

Quality performance indicators for the surgical treatment of gastric adenocarcinoma: a systematic review

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Introduction

Quality performance indicators (QPI) are objective measurements that are used to monitor and improve elements of patient care that are fundamental to overall outcome. These QPIs may be utilized to identify characteristics of high performing providers across jurisdictions, drive quality improvement, and develop benchmarking standards for the delivery of health care within communities.¹ Measuring patient outcomes and defining optimal treatment pathways in cancer is complex and must consider each part of the patient journey from initial presentation, diagnosis, staging, treatment and post-treatment care in order to

Abstract

Background: A systematic review was undertaken to identify existing quality performance indicators (QPI) for the surgical treatment of gastric adenocarcinoma (GA) with the aim of defining a set of QPIs that can be used to assist in the accreditation of institutions for training, allow cross jurisdiction comparison of treatment and outcomes, as well as provide a basis to develop quality improvement programs. These QPIs capture key components of patient care that are fundamental to overall outcome.

Methods: A systematic literature review was conducted searching MEDLINE, PubMed, EMBASE, and SCOPUS with all literature available until the date of 1 August 2021 included. Search terms utilized were ‘Quality of health care OR Quality improvement or Quality control OR Quality indicators’, AND ‘Gastrectomy’ OR ‘Stomach neoplasm’ OR ‘Adenocarcinoma’ OR ‘Gastric resection’ OR ‘Gastric cancer’.

Results: Twelve articles were included in the final analysis. The selected studies included editorials ($n = 2$), retrospective review of institutional experience ($n = 5$), cohort studies ($n = 2$), survey methodology ($n = 1$), expert guidelines ($n = 1$) and consensus statement ($n = 1$). For GC QPIs, process measures included patient discussion at multi-disciplinary meetings, access to perioperative multimodal diagnostic pathways, and specific surgical metrics (margin negative resections and adequate lymphadenectomy). Outcome measures included the RO resection rate, reoperation, readmission rate, and length of hospital stay.

Conclusions: There is a relative paucity of internationally agreed QPI for the surgical management of gastric adenocarcinoma. The data from this review will form the basis of a project to develop internationally agreed and feasible QPI for gastric cancer resections.

establish what an ‘ideal’ treatment pathway should resemble. Importantly, QPIs attempt to capture significant aspects of patient care along this pathway, provide an opportunity to objectively measure accomplishment and provide a foundation for specific quality improvement initiatives.

The management of gastric adenocarcinoma (GA) is complex multi-faceted and now requires the sequential input of multiple specialties including gastroenterology and endoscopy, medical oncology, radiology and metabolic imaging, pre-habilitation services, surgery, intensive care, nutrition and rehabilitation services. The management of all patients should be reviewed at least once in a formal

multidisciplinary setting, and many with advanced disease, or complex needs and comorbidities, are reviewed multiple times to ensure that specific interventions are undertaken at the optimal time and sequenced correctly. Historically, emphasis on quality of care in GC has been placed on the technical elements of resectional surgery including obtaining acceptable resection margins, undertaking an appropriately aggressive regional lymphadenectomy and precise surgical anastomotic technique. Most frequently, institutional surgical volume has been used as a proxy measure for quality of care.²⁻⁴ However, while a volume-outcome relationship has been established for oesophagectomy,⁵ it has not been convincingly established for gastrectomy⁶ and many smaller volume institutions report good results following surgical treatment of GC,^{2,3} although the successful performance of gastric resections does require a suitably trained and resourced surgical team.^{3,4} Consequently, developing effective QPIs for the treatment of patients with GC is important and they must reflect both the complexities of modern GC management, and the multidisciplinary contribution of

the many services involved in patient care. This systematic review was therefore undertaken to summarize currently proposed QPIs for use in the care of patients with GC with the aim of defining a set of QPIs that can be used to assist in the accreditation of institutions for training, allow cross jurisdiction comparison of treatment process and outcomes, as well as provide a basis to develop quality improvement programs.

Materials and methods

Systematic literature search

The search terms used were: 'Quality of health care OR Quality improvement or Quality control OR Quality indicators', AND 'Gastrectomy' OR 'Stomach neoplasm' OR 'Adenocarcinoma' OR 'Gastric resection' OR 'Gastric cancer' The databases examined were MEDLINE, EMBASE, PubMed, and SCOPUS, with all literature available reviewed and included until 1 August 2021. The search was

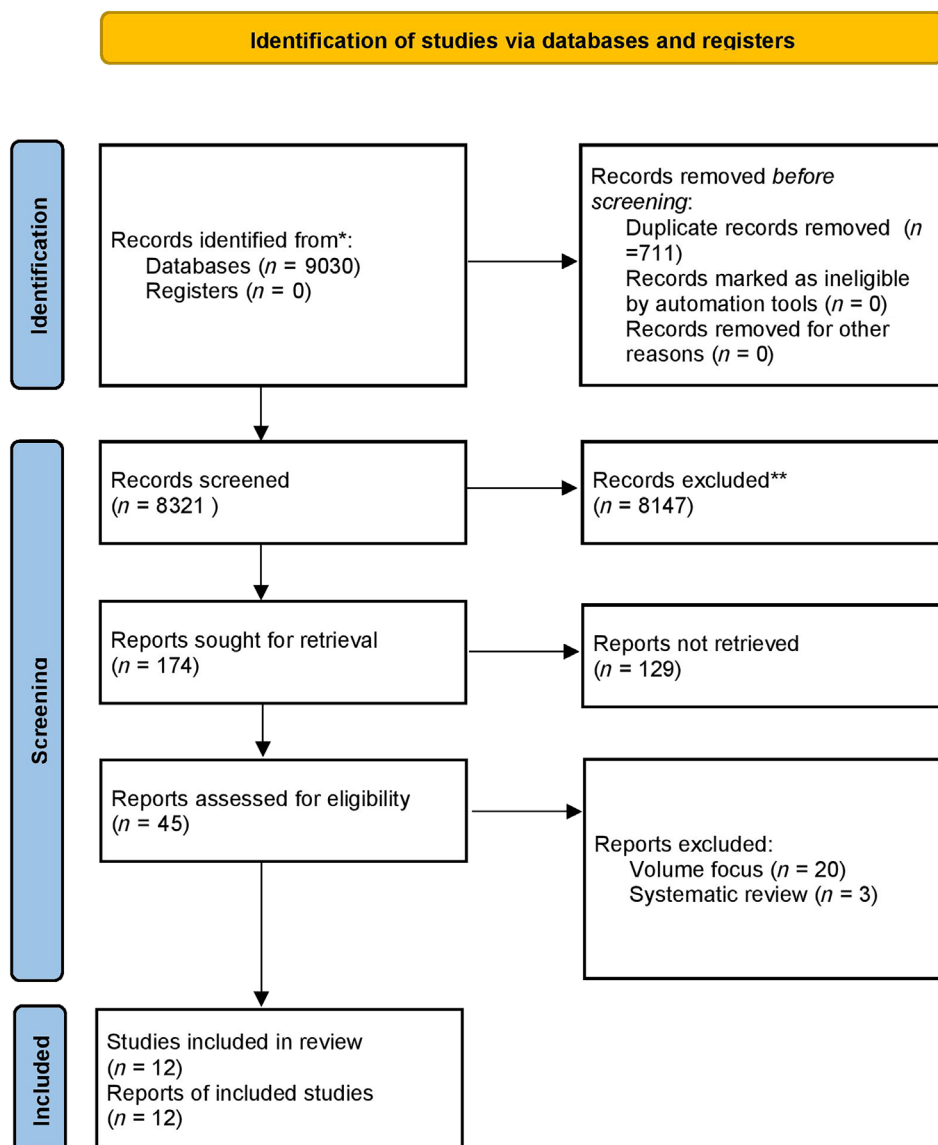


Fig. 1. PRISMA⁷ diagram describing the results of the systematic literature search and review.

Database	Citations
Medline	386
Scopus	2134
Embase	1525
Pubmed	4985

Fig. 2. Hits per database detailing the yield for each database.

run according to the validated methods of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.⁷ Figure 1 for diagram describes the results of the systematic literature search using the PRISMA guidelines. No language or geographical limits were set. The reference lists of all included papers were manually searched to identify further relevant investigations.

Study selection

Studies that investigated or reported specific QPIs relating to the management of GC were included. These included QPIs derived by any method such as consensus based or evidence based QPIs. Studies were excluded if only surgical case volume was reported as a quality indicator or if they solely reported on other cancer diagnoses such as gastrointestinal stromal tumour or lymphoma. Existing systematic reviews were excluded from the final analysis. Publications were reviewed for inclusion independently by the authors with disagreement resolved by consultation. The Donabedian model to evaluate patient care was used to classify proposed QPIs as structural, process related or outcome measures.⁸ Structure indicators relate to the setting in which care takes place. Process indicators indicate the actual diagnostic or therapeutic intervention that the patient undergoes, outcome indicators are the actual outcomes related to those interventions received by the patient.^{8,9}

Data abstraction and analysis

An inductive approach was utilized to systematically examine the literature. Two authors read through the articles several times. Details of included studies such as sample size, study design, participant type, country of origin and proposed QPI were recorded,

tabulated and rated according to the Oxford Centre for Evidence-Based Medicine.¹⁰

Results

Study characteristics

The literature search resulted in a total of 9030 articles. After the removal of duplicates, a total of 8321 article titles were screened (Fig. 1). The search yield per database are detailed (Fig. 2). Potential quality of care indicators were reviewed and defined as either structure, process or outcome based QPI.⁸ The only structure-based QPI reported was hospital patient/procedure volume¹¹ and this was omitted from the final analysis as per our exclusion criteria. Twelve publications^{12–23} were included for final analyses in Table 1. The proposed process and outcome QPIs are summarized in Table 2. The selected studies included editorials ($n = 2$),^{18,22} retrospective reviews ($n = 5$),^{13,15,17,20,21} cohort studies ($n = 2$),^{12,23} consensus statement ($n = 1$),¹⁶ guidelines ($n = 1$),¹⁴ and survey methodology ($n = 1$).¹⁹ Some of the key clinically relevant identified QPIs are summarized and catalogued into Process/Structure or Outcome based QPIs and discussed below.

Process indicators

Multidisciplinary team discussion

Multi-disciplinary team (MDT) review of all patients with GC is critical to ensure optimal treatment outcomes and timely delivery and sequencing of different treatment modalities. The core membership of the MDT should consist of Surgeons, Nurse Specialists, medical and radiation oncologists, radiologists and pathologists. Poor coordination of care may lead to suboptimal patient outcomes, significant treatment delays and inconsistent diagnostic and management pathways. Formal MDT discussions, where results of all treatments available to a given patient, and the documentation of resulting decisions are important.^{13,14,17}

Multi-modality treatment

Published peri-operative care QPIs are largely composed of the delivery of neo-adjuvant and adjuvant chemotherapy to patients with GC. Variation exists in specific regimens and the ideal

Table 1 Summary of included publications describing QPIs and Oxford rating for each publication

Author	Year	Study design	Oxford rating	Site of research
Portuondo ¹²	2021	Cohort study	4	United States of America
Ju ¹³	2019	Retrospective review	3	United States of America
Allum ¹⁴	2018	Expert guidelines	5	Europe
Elmi ¹⁵	2016	Retrospective review	3	Canada
Brar ¹⁶	2013	Consensus	5	Canada
Higashi ¹⁷	2013	Retrospective review	3	Japan
Dixon ¹⁸	2009	Editorial	5	Canada
Qureshi ¹⁹	2009	Survey	5	Canada
Verlato ²⁰	2008	Retrospective review	3	Italy
Callahan ²¹	2003	Retrospective Review	3	United States of America
Peeters ²²	2003	Editorial	5	Netherlands
Birkmeyer ²³	2001	Cohort study	4	Lebanon

Note: Summary of included publications describing quality performance indicators for the surgical management of gastric cancer.

Table 2 List of quality indicators – Gastric cancer

Type	Quality of care indicator	References
Process	Multidisciplinary team care/conferences	13,14
	Margin negative resection	16,19
	Laparoscopic gastric resection for T ₁ disease	16
	Lymphadenectomy ≥15 nodes	12,16,17,19,20,22
	Resection of adjacent organs	20
	Roux-en-Y reconstruction	16
	Intraoperative blood transfusion	15,18
	Neo adjuvant chemotherapy	12
	Perioperative chemotherapy	12
	Adjuvant therapy	12,22
	Surgeon subspecialty training	21
	Pre-treatment contrast staging CT scan	17
	Pre op serum tumour markers	17
	Endoscopic documentation	17
	• Macroscopic type	
	• Location	
	• Tumour size	
	• Depth of invasion according to endoscopic diagnosis	
	• Ulceration	
	Pre-operative biopsy and pathological diagnosis	17
	Informed consent documented	17
	Thromboembolic prophylaxis	17
	Presence or absence of para-aortic enlarged lymph nodes on CT scan	17
	Presence or absence of para-aortic lymph node metastasis intraoperative	17
	Surgical findings documented	17
	• Method of resection	
	• Method of reconstruction	
	• Extent of lymph node dissection	
	• Location	
	• Depth of invasion	
	• Extent of lymph node metastasis	
	• Whether or not metastasis is present	
	• Curativeness of surgery	
	Pathological findings	17
	• Depth of invasion	
	• Presence/absence of lymph node metastasis	
	• Number of lymph node metastasis	
	• Presence/absence of vascular invasion	
	• Presence/absence of cancer cells at surgical margins	
	• TNM stage or stage according to Japanese classification of gastric carcinoma	
	• Curability	
	• Cytology of peritoneal lavage or ascites(except cases recorded as T ₁ or T ₂ in the intraoperative diagnosis)	
	Medical findings explained to patient	17
	Post-operative dietary guidance provided to patient prior to discharge	17
	Serum CEA, abdominal diagnostic imaging and endoscopy performed annually for 3 years after surgery	17
	Endoscopic resection was performed, or not if not reason not stated in the medical records	17
	Endoscopic resection	17
• Informed consent		
• Depth of invasion		
• Size of lesion		
• Histological subtype		
• Presence or absence of ulceration		
• Presence of absence of vascular invasion		
• Status of horizontal and vertical cut end		
• Repeat endoscopy for possible recurrence annually for 3 years		
• Choice of adjuvant chemotherapy		

Table 2 Continued

Type	Quality of care indicator	References
Outcome	RO resection	16,17,19
	Perioperative blood transfusion	18
	Intra-operative complications	20
	Post-operative complications	20
	Return to the operating room	23
	Post-operative mortality	20

Note: Proposed quality indicators for patients undergoing surgery for gastric cancer.
Abbreviations: CT, computed tomographic scan; CEA, carcinoembryonic antigen; TNM; tumour, node, metastasis.

regimen is yet to be established. Massarweh *et al.* concluded that the delivery of perioperative multimodality therapy to patients with locally advanced disease is a critical component of optimal care. The publication also raised the salient point that it remains unclear if the use of a neoadjuvant or adjuvant therapy approach is associated with a greater likelihood of patients receiving multimodality therapy and thus improved oncological outcomes.¹² Higashi *et al.* highlighted the utilization of multimodal therapy as a key QPI, specifically pre-operative, perioperative and adjuvant chemotherapy.¹⁷

Extent of lymph node dissection

Several articles highlighted the importance of the extent of lymph node dissection as a QPI. The number of lymph nodes and a D2 lymphadenectomy were considered key QPI's.¹¹ A D2 lymphadenectomy was defined as the removal of stomach, peri-gastric lymph nodes and the removal of second tier lymph nodes in the extra peri-gastric areas which generally fall along branches of the celiac axis including the left gastric, splenic, common hepatic and proper hepatic arteries.²⁴ Brar *et al.* conducted a RAND/UCLA (University of California, Los Angeles School of Medicine) appropriateness study and concluded that a D2 lymphadenectomy was considered appropriate in all patients with tumours >T1NO according to the AJCC (American Joint Committee on Cancer) staging system 15. The expert panel found that it was appropriate but not necessary to assess 16 or more lymph nodes in a curative resection.

Surgical approach

Brar *et al.* identified that an open distal gastrectomy was appropriate for all patients with a distal GC and a laparoscopic distal gastrectomy was appropriate for distal GC patients with AJCC T1-T2 disease only. Conversely, for a proximal GC, laparoscopic total gastrectomy was considered appropriate for patients with T1NO disease and indeterminate for patients with T2NO or more advanced disease. In terms of reconstructive options, an expert agreement advocated for a Roux-en-Y reconstruction for subtotal gastrectomy as well as esophagojejunostomy with or without pouch formation for total gastrectomy. A similar consensus was not reached for a Billroth 1 or 2 Reconstruction.¹⁶

Surgeon training

Surgeon subspecialty interest and training should be considered a key QPI. Mortality and morbidity rates were substantially lower when

performed by subspecialty interested and trained surgeons even after accounting for surgeon volume and patient characteristics. Callahan *et al.* demonstrated that adjusted mortality rate for patients treated by subspecialty trained surgeons was 6.5%, while the adjusted mortality rate for non-subspecialty trained surgeons was 8.7%.²¹

Peri-operative care

Fast track surgery pathways also referred to as Enhanced Recovery after Surgery pathways were identified as a QPI by Higashi *et al.* These pathways consist of specific perioperative recommendations with the aim of reducing surgical stress, complications, length of stay and ultimately contribute to a higher level of care for patients with GC. Dixon *et al.* proposed that intraoperative blood loss along with the accompanying need for post-operative blood transfusion in the surgical oncology patients was an important modifiable QPI.¹⁷

Outcome indicators

Outcome QPI's were primarily focused on the importance of microscopically clear margins (RO) resections. Other outcome indicators revolved largely around perioperative complications as well as disease specific and overall survival. Birkmeyer *et al.* concluded that unplanned return to OT most often reflected issues with the operation and thus represents a useful QPI.²³

Discussion

Globally there were over 1 million new diagnoses and three quarters of a million deaths due to GC in 2018²⁵ confirming that it remains a significant health issue. In spite of recent advances in neoadjuvant, adjuvant chemo-radiotherapy and immunotherapy²⁶ surgical resection remains a crucial part of curative treatment, although gastric resection represents a spectrum of challenges to surgeons and surgical providers. Distal gastric resections are viewed by most surgical training bodies as part of a core set of operations that can be undertaken by general surgeons while total gastric resections and oesophago-gastric resections are regarded as complex procedures, require specific training and institutional support to undertake safely. In addition, the development of minimally invasive techniques to treat early cancers endoscopically or laparoscopically/robotically have also increased the technical and organizational requirements necessary to treat early-stage and distally located disease. Developing a universally accepted and easily

measurable set of QPIs for the surgical treatment of GC should capture the necessary elements of successful surgical treatment and allow these to be applied to evolving management pathways.

Surprisingly, only institutional volume has been suggested as structural QPI for GC. In contrast, for other complex upper gastrointestinal cancers the presence of necessary ancillary services (interventional radiology, endoscopy, intensive care, pathology, pain management and oncology) have been proposed as being important QPI's for patient selection and perioperative care.²⁷ This omission may be partly historical in that oncology and specialist pain services have only recently become intimately involved in the curative pathway for GC and prior to 2000 only provided palliative treatment. Similarly, while endoscopic services have always been involved in diagnosis of GC, recent advances have meant that endoscopic resection may be the treatment of choice in T_{1a} lesions and endoscopic management of anastomotic complications is increasingly employed. The role of Endoscopic Mucosal Resection (EMR) and in particular Endoscopic Sub-mucosal Dissection (ESD) for early gastric cancer as a QPI warrants further investigation. ESD in particular is widely practiced in East Asia and excellent outcomes for early gastric cancer has been reported. Nevertheless, its adoption in the West is relatively limited. Factors for this include differences in tumour biology and presentation, limitation in training opportunities and volume.² Vlayen *et al.* highlighted the proportion of patients who were diagnosed with T_{1a} GC who underwent endoscopic mucosal resection as a QPI.³ The role of ESD as a QPI should be further investigated and developed as a QPI once expert consensus is reached.

Provider QPIs were most numerous and broadly fell into two groups. The presence of specific hospital services and documentation of their utilization included a specialized multidisciplinary team with regular meetings to review patient care and determine treatment,^{13,14} as well as specialized endoscopic and laparoscopic services to treat early-stage tumours^{16,17} with documentation of their utilization, and access to adjuvant and neoadjuvant chemotherapy with documentation of its utilization.¹² Provider QPIs also included accepted surgical metrics of margin negative resections,¹⁷ a lymphadenectomy comprising at least 15 lymph nodes,^{16,19} the preferability of a Roux-en-Y reconstruction,¹⁶ and subspecialty trained Oesophagogastric surgeons.²¹ The NCCN guidelines nevertheless recommend gastrectomy with the goal of examining at least 16 lymph nodes, and emphasize that routine or prophylactic pancreatectomy is not recommended with D2 lymph node resection and splenectomy is acceptable only when the spleen is involved or extensive hilar adenopathy is noted.²⁸

Higashi *et al.*¹⁷ have emphasized thorough and detailed documentation of procedural (both diagnostic and therapeutic endoscopy as well as surgical resection) findings and documentation of informed consent and discussion of the findings, and their implications, with patients. In addition, these investigators have also recommended detailed pathology reporting of multiple important metrics. In an audit of 18 cancer care hospitals throughout Japan these recommendations were achieved in between 12% (endoscopic findings) and 79% (surgical findings) of patients, while the pathological metrics were present in 51% of pathology reports. Most institutions now utilize synoptic pathology reporting for

many cancers to ensure that all important positive and negative findings are clearly documented and there is growing use of synoptic multidisciplinary meeting minutes for the same reason.²⁹ While many of the surgical indices are noted by surgeons intra-operatively, important negative findings are not always recorded. The development of synoptic operation notes would ensure that these details are clearly and consistently documented in patient records.

Outcome measures of surgical quality included the rate of margin negative resections,^{16,19,28} the incidence and need for blood transfusion¹⁸ and the development of intra-operative and post-operative complications.²⁰ For these QPI, having accurate definitions form a significant part of their ability to measure quality of care. For instance, margin negative resections must consider patients undergoing successful resections but subsequently being reported as having a positive serosal margin (stage T₃), and define what constitutes an acceptable mucosal resection margin. Similarly, the requirement for preoperative blood transfusion must be now viewed in the context of patients undergoing resection for bleeding tumours and patients with marrow suppression following neoadjuvant chemotherapy. Post-operative complications such as anastomotic leak require internationally accepted definitions and many institutions only report on Clavien-Dindo grade ≥ 3 complications.³⁰ A second part of measuring outcome metrics is to establish internationally accepted minimum standard benchmarks to enable comparison across providers and countries. However, this process must consider using risk adjusted outcomes to provide meaningful comparison between providers. A limitation of this review is the absence of the mesh term 'Benchmarking'; potentially resulting in a narrow search field. Only publications in English were included in this systematic review, thus potentially omitting publications in other languages. As gastric cancer is predominant in East Asia, this may have limited our search. It is also important to acknowledge that our systematic review reports health care outcomes and not patient reported measures. Some examples of this include quality of life, significant complications and overall survival. Another limitation of the QPI's included is the fact that many QPI's are based on expert opinion and higher level of evidence of their impact on surgical results is lacking. It is imperative that the measurement of QPI's translate to improved patient outcome. This impact can be measured by validating pre-existing patient clinical data against these QPI's.

The data from this review will be used to inform a project to develop a set of internationally agreed and measurable QPI for GC. Experts in the field will be contacted via email to solicit additional potential QPIs and a modified Delphi³¹ process will be employed to appraise potential QPIs via online surveys and in a face to face/virtual workshop. QPI's identified in this study supplemented by latest guidelines will be utilized to inform this process.²⁸ In addition to the QPI's mentioned above, the authors will also validate other important QPI's that are pertinent to the care of the patient such as hospital acquired complications. There remains a lack of systematic assessment and internationally agreed upon QPI's for the management of gastric cancer as pointed by a well written paper by Dikken *et al.*⁹ The outcome of this work will be to

establish a list of clinically relevant and measurable QPIs that can be used by clinicians treating GC to benchmark their care against those of their peers.

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Conflict of interest

None declared.

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Author contributions

Suheelan Kulasegaran: Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; resources; software; supervision; validation; visualization; writing – original draft; writing – review and editing.

Braden Woodhouse: Conceptualization; methodology; validation; writing – review and editing. **Andrew D. MacCormick:** Conceptualization; formal analysis; investigation; methodology; supervision; visualization; writing – original draft; writing – review and editing.

Sanket Srinivasa: Conceptualization; formal analysis; investigation; methodology; project administration; software; supervision; validation; visualization; writing – original draft; writing – review and editing. **Jonathan Koea:** Conceptualization; data curation; investigation; methodology; project administration; supervision; validation; visualization; writing – original draft; writing – review and editing.

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