also manifest neuroendocrine tumors of the thymus or bronchus, adrenal adenomas, lipomas, and axillary skin tags.

(continued)

Table 3. Excluded Candidate Indicators (continued)

Candidate indicator	Appropriateness total score		Reason for exclusion				Additional exclusion reason provided	Definitions
	Median score ^a	Panelist agreement, %	Lack of consistency or not feasible to measure	Inability to generalize	Insufficient evidence	Vagueness of definition		
17. Preoperative parathyroid fine-needle aspiration biopsy of the parathyroid gland should not be performed.	7	67	No	No	No	No	Very rare. There are a variety of scenarios in which this may occur (eg, intention to aspirate a thyroid nodule) and may therefore not be the best quality indicator.	Vitamin D deficiency is defined as 25-hydroxyvitamin D levels <20 ng/mL. The definition of successful parathyroidectomy is normocalcemia at 6 mo post surgery.
18. Patients at high risk for postoperative hypocalcemia should be treated with postoperative calcium supplementation.	6	33	No	No	No	Yes	NA	Patients undergoing bilateral exploration have considerably higher rates of mild and severe hypocalcemic symptoms.
19. Recurrent hyperparathyroidism rate	7	67	No	No	No	No	Redundant	Recurrent hyperparathyroidism is defined as recurrence of hypercalcemia after a normocalcemic interval at more than 6 mo after parathyroidectomy.

Abbreviations: NA, not applicable; pHPT, primary hyperparathyroidism.

^a Scores were measured on a 9-point scale.

Table 4. The Top 5 Quality Indicators per Specialty^a

Rank	Quality indicator	Total sum of rank
Primary care		
1	Primary hyperparathyroidism is diagnosed on biochemical grounds, and biochemical evaluation of suspected pHPT should include adequate calcium measurement (total calcium, corrected calcium, ionized calcium as appropriate), PTH, creatinine, and 25-hydroxyvitamin D levels.	35
2	Parathyroidectomy is indicated, and is the preferred treatment, for all patients with symptomatic pHPT.	20
3	Parathyroidectomy is indicated regardless of whether objective symptoms are present or absent when there is objective evidence of kidney involvement, including silent nephrolithiasis on kidney imaging, nephrocalcinosis, hypercalciuria with increased stone risk, or impaired kidney function.	15
4	24-hour urinary calcium and vitamin D serum levels should be measured in patients with pHPT, specifically those at risk for familial hypocalciuric hypercalcemia.	12
5 ^b	Parathyroidectomy is indicated regardless of whether objective symptoms are present or absent when the serum calcium level is >1 mg/dL (0.25 mmol/L) above normal.	11
5 ^b	Parathyroidectomy is indicated regardless of whether objective symptoms are present or absent in patients with osteoporosis, fragility fracture, or evidence of vertebral compression fracture on spine imaging.	11
Endocrine care		
1	Primary hyperparathyroidism is diagnosed on biochemical grounds, and biochemical evaluation of suspected pHPT should include adequate calcium measurement (total calcium, corrected calcium, ionized calcium as appropriate), PTH, creatinine, and 25-hydroxyvitamin D levels.	25
2	24-hour urinary calcium and vitamin D serum levels should be measured in patients with pHPT, specifically those at risk for familial hypocalciuric hypercalcemia.	24
3	If the patient meets an indication for parathyroidectomy, negative imaging results should not preclude parathyroidectomy.	21
4	Parathyroidectomy is indicated, and is the preferred treatment, for all patients with symptomatic pHPT.	18
5	Patients should not receive medical therapy (cinacalcet) for definitive management.	12
Surgical care		
1	Appropriate surgical strategies for parathyroidectomy include limited parathyroid exploration with use of intraoperative PTH or four gland parathyroid exploration.	26
2	Patients undergoing surgery for pHPT should have a cure rate approaching 98%.	22
3 ^b	Postoperative complication rate: recurrent laryngeal nerve paralysis and cervical hematoma	18
3 ^b	Persistent hyperparathyroidism rate	18
4	Preoperative imaging should start with the performance of cervical ultrasonography combined with sestamibi or 4-dimensional computed tomography.	14
5	If the patient meets an indication for parathyroidectomy, negative imaging results should not preclude parathyroidectomy.	12

Abbreviations: pHPT, primary hyperparathyroidism; PTH, parathyroid hormone.

^a For definitions of quality indicators, refer to Table 2.

^b Quality indicators have the same total sum of rank.

to guide the process of improvement, but also can assess the implementation of evidence-based guideline recommendations. A panel of physicians representing endocrinology, otolaryngology, and surgery, both academic and community based, determined the 5 most important indicators for each clinical specialty. To our knowledge, these are the first pHPT QIs developed through a robust evidence and consensus-based methodology. The proposed QIs are generalizable, transcend specialties and disciplines, and account for variability in the perception of quality that exists internationally. Furthermore, they cover a wide range of diagnostics and treatment aspects of pHPT. Using these QIs in clinical practice and data registries may help those delivering and funding care to ensure high-quality and cost-effective care pathways for patients with pHPT.

As demonstrated in other clinical areas, QIs are a crucial step toward improving the quality of care.¹⁸⁻²¹ The most frequently used implementation strategies of QIs are audit and feedback.²² Public dissemination of quality report cards (reports that provide information about various aspects of care at individual facilities) have become valuable in enhancing quality of care.^{23,24} The reasoning behind publishing report

cards is that public information about quality will increase understandable benchmarking and thus demand for quality, generating incentives for health care practitioners and administrators to invest in quality improvement.²⁵ The effect of monitoring QI data to promote quality improvement, and ultimately patient care, has been demonstrated. An example of an acute-care hospital highlights this idea where feedback of mortality rates reduced the standardized mortality rate by implementing QI-informed improvement initiatives.²⁶ Efforts should be made to design robust registries that capture clinical outcomes in addition to administrative data, further serving to target important outcomes and provide guidance for health payers to incentivize quality based on QIs, such as those developed in this study.

The 18 proposed QIs evaluate different aspects of pHPT care, including diagnosis, preoperative evaluation, evidence-based therapies, and surgical outcomes. The diagnosis of pHPT should be made on biochemical grounds and is reflected in a QI for both primary and endocrine care. Two additional QIs captured the use of 24-hour urine and preoperative imaging techniques after the diagnosis of pHPT has been made. Optimizing preoperative imaging techniques leads to a more cost-

effective strategy, aligning with existing guidelines. Six QIs review indications for surgery in pHPT and the definitive management of pHPT, recognizing underuse of surgery.^{5,7} Of importance to surgical care, 1 QI assesses the appropriate surgical approach and 3 evaluate surgical outcomes, including surgical cure rate, postoperative complication rates, and persistent hyperparathyroidism rate. Within the surgical QIs, the panel recommended that the surgical approach for pHPT should include limited exploration, only with intraoperative PTH availability. Given resource constraints in many regions, specifically where this study was centered, an alternative accepted approach includes four parathyroid gland exploration and parathyroidectomy based on the surgeon's assessment. This QI is an example of ensuring benchmarking is related to evidence-based strategies for optimizing outcomes, and alternative surgical strategies, such as focused parathyroidectomy without intraoperative PTH, were not endorsed because of reported higher rates of recurrent and/or persistent disease.

Limitations

There are a few limitations of this study. First, certain QIs may apply only in specific clinical settings, particularly the ability to measure the indicator using locally available data. To use these indicators in assessing care locally, data capture is a critical component to assess quality of care.^{27,28} Owing to the geographic limitation and the fact that we only included panelists from a single health care system, other health systems may wish to add QIs depending on resource allocation and funding models, while the indicators chosen in this panel are inclusive. We selected the top 5 QIs because it may become impractical and expensive to measure more in a real-life context. While the selected top 5 QIs represent what the panel believed mattered most, this may be most applicable to the practice patterns, training, and delivery model where the panel members work. Therefore, clinicians within other regions may want to select an alternative top 5 from the list of 18 QIs or con-

sider doing their own RAND-University of California, Los Angeles methodology using the CIs we selected. We specified excluded indicators, including those difficult to measure, because these may be of use in the future as health data becomes increasingly available. All panelists had equal weight in the rating process, which might have resulted in a certain specialist voting on a metric that does not correspond to their area of expertise. Furthermore, we did not have a primary care physician on the expert panel, but given that the panelists are part of multidisciplinary physician networks, we were cognizant to include multiple QIs addressing the diagnosis and workup of pHPT. Lastly, while we did not have a patient on the panel, we did select physicians who have academic experience in qualitative and quantitative studies of patient quality of life for those patients living with pHPT. Future validation studies could include general members of the public and patient advocates. Additionally, future studies should investigate how these QIs will be monitored and if they improved the quality of care for patients with pHPT.

Conclusions

In this quality improvement study, we developed a list of 18 indicators to measure the quality of care in patients undergoing workup and management for pHPT. Furthermore, we present the top 5 QIs for each health care professional specialty commonly treating pHPT, including primary care, endocrinology, and surgery. Quality indicators not only assess the quality of care to guide the process of improvement, but they also can assess the implementation of evidence-based guideline recommendations. The proposed QIs are generalizable, transcend specialties and disciplines, and account for variability in the perception of quality that exists internationally. Using these indicators in clinical practice and data registries may help those delivering and funding care to ensure high-quality and cost-effective care pathways for patients with pHPT.

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