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Conceptualising Centres of Clinical Excellence: A scoping review

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Author Contributors: All authors were involved in the screening of records and data extractions. TK was the main author of this work and was responsible for the study design and coordination of the team. TK and EL were responsible for drafting the manuscript and all authors helped with the critical review of the manuscript.

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Ethics and Dissemination: This study does not require human ethics committee approval. All sources will be adequately referenced. The findings of our scoping review will be disseminated through presentations at conferences and relevant forums. The completed scoping review will be submitted in a peer-reviewed journal and will form part of a PhD thesis.

Supplemental material: Attached supplemental file.

Strengths and Limitations of this study

- The study used inclusive search strategies (peer-reviewed journals and grey literature) and a stringent review process using two independent reviewers throughout the process.
- The nature of CoCE may mean that relevant information published in non-indexed sources will have been missed.
- The study used Arksey and O'Malley's framework with enhancement from Levac and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews.
- There is a potential to miss centres that have not published any studies or records but are an established CoCE.

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Tables and Figures

Table 1: Inclusion and exclusion criteria

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Table 3: Characteristics of CoCE initiatives

Table 4: Outline of Selection/Nomination Process of CoCE.

Figure 1: PRISMA flow diagram

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ABSTRACT

Background

Centres of Clinical Excellence (CoCE) are nominally healthcare facilities that provide excellent, patient-centred, evidence-based care. However, despite the increasing prevalence of CoCE internationally, there is a lack of clarity on how these centres are identified, described and monitored.

Objectives

To explore how CoCE have been described in the literature; the defining characteristics, the selection criteria and processes, and the monitoring and evaluation protocols that have been used.

Design

Scoping review using Arksey and O'Malley's framework with enhancement from Levac. We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews. A comprehensive search using MEDLINE Ovid, PubMed, Web of Science, CINAHL and Scopus to identify relevant published studies between January 2010 and June 2022.

Results

Fifty records describing 45 initiatives were included. With the exception of one initiative, all focussed on one clinical condition/population, and most were published in the USA (n=25, 56%). These clinical conditions were mostly cardiovascular disease (n=8, 17%), spinal surgeries (n=4, 9%), and pituitary tumours (n=4, 9%). More than half of the initiatives (n=30, 67%) described a structured process to establish CoCE. The definitions of CoCE were not uniform. Common defining features included the volume of patients treated, a concentration of medical expertise, a highly skilled multi-disciplinary team, delivery of high-quality care, and achievement of excellent patient outcomes. The selection process as a CoCE varied from self-identification with no explicit criteria or assessment process, to application and assessment by an approval panel.

Conclusion

Despite a growing prevalence of CoCE, there are inconsistencies in how these centres are established, identified, monitored and evaluated. Common (but not uniform) features of CoCEs are highly skilled staff, high-quality care delivery and optimal patient outcomes.

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INTRODUCTION

Healthcare facilities worldwide have a shared goal to continually improve healthcare delivery, often using stringent standards and indicators.(1, 2) Improvements in healthcare delivery can take the form of defining best clinical practice or effectively demonstrating important aspects of care, such as safety, access, affordability, equity, effectiveness and efficiency.

Most healthcare organisations must meet national quality and safety standards to address clinical practice and organisational performance.(1) Accreditation is instrumental in achieving a baseline standard of care, but it has inherent limitations when it comes to achieving care that strives to be excellent or seeks to optimise patient-reported outcomes and experience. Recognising this gap between care that meets standards for accreditation and "excellent" care, some healthcare facilities are taking proactive steps to engage in self-improvement and seeking recognition for delivering exceptional care.

This aspiration for excellence within healthcare is often labelled as 'clinical excellence'(3) with organisations that deliver exceptional patient care being termed Centres of Excellence or Centres of Clinical Excellence (CoCE).(4-6) Additionally, terms such as 'research excellence',(7) 'service excellence'(8) and 'operational excellence'(9) are also used to delineate various other dimensions of excellence within healthcare. A recently published review(6) summarised evidence pertaining to Centres of Excellence in healthcare, education, research, industry and information technology. The authors of this review concluded that there are inconsistencies in how healthcare facilities are designated as Centres of Excellence and ambiguity between Centres of Excellence and regular healthcare facilities, with limited information on how these Centres were evaluated.

Attaining recognition as a CoCE could be a source of inspiration, as it encourages healthcare facilities and health professionals to pursue the best clinical care for their patients as well as being recognised as the lead in healthcare provision.(10) This motivates healthcare facilities to aspire to promote high-quality up-to-date evidence-based care to their community.(10) Despite the increasing use of the term CoCE, there is a lack of clarity about how this term is defined, how sites are nominated and selected as CoCE and how CoCE are evaluated and monitored.

The primary aim of this scoping review was to map evidence on CoCE in healthcare. We sought to explore and answer the following questions systematically:

1. What Centres of Clinical Excellence have been described in the literature?
2. What are the defining characteristics of Centres of Clinical Excellence?
3. How are Centres of Clinical Excellence selected or nominated?
4. What monitoring processes are employed to remain as Centres of Clinical Excellence?

Through conducting this review, we planned to explore the multifaceted dimensions of Centres of Clinical Excellence.

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METHOD

Protocol and Registration

We registered the scoping review protocol on Open Science Framework. We employed the scoping review framework proposed by Arksey and O'Malley(11) with the refinement outlined by Levac, Colquhoun and O'Brien(12) to evaluate the evidence on CoCE. We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR).(13)

Information sources and searches

We developed a search strategy with the support of a research librarian (Supplementary file 1). We searched MEDLINE Ovid, PubMed, Web of Science, CINAHL and Scopus to identify recent published records between January 2010 and June 2022. We also searched for grey literature (government reports, policies, protocols, conference proceedings, unpublished studies) and relevant websites using Google and Google Scholar. Reference lists of included records were searched to check for further relevant records.

Inclusion and exclusion criteria are presented in Table 1. We included records that discussed CoCE that provided clinical care for people with any health condition in any setting (primary care, inpatient, outpatient or community). To be included, records had to describe how a CoCE was defined, established, monitored or evaluated. We excluded records that used the term "CoCE" without outlining any criteria. Centres of Excellence that were not designed to provide clinical care (such as Centres of Research Excellence) were excluded. Given the exploratory nature of the research questions, there was no limitation to study populations or interventions.

Insert Table 1

Selection of records

The search results were imported into Covidence, and duplicates were removed. As recommended by Levac,(12) two reviewers independently screened titles and abstracts and reviewed full-text documents using the inclusion criteria (see Table 1). One reviewer (TK) conducted the online search for relevant websites (first 20 pages on Google search) and two reviewers (TK and LB) completed the screening and review of the grey literature independently. The inclusion and exclusion criteria were reviewed periodically throughout the title and abstract screening process to ensure the criteria facilitated the identification and inclusion of relevant studies.

Data charting process

A data extraction form was developed for the study (supplementary file 2). We pilot-tested the extraction form with the first 15 eligible records to ensure consistent data collection. Two

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reviewers independently (TK and EL) extracted data on all included studies using the extraction form on Covidence. Quality of individual records were not assessed due to the descriptive nature of the review aims.

Synthesis of results

We synthesised the research findings according to the research questions and presented data from all included studies in tabular form. Study characteristics was presented descriptively, and the research questions were presented narratively. The CoCE will be identified as initiatives and the search results will be defined as records. The centres will be described either as a theoretical or physical centre. A theoretical centre is a centre that describes aspirational criteria/framework to develop a CoCE. Comparatively, a physical centre is a centre that have documented criteria/framework/description used to establish a CoCE. Initiatives that described a framework (that was developed or is aspirational) were tabled as 'Framework adapted/created'.

Patient and public involvement

Patients were not involved in the design or completion of this study.

Insert Figure 1

RESULTS

Selection of sources of evidence

Overall, 9077 records were identified from database search and 36 records were identified through grey literature search. A further three records were identified by reviewing reference lists of included records. 50 records describing 45 initiatives relating to CoCE were included in the analysis (Figure 1). The complete search results and strategies are available in the Supplemental material.

Characteristics of sources of evidence

Most records (n=43, 86%) were published in or after 2015. Nearly all of the included records (n=44, 88%) were published in peer-reviewed journals, but only 15 (30%) were research articles, the remaining 28 (56%) records were other article types such as editorials or case reports. Two websites were identified as additional records for initiatives identified through the literature search. See Tables 2 and 3.

Insert Table 2

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Synthesis of results

Less than half (n=20, 47%) centres identified were physical CoCE. With the exception of one CoCE which provided care for people with diabetes and cardiovascular disease (14), all identified CoCE treated a single clinical condition or population. The commonly described conditions were cardiovascular disease(15-22) (n=8, 17%), spinal surgeries(23-26) (n=4, 9%), pituitary tumours(27-30) (n=4, 9%), diabetes(14, 31, 32) (n=3, 6%), and obstetrics(33, 34) (n=2, 4%).

Some CoCE (n=6, 13%) were located across several countries,(16, 20, 24, 27, 35, 36) whereas the majority were described as stand-alone clinical centres, such as wards, surgical centres or clinics. Eight CoCE (18%) were located in low-and middle-income countries.(19, 31, 37-42) More than half of CoCE were located in the USA (n=25, 53%). CoCEs established in high-income countries were typically described in terms of high-quality of care delivery, such as standardised care and optimal outcome (n=12, 27%),(18, 20-22, 24, 32, 34, 37, 38, 43-45) comprehensive multi-disciplinary care (n=8, 18%)(15, 27, 30, 31, 39, 46-48) or accessible patient-centred care (n=7, 16%).(4, 14, 28, 35, 41, 49-51)

More than half of the initiatives (n=30, 67%) described a structured process that was used, or could be used, to establish the CoCE. While many initiatives reported that the CoCE was established using a framework or series of developmental stages, details regarding the developmental stages were rarely available. Five initiatives reported using published frameworks (Elrod and Fortenberry,(28, 36, 44) Christmas(52) and National Cancer Institute(22)) to guide their process to establish the CoCE. See Table 3 for further details.

Insert Table 3

Defining characteristics of CoCE

Less than one fifth (n=19, 42%) of the initiatives explicitly defined the characteristics of the CoCE. Seven (16%) initiatives(19, 23, 25, 28, 36, 44, 53) used the definition from Elrod and Fortenberry "a program within a healthcare institution which is assembled to supply an exceptionally high concentration of expertise and related resource centred on a particular area of medicine, delivering associated care in a comprehensive, interdisciplinary fashion to afford the best patient outcomes possible".[(4)(p16)]

High volumes of patients treated/procedures performed, staffing and infrastructure resources and above-average quality of care and patient outcomes were the most commonly described defining features of CoCEs. Key components that were reported regarding staffing were medical expertise, highly skilled multi-disciplinary teams and staff: patient ratios. Other resources that were described as part of the CoCEs were infrastructure (n=15, 33%) such as building space and examination rooms, and specialised equipment (n=9, 20%). High quality of care delivery was described in terms of standardised care and optimal outcome (n=12, 27%),(18, 20-22, 24, 32, 34, 37, 38, 43-45) comprehensive multi-disciplinary care (n=8,

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18%)(15, 27, 30, 31, 39, 46-48) or accessible patient-centred care (n=7, 16%)(4, 14, 28, 35, 41, 49, 50). Availability of treatment protocols were described as an important feature in 7 initiatives (15%). See Table 3 for details.

There were differences noted in defining characteristics of CoCE located in low- and middle-income countries, compared to CoCE in high-income countries. While most CoCE had common features regarding staff expertise, equipment and patient outcomes, CoCE in low- and middle-income countries tended to be established by collaborating with larger local or international healthcare facilities and to provide a healthcare service that otherwise was not available in the region, for instance neurosurgery in Peru and comprehensive dental care in Guwahati, India.

Selection or nomination process of Centres of Clinical Excellence

No details were available about how sites were selected as CoCE in half (n=24, 53%) of the included initiatives. While 21 initiatives reported that there was a selection or nomination process to be recognised as a CoCE, the details of the selection/nomination process were inconsistently reported. Processes used to select centres as CoCEs were varied and included application and assessment by an approval panel (n=9, 45%)(4, 8, 22, 33, 42, 44, 53-55), self-identification as a CoCE with no explicit criteria or external assessment (n=6, 30%)(14, 15, 18, 28, 40, 49) and site-visit by funding body to assess suitability (n=1, 5%)(17). Only four (20%)(35, 45, 47, 56) initiatives presented the process used to select the CoCE in its entirety, which are presented in Table 4.

The bodies providing oversight of nomination or selection of the CoCE were professional bodies (e.g., Infectious Diseases Society of America,(53) Society of Obstetric Anaesthesia and Perinatology,(33) Lymphatics Education and Research Network,(47) American Academy of Orthopaedic Surgeons(25)), National Cancer Institute National standards,(22) insurers,(44, 54), organisation(4, 37, 45) and REAL- PANLAR (Pan American League of Associations for Rheumatology).(35)

Insert Table 4

Monitoring protocols to remain a designated Centre of Clinical Excellence

Only 24 (53%) of the included initiatives reporting a monitoring process for the CoCE. Monitoring was mandatory for 6 (25%)(33, 35, 47, 51, 53, 56) initiatives through a recertification process. Other initiatives reported the importance of monitoring outcomes such as productivity (n=5, 21%),(16, 18, 38, 42, 49) patient outcomes (n=9, 36%),(14, 15, 26, 28, 31, 44, 46, 48) quality metrics (n=3, 13%)(23, 25, 36) and efficiency and cost effectiveness of the program (n=1, 4%),(39) but there was no evidence that this monitoring process was routinely performed or overseen by any parties.

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DISCUSSION

Summary of evidence

To our knowledge, this is the first scoping review completed on CoCE in healthcare. This scoping review provides an in-depth insight on CoCEs reported in the literature.

Despite being able to identify numerous initiatives describing CoCE, we were unable to identify processes used to select more than half of the identified initiatives. When selection processes were documented, they were inconsistent between initiatives. Further, there were inconsistencies in monitoring CoCE performance. Without consensus on what defines a CoCE, and without a recognised body to monitor the performance within each CoCE, there is no guarantee that care being delivered by sites claiming to be CoCEs are actually delivering excellent (or even better-than-usual) healthcare.

The most common defining feature of CoCEs included in this review was resource availability, specifically personnel, infrastructure and equipment. It is well established that there are associations between staffing levels, skill mix infrastructure and patient outcomes(57-61) Further, infrastructure and specialised expertise are key factors in establishing Centres of Excellence in Healthcare and other industries.(8) Therefore these findings regarding features of CoCE are not at all surprising, but reinforce that CoCE described in the literature have been designed to align with what is known about healthcare delivery that leads to improved patient outcomes.

While frameworks or processes used to establish or describe a CoCE serve as valuable guides to others in the field, they may have limitations when they have been developed for a specific healthcare facility or disease group. For example, the Willis-Knighton Health System is a non-for-profit healthcare network in Louisiana, USA that operates eleven self-nominated centres of excellence. The framework used to establish these centres of excellence, was described by Elrod and Fortenberry and was cited by authors of eight initiatives in our review to describe or establish their centres. While this framework was used as guidance, consideration should be given as to whether this framework is fit for purpose beyond the state of Louisiana and in countries with different healthcare models to USA. Additionally, it is not clear that this framework meets a universally agreed definition of excellence in healthcare. Empirical research to define “excellent care” from patient’s, healthcare facilities’ or funders’ perspectives could increase the validity of the frameworks, and subsequently the CoCEs.

Selection procedures for CoCE were inconsistently reported and were not available for nearly half the included initiatives. The description of excellent care provided by the CoCE varied, seemingly associated with which agency was responsible for creating the definition. Descriptions of excellence encompassed patient-centric outcomes (e.g. optimising clinical outcomes and quality of life), service-centric outcomes (e.g. staff skill development, resource availability and meeting quality and safety accreditation) and economic outcomes (e.g. cost of treatment, length of stay). The concept of excellence was sometimes conflated with high

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volume of patients who received care at the centre. Excellence for some centres from low- and middle-income countries was defined (either by self-nomination or by the government or collaborating international institution) in terms of providing a particular healthcare service when none was previously available in the region. Many of these aspects of excellence reflect commonly measured quality indicators of healthcare in high income countries, namely effectiveness, access, safety and efficiency.(62) However, cost is not included as a quality metric in countries such as Australia, Canada or the UK, but is included a measure of quality in the US Commonwealth Fund framework.(62) The inclusion of cost as a feature of some CoCE could be reflective of the different funding models (e.g. fee-for-service versus universal healthcare) or healthcare priorities within the centres or by the bodies determining a site's excellence. The centres that reported economic outcomes as a measure of clinical excellence were predominantly located in the USA and were nominated by healthcare funders.(63, 64)

Benchmarking is a well-recognised process to identify best-performing healthcare facilities in term of patient outcomes and system performance.(65) However, while there is an implicit assumption that a CoCE will deliver care that is superior to another (non-excellent) centre, most of the included initiatives in our review did not benchmark with other services using transparent criteria. While a minority of the initiatives reported a certification process, there was no evidence that this process included healthcare facilities being benchmarked against other facilities. Benchmarking allows tracking of performance overtime while comparing performance against other facilities, thereby demonstrating what is feasible to achieved in terms of quality of care.(65) For the initiatives included in this review, without comparison to other healthcare facilities and without a standardised set of explicit, evidence-based and measurable criteria, it raises disparity and challenges on how these centres can claim to be legitimate CoCEs.

It is recognised that healthcare performance can be variable,(65) so healthcare facilities should monitor and evaluate their programs to ensure continued excellence. This process needs to be feasible within the time and resource constraints. Just over half the initiatives included in this review reported monitoring their service, and described various processes including measuring patient outcomes, service productivity and quality metrics to maintain the designation of CoCEs. Only six initiatives reported a structured process, where their ongoing performance was reviewed and assessed by an overseeing body to maintain their status as CoCE. Clearly more attention should be paid to demonstrate the sustainability of excellence initiatives.

CONCLUSION

Although CoCE are increasingly reported in the literature, there are inconsistencies in how these CoCEs are established, monitored and evaluated. Processes used range from self-designation or adapting criteria from other centres to using external evaluation and periodic

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recertifications. Features of CoCE centred around skilled medical and multi-disciplinary teams and other resources such as infrastructure and equipment. More work is required to develop transparent systems and processes to ensure that centres claiming to be "excellent" can demonstrate that they are delivering the highest quality care.

IMPLICATION FOR PRACTICE AND FUTURE RESEARCH

This review highlights the need for clear criteria that healthcare facilities use to identify or establish a CoCE. The processes used also need to be transparent, so they are easily available for certification or auditing purposes. The concept of a healthcare centre promoting "excellence" can also vary depending on different perspectives: patient, systems or funding. There needs to be clear guidelines that highlights the impact of "excellence" from these perspectives to ensure transparency why a centre was nominated as a CoCE, and the monitoring processes used. The findings from this review will contribute to international efforts to establish CoCE using robust, transparent criteria and key performance indicators.

STRENGTHS AND LIMITATIONS

The strengths of our scoping review include the inclusive search strategies (peer reviewed journals and grey literatures) and stringent review process using two independent reviewers throughout the process. There is a potential that there may be established CoCE that have not published any studies or reports, which we then have not identified. Whilst we sought assistance from an academic librarian to ensure the search strategies were clear and comprehensive, centres that describe excellence using different terms and relevant information published in non-indexed sources may have been missed. This is a particular challenge of this focus of work which straddles healthcare organisation, clinical practice and academic research.

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Table 1 Inclusion and Exclusion Criteria

Table 1: Eligibility criteria for article selection
Inclusion criteria
➢ Available in the English language ➢ Information on CoCE ➢ Healthcare organisations or services providing clinical care to people with any healthcare condition ➢ Published from January 2010 ➢ Any geographical location ➢ Studies describing the development/defining/monitoring/evaluation/frameworks of CoCE
Exclusion criteria
➢ Records that describe a study conducted at CoCE (e.g. using participants from CoCE) ➢ Centres that do not provide clinical care (e.g. Centres of Research Excellence or Centres of Leadership Excellence) ➢ Conference abstracts/papers, letters, NICE guidelines, JBI guidelines ➢ Only looking at costs associated within one CoCE (no comparator) ➢ Only looking at clinical outcomes for people receiving care at CoCE (no comparator) ➢ Using term "CoCE" without outlining the criteria

Abbreviation: CoCE- Centres of Clinical Excellence; NICE- National Institute for Health and Care Excellence; JBI- Joanna Briggs Institute

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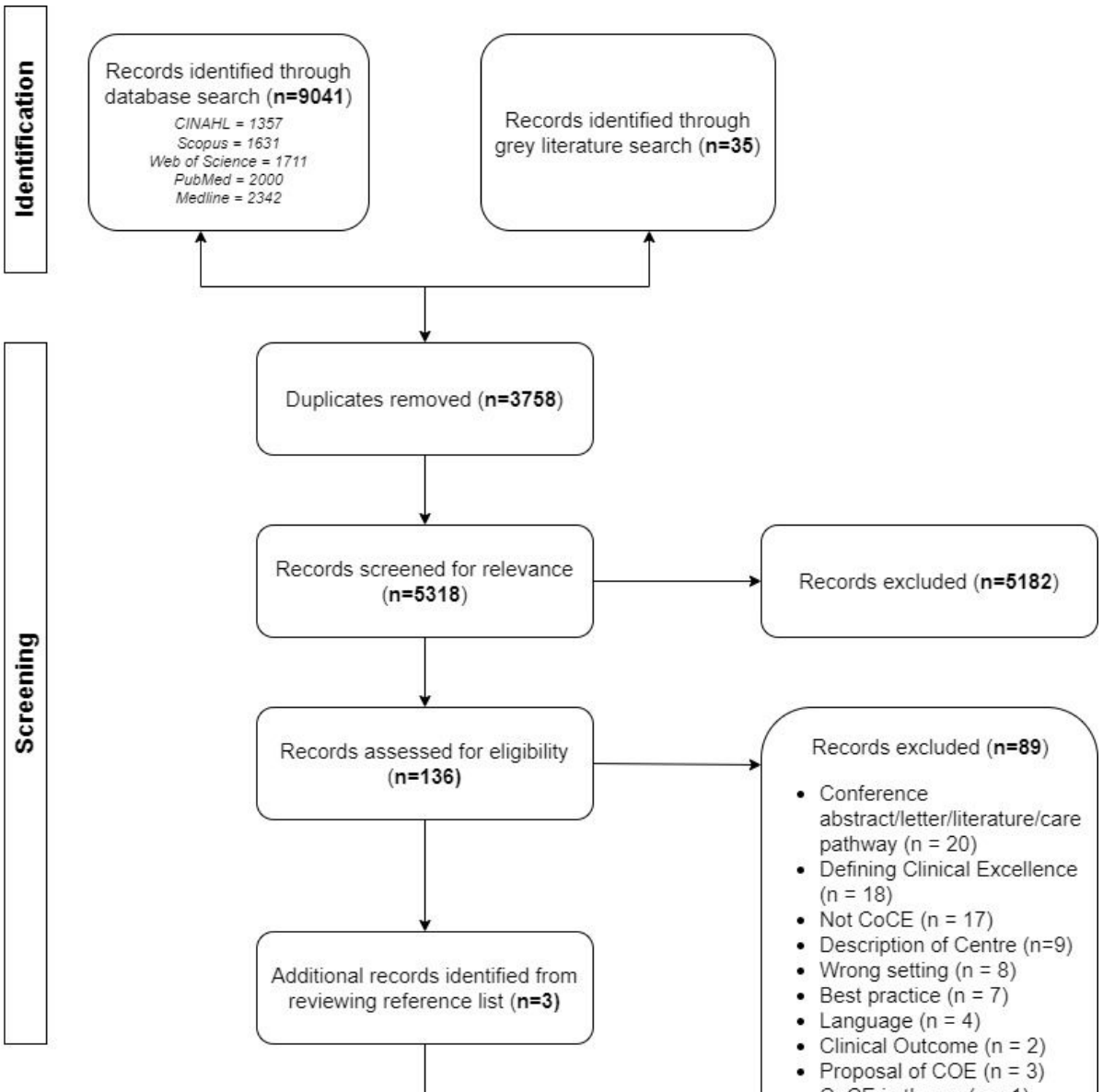

Figure 1 PRISMA flow diagram. *Abbreviation: CoCE- Centres of Clinical Excellence; COE- Centre of Excellence*

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Table 2 Characteristics of included records

Types of literature from included records (n=50)	N(%)
Research articles	15 (30%)
Others (Editorial, reports, case reports) from peer reviewed journals	28 (56%)
Book chapters	3 (6%)
Websites	2 (4%)
Systematic review	1 (2%)
Government report	1 (2%)
Country of Centre or initiatives described (n=45)	
USA	25 (56%)
Others	20 (44%)
Clinical Conditions from initiatives described (n=45)	
Cardiovascular disease	8 (18%)
Spinal surgery	4 (9%)
Pituitary tumours	4 (9%)
Diabetes	3 (7%)
Pregnancy related	2 (4%)
Others	24 (53%)

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Table 3 Characteristics of CoCE initiatives

1st Author of main record describing initiative	Theoretical Centre (T) or Physical Centre (P)	Framework adapted / created	Resources				Processes used or suggested for CoCE		
			Personnel	Infrastructure	Equipment	Other	Criteria described	Processes to establish a CoCE	Processes to monitor a CoCE
Bitzer et al(46)	T	X	X	X			X		X
Burkett et al(23)	T		X				X		X
Campbell et al(37)	P	X	X	X			X	X	
Carvalho and Jill(33)	T	X	X		X		X	X	X
Casanueva et al(27) & Tritos(30)	T	X	X				X		
Chang et al(47) & Lymphatic Education & Research Network(66)	P	X	X			X	X	X	X
Choque-Velasquez et al(38)	P		X		X	X			X
Coon et al(67)	P	X	X				X		
Creehan et al(68)	T	X	X				X		
Daming et al(18)	P	X	X	X			X	X	X
Deshmukh et al(39)	P	X	X				X		X
Dietz et al(43)	T	X	X		X	X	X		
Distiller and Brown(31)	P		X			X	X		X
Draznin et al(32)	T	X	X	X			X		
El-Eshmawi et al(15)	P	X	X	X			X	X	X
Elrod and Fortenberry(4)	P	X	X	X			X	X	
Ferguson and Froehlich(49)	P		X					X	X
Frara et al(28)	T	X	X	X			X	X	X
Geetha et al(52)	P	X					X		
Haider et al(36)	T	X	X				X		X
King, Jamieson and Berg(44)	P	X					X	X	X
Kullar et al(53)	P	X	X				X	X	X
Lancellotti, Dulgheru and Sakalihasan (16) & Chambers et al(17)	T		X	X			X		X
Li et al(54)	T						X	X	

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Marinoff and Heiberger(40)	P		X	X				X	
Martin et al(24)	T	X					X		
McLaughlin et al(29)	T		X		X	X	X		X
Nakov et al(19)	P		X				X		
Piccini et al(20)	T	X	X	X		X	X		
Pronovost et al(48)	T	X					X		X
Safer Care Victoria(50)	T	X					X		
Sandhu et al(21)	T	X	X						
Santos-Moreno et al(35, 69, 70)	P	X	X	X	X		X	X	X
Sheha and Iyer(25)	T		X				X		X
Shikora, Delegge and Van Way III(56)	P	X	X	X	X		X	X	X
Shommu et al(71)	T						X		
Silver et al(34)	T		X	X			X		
Steiner et al(72)	T		X				X	X	
Tapela et al(41)	P		X	X	X	X	X		
Thomas et al(14)	P		X					X	X
Vivian et al(45)	P	X	X	X	X	X	X	X	
Williams(22)	T	X	X		X		X	X	
Wirth et al(51)	T	X	X				X	X	X
Wu et al(26)	T	X					X		X
Yao and Zhou(42)	P	X	X			X		X	X
Total	**21 (P) 24 (T)**	**30**	**37**	**15**	**9**	**9**	**39**	**20**	**24**

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Table 4 Outline of Selection/Nomination Process of CoCE.

1st Author	Steps outlined
Chang et al(47) & Lymphatic Education & Research Network(66)	1. Applications will be reviewed by the LE&RN Global Oversight Committee (GOC). All applications will be scored, using the following three individual criteria: a. The quality of the overall application/services. b. Unique offerings or particular characteristics that add to the Lymphatic disease clinic. c. Miscellaneous (e.g., lymphatic disease community citizenship, research).
Santos-Moreno et al(35)	1. Implementing an attention model for the patients diagnosed with rheumatoid arthritis, in accordance with the requirements of each type of centre of excellence. 2. Filling the self-assessment form of each type of centre of excellence and implementing improvement actions. 3. Requesting and preparing for a verification visit. 4. Receiving a verification visit from REAL-PANLAR. 5. Official notice of the results of the assistance and verification visit.
Shikora, Delegge and Van Way III(56)	1. Online application completed by surgeon or facility. 2. Successful application results in provisional status. 3. Within 2 years must seek full approval and pass on-site inspection and indicates has excellent outcome. 4. Mandatory submission of all patient data to a database.
Vivian et al(45)	1. Establishing the foundation (leadership structure and purpose). 2. Formalising the Centre of Excellence program (clinical education training, multi-disciplinary team involvement). 3. Solidifying the Centre of Excellence status (certification/accreditation by external institute).

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Supplemental file

Search Strategy

Databases search: MEDLINE Ovid, PubMed, Web of Science, CINAHL and Scopus

Keywords used: "centre of clinical excellence" OR "networks of excellence" OR "best practice" OR "clinical exemplars" OR "integrated healthcare delivery" OR "excellence" OR "clinical protocols" OR "clinical competence" as search terms, subject headings, concepts or keywords.

MEDLINE Ovid
(((centre* or network* or best practice or institute*) adj3 clinical excellence) or center of excellence or centre of excellence).ti,ab,kf.

CoE – Centre of Excellence
*Research article in peer reviewed journal
#Other in peer reviewed journal
^Case report in peer reviewed journal

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Table 1: Description of the aim and type of publication and information on how CoCE were described in the initiatives.

1st Author	Country / Region	Aim of publication	Type of publication	How is CoCE described in the study					
				Name of CoCE	Year CoCE established	Framework adapted/created	Function of CoCE	Clinical focus area of CoCE	Resources
Bitzer et al[1]	Europe	Describing the framework and characteristics of an "ideal" CoE of Sexual Medicine and Sexual Therapy	Other#	Centre of Excellence for Sexual Medicine	Not reported	Created by authors	Diagnosis and treatment of Sexual dysfunction. Aim to • To provide a frame for patient centred and relationship based care • To provide multidisciplinary diagnostic assessment, individualized therapeutic options, documentation and follow-up of patients • Provide training for medical students, residents and fellows	Sexual medicine	**Personnel** • Multi-disciplinary team **Infrastructure** • A room for counselling/therapy • Examination room
Burkett et al[2]	Not reported	To present the concept of “centers of excellence” and how they are applied to spine care. Provided an overview of spinal CoE.	Book chapter	Spine Centre of Excellence	Not reported	Not reported	• To achieve exceptional quality of spine care at lower cost. • To establish a regional presence and a robust patient population. • To demonstrate that the organization meets high performance standards. • To stand out among other area institutions.	Spinal surgeries	**Personnel** • Specialties involved may include neurosurgery, orthopaedic surgery, rehabilitation, occupational therapy and physical therapy, pain management, specialized nursing, radiology, behaviour medicine, and psychiatry
Campbell et al[3]	India	Examines the evolution of a Centre of excellence as an innovative model for	Research article*	Operation Smile Guwahati	2009	Created by authors and collaborators	To provide standardized and comprehensive cleft care at one institution, with vision of making	Cleft palate	**Personnel** • Healthcare professionals in multiple disciplines

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		sustainable cleft care in the developing world		Comprehensive Cleft Care Center (GCCCC)		from Operation Smile	Assam a cleft-free state.		**Infrastructure** • Modern surgical suite and clinical space • Modern integrated operating suite, advanced surgical equipment, sophisticated anaesthesia and monitoring capabilities
Carvalho and Jill[4]	USA	To describe designation process of Centres of Excellence in obstetric ant	Other# & Website	CoE for Anaesthesia Care of Obstetric Patients	2018	The criteria for Centres of Excellence designation, which covers all aspects of obstetric anaesthesia care, were generated by expert consensus and incorporate evidence-based recommendations.	CoE designation process is designed to recognize institutions and programs that demonstrate excellence in obstetric anaesthesia care, to set a benchmark level of expected care to improve the standards nationally, and to provide a broad surrogate quality metric of institutions providing obstetric anaesthesia card.	Obstetric Anaesthesia and Perinatology	**Personnel** • Obstetric anaesthesiologist • 24/7 coverage of obstetric patients by at least 1 anaesthesiologist **Equipment** • Includes access to blood transfusion equipment and supplies, access to resuscitation and intubation equipment and supplies
Casanueva et al[5] & Tritos[6]	International	To describe the criteria for developing Pituitary Tumors CoE	Other#& Website	Pituitary Tumor Centers of Excellence (PTCOE)	Criteria disseminated 2017	Expert working group drafted framework. The draft was modified and	• Provide the best multidisciplinary care for patients with pituitary tumours and related pathologies. • Advance pituitary science • Provide adequate patient	Patients with pituitary tumours	**Personnel** • Medical specialists • Multidisciplinary supports • Basic requirements for surgical training and

CoE – Centre of Excellence
*Research article in peer reviewed journal
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						approved by the Board of Directors of the Pituitary Society. The document was presented to international groups, modified and endorsed.	education and community outreach. • Act as a training centre for residents in the treatment of pituitary • Pathologies • Advise health administrations and authorities on specific problems.		endocrinologist training listed.
Chang et al[7] & Lymphatic Education & Research Network[8]	USA	To describe the steps taken to establish standards for Centres of Excellence for Lymphatic Disease Described 5 categories of Centres of Excellence: • Comprehensive Centre of Excellence • Network of Excellence • Referral Network of Excellence • Lymphatic Disease Surgery Centre of Excellence • Lymphatic Disease Conservative Care Centre of Excellence.	Research article*, website	Lymphatic Education and research network CoE	Criteria published 2021	Lymphatic Education and Research Network initiated a Centres of Excellence program to designate institutions that provide services for lymphatic disease patients	• Provide multidisciplinary clinical care • Provide professional and education • Involvement in clinical research Work with local and international CoCEs to continually improve the lives of people with LD and their families.	Lymphatic disease	**Personnel** • Multi-disciplinary input • Suggested expertise requirements listed in detail **Resources** • Assessment tools listed

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Choque-Velasquez et al[9]	Peru	To describe the development of Neurosurgical Centre of Excellence in Peru	Research article*	Specialized Neurosurgical Centre of Excellence	2016	Not specified what process used	To improve the treatment of neurosurgical diseases in the region, thus optimising their outcomes and decreasing transfers to the neurosurgical departments in the capital district	Specialty neurosurgical centre, Peru	**Personnel** • Staff training by neurosurgeons and nurses from Finland **Equipment** • Equipment provided/repaired **Other** • Neurosurgical protocols developed
Coon et al[10]	USA	Introduced key aspects of coordinated care for patients with MSA and their caregivers, discuss various outcome measures, and share experiences from two centers with multidisciplinary clinics.	Other#	Multiple System Atrophy CoE	Multiple Centres discussed. Established between 2015 - 2019.	Created by authors but process not described	Not reported	Multiple System Atrophy	**Personnel** • Multi-disciplinary team
Creehan et al [11]	USA	Describe the development of a framework for Centres of Pressure Ulcer Prevention Excellence	Research article*	Centers for Pressure Ulcer Prevention Excellence	The process developed in 2014	Framework developed using Donabedian model. Systematic literature reviews, analysis of exemplars, and nominal	Inspirational centre - to develop a framework. Aim to achieve and sustain reductions in avoidable hospital-acquired pressure ulcers	Pressure ulcer	**Personnel** • Frontline staff engagement and hospital • Administrator • Leadership

CoE – Centre of Excellence
*Research article in peer reviewed journal
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						group process techniques were used to create the framework, based on 4 Magnet Model domains.			
Daming et al[12]	USA	A guide for creating a center of excellence for prenatal care for women with cardiovascular disease.	Other#	Maternal Cardiac CoE	2014	Developed a 3 staged framework (vision-> design and development -> implement, monitor and review).	To manage pregnant women consistently and systematically with heart disease.	Maternal cardiac health	**Personnel** • Program coordinator • Multi-disciplinary team (recommendation provided for speciality **Infrastructure**: • Dedicated outpatient clinic
Deshmukh et al[13]	India	To evaluate the impact of the Centre of Excellence at Vidya Shikshan Prasarak Mandal Dental College and Research Centre	Research article*	Centre of Excellence at Vidya Shikshan Prasarak Mandal Dental College and Research Centre	2016	The present CoE model was planned and executed with consensus building for 12 months using several methods to involve stakeholder	• To provide comprehensive oral healthcare for economically disadvantaged groups in rural India. • To foster organisational development through an integrated approach. • To stand out as a pioneer in Central Indian region in the fields of maxillofacial rehabilitation and	Oral healthcare	**Personnel** • Academic faculty, consultants and post-graduate students

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						groups (staff, students and patients)	oral implantology.		
Dietz et al[14]	USA	Summary of best practices for the prevention and treatment of PJI within the context of a CoE.	Case report^	Centers of Excellence in Addressing Periprosthetic Joint Infection	Not reported	Creating a basis for framework within the literature, based on work on musculoskeletal infection symposium	Centers of Excellence provide better overall outcomes and lower financial, physical, and emotional costs to the patient, thus providing a greater value by decreasing variability in treatment pathways and incorporating best practices based on evidence.	Periprosthetic joint infection	**Personnel** • Multi-disciplinary teams **Equipment** • Electronic medical records **Others** • Protocols for pre-operative screening and evaluation • Risk reduction protocols and processes
Distiller and Brown[15]	South Africa	Not reported	Book Chapter	Centres for Diabetes Excellence	1994	Not reported	To improve diabetes management and provide "one-stop shop" for patients. With all services in one place, and a well-managed appointment system, patients experienced minimal waiting and optimal consultation times.	Diabetes	**Personnel** • Trained medical staff (specialists, GPs or physicians) **Other** • every centre must provide a direct 24-h emergency telephone number ("Hotline")
Draznin et al[16]	USA	Proposing a framework to guide advancement for clinical CoE	Other#	Diabetes Center of Excellence	Not reported	6 domains or pillars to serve as guiding principles	To improve population health, patient care experience (including quality and satisfaction) and reducing healthcare costs. Diagnosis and management of diabetes.	Diabetes	**Personnel** • Adequate in terms of number, skills, experience • Multi-disciplinary professional teams guided by clinician diabetologists experienced in

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									managing complex, high-risk individuals **Infrastructure** • appropriate to qualify as a centre and technologies
El-Eshmawi et al[17]	USA	To define the structure of a mitral center of excellence and to review current clinical outcomes	Other#	Mitral Valve Center of Excellence	Not Reported	Description of functioning of self-nominated Centre of Excellence	Provides a structure for a multidisciplinary heart team to provide state of the art care for patients with degenerative mitral valve disease	Mitral valve disease	**Personnel** • Crucial - surgeons trained in mitral valve repair; anaesthesia team, intensive care team, interventional cardiologist **Infrastructure** • Mitral valve clinic; access to advanced cardiac imaging; data monitoring team
Elrod and Fortenberry [18]	USA	To guide healthcare establishments to replicate noted processes to realize their own CoE	Other#	Willis-Knighton Health System CoE (has 11 CoE in different clinical areas)	1980's	Based on information and insights gleaned from 1 healthcare provider's (Willis-Knighton Health System) experience assembling and operating Centers of	To deliver innovative, high-quality healthcare that would attract increasing number of patients	11 clinical areas by this healthcare provider	**Personnel** • Skilled and experienced personnel **Infrastructure** • Appropriate accommodation necessary to deliver continuum of care

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						Excellence.			
Ferguson and Froehlich[19]	USA	Describe the development of the program, its guiding principles, challenges and early results	Case report^	The Total Joint Centre	2010	Not reported. Intuitive quality improvement process with assistance from external consultant	To provide state-of-the-art, high quality, patient-centric, efficient healthcare	Joint replacements	**Personnel** • Multi-disciplinary team • Patient navigators employed
Frara et al[20]	Authorship team from Spain	Not reported. Discussion paper	Case report^	Pituitary tumors centers of excellence	Not reported	Adapted from Elrod and Fortenerry	To provide a high-level care to pituitary patients, to advance pituitary science.	Pituitary tumors	**Personnel** • Specialist medical staffing and nursing **Infrastructure** • Physical place availability
Geetha et al[21]	USA	Apply the definition of clinical excellence to nephrology	Other#	Miller-Coulson Academy of Clinical Excellence	2015	Adapted clinical excellence framework from Christmas	Not reported	Nephrology	Not reported
Haider et al[22]	LMIC	• To explore the role of international urologic organisations in developing CoE in patient care, training and dissemination of knowledge. • To explore strategies used to improve the standard of care and	Case report^	Not reported	Not reported	Used Elrod and Fortenberry	To contribute to health system strengthening through international partnerships	Urology Surgery	**Personnel** • Staff with depth and breadth of knowledge and qualifications

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		outcomes of urologic conditions in LMIC. • To provide a roadmap on how similar international surgical organizations can contribute to developing CoE in LMIC through health system strengthening.							
King, Jamieson and Berg[23]	USA	To use the example of transplant programs (with extensive national-level data) as examples of the strategic planning required to accomplish comprehensive. Interdisciplinary care affording the best possible outcomes, and rightfully claim to serve as centres of Excellence.	Other#	Presents 9 Centres of Excellence designations within solid-organ transplantation	Not reported	Elrod and Fortenberry	Providing best outcomes and care to people undergoing organ transplantation	Hepatology	Not reported
Kullar et al[24]	USA	• To describe the process and purpose of designating institutions as Antimicrobial Stewardship Centres of Excellence CoEs. • To provide awareness to	Research article*	Antimicrobial Stewardship Centres of Excellence (program)	2017	Built on core elements of Centers for Disease Control and Prevention. Added aspects of meaningful	Effectively implement of antimicrobial stewardship programs	Infectious Disease	**Personnel** • Clinical expertise

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		clinicians on opportunities available through Infectious • Diseases Society of America with this CoE designation				differentiation by workgroup of infectious diseases physicians and pharmacists.			
Lancellotti, Dulgheru and Sakalihasan [25] & Chambers et al[26]	Multiple European countries	Chambers: to discuss Standards for mitral and aortic valve multidisciplinary team practice within a 'Heart Valve Center of Excellence'.	Other#& Research article*	Heart Valve Centre of Excellence	Not reported	Not reported	To perform durable mitral valve repair at close to zero risk in patients with asymptomatic severe mitral regurgitation caused by prolapse. The intention was that invasive valve interventions should not occur outside Heart Valve Centres of Excellence	Heart Valve Surgery	**Personnel** • Multi-disciplinary team (medical and nursing) proficient in diagnosing and treating all cardiac valve syndromes and disorders **Infrastructure** • Facilities to treat and refer patients for valvular surgery/intervention. • Access to expert imaging
Li et al[27]	USA	To evaluate the current status of defining and using CoE designation	Research article*	Not reported	Not reported	Not reported	Not reported	Multiple area	Not reported
Marinoff and Heiberger[28]	China	To share accomplishments and limitations from creating a Centre of Excellence in Low Vision rehabilitation in China	Case report^	Center of Excellence in Low Vision and Vision Rehabilitation	2010	Not reported	Treatment of people with low vision	Low vision and vision rehabilitation	**Personnel** • Trained doctors and nurses **Infrastructure** • Occupies 6,240 square feet and is equipped with four low vision examination rooms, a special testing room, an

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									assistive technology room, a dispensing area, and a classroom, access to multiple low vision devices
Martin et al[29]	Various countries	Utilize available literature to better characterize the features of a spine COE at a tertiary care center and determine the impact of CoEs on patient satisfaction and outcomes.	Systematic Review & Case report^	Spine CoE	2021	The COE's (Midwest academic tertiary care) mission entails three primary emphases: value, quality, and accountability.	Standardisation of protocols for the works up of suspected spinal cord compression across the regional hospital system to improve time to diagnosis, transport and intervention.	Spine	Not reported
McLaughlin et al[30]	USA	Review the literature supporting the establishment of pituitary CoEs, suggest criteria for COE recognition, consider the development of standards of care, and discuss potential pitfalls.	Other#	Pituitary Centre of excellence	NA	Not reported for pituitary tumour, however provided examples of other models e.g., bariatric	Treatment of pituitary tumour and described primary mission and criteria for verification	Pituitary	**Personnel** • Multi-disciplinary approach related to pituitary tumours and hormonal disorders. • At least 1 neurosurgeon with transsphenoidal surgical experience • Training for team **Equipment** • Equipment and instrumentation for endonasal cranial base surgery including endoscopic equipment

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									Others • Clinical pathways and standard operating procedures
Nakov et al[31]	Bulgaria	Focus on the importance of performing the most appropriate testing strategies for ATTR amyloidosis and establishing a CoE for this rare disease. Highlights experience in establishing a CoE in Sofia, Bulgaria and define the fundamental steps needed to successfully launch a program.	Other#	CoE for ATTR amyloidosis	2016	Not reported	Treatment for Amyloidosis	Transthyretin Amyloidosis	**Personnel** • Dedicated team of experts specialized in the range of medical fields required to diagnose the patients effectively and education/training for staff
Piccini et al[32]	Not specifically identified	HRS hopes to accelerate this evolution by reviewing the rationale for AF CoEs, the available evidence for integrated and multidisciplinary care, and future challenges and opportunities. The document also defines the key priorities to be used as a guide for HRS and its diverse	Other#	Atrial Fibrillation CoE	Not reported	Fundamentals of team-based integrated care models in atrial fibrillation	To improve outcomes by providing a better patient experience and delivering high-quality, guideline-recommended, state of the art care	Atrial Fibrillation	**Personnel** • Multi- disciplinary team **Infrastructure** • Dedicated lab with fluoroscopy • Electrophysiology recording system • Emergency equipment **Others** • Complication standard operating procedure

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		stakeholders to build consensus on defining the core components of an AF CoE.							
Pronovost et al[33]	USA	Defines explicit criteria for provider-based CoEs and how to apply them within a healthcare organization	Case report^	General description of CoE	Not reported	Reported used a framework based on University Hospital, USA and listed the criteria used to establish CoE as a framework.	Have access to multi-D team and seek to improve patient experience and outcomes and reduce cost.	NA	Not reported specifically. Used examples from other CoE
Safer Care Victoria[34]	Australia	Discuss approaches to engaging clinicians and consumers to improve the quality and safety of health care in Vitoria. Spells out the purpose, role and structure of the CoCE.	Website – grey literature	Safer Care Victoria Centres of Clinical Excellence	2021	Aligns with Safe Care Victoria Strategic Plan 2020-2023.	Contribute to the key strategic domains of leadership, partnership and planning, monitoring and improvement with the aim of improving healthcare across Victoria, so it is safe, more effective and person-centred.	Multiple setting	Not reported
Sandhu et al[35]	USA	To gain a better understanding from key stakeholder groups on current practices needs and potential barriers to implementing optimal integrated AF care.	Other#	Atrial Fibrillation CoE	2022	AF CoE task force provides recommendations on defining, developing, implementing and evaluating an AF CoE	To standardise the care of AF patients based on guideline directed care to achieve best outcomes.	Atrial Fibrillation	**Personnel** • Identified the need for multi-disciplinary team

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Santos-Moreno et al[36-38]	South America	• To define the minimum standard of care. • To describe the history and current context of the CoE in comprehensive care in patients with RA with suggestions on how to create CoE in RA • Proposed a systematic and progressive methodology that will help all the institutions to develop successful models without faltering in the process	Research article* & Other#	Centre of Excellence in Rheumatoid Arthritis	Not stated	Created own framework and integrated healthcare models and endorsed by REAL-PANLAR Based on 3 pillars - the volume of patients with a specific condition or entity - continuous improvement - the quality of healthcare	The ultimate goal of the CoE is to define a model of comprehensive care that meets the needs of the region in order to improve the accessibility, quality, and timeliness of care, and access to appropriate diagnosis and treatment. This is to facilitate access to better quality treatment, achieve disease remission, improve their quality of life, and reduce long-term disability for RA patients.	Rheumatoid Arthritis	Three CoE Modes were presented and each model (standard CoE, Optimal CoE, Model CoE) had different requirements of staff, equipment and infrastructure **Personnel (at minimum)** • Multi-disciplinary team led by rheumatologist **Infrastructure** • Access to radiology • Access to pathology **Equipment** • Standardised tools
Sheha and Iyer[39]	USA	General description of CoE and applying general principles of healthcare CoE to spine surgery	Other#	Spine CoE	Multiple centres that was previously established was discussed in the study	Not reported	An opportunity to accurately evaluate the true value of outpatient spine surgery	Ambulatory spinal surgery	**Personnel** • Multi-disciplinary team • Education
Shikora,	USA	Describes the creation,	Case	Nutrition	2003 -	Consideration	Not reported	Nutritional	Specified BSCoE and how this

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Delegge and Van Way III[40]		implementation, and benefits of the BSCoE (Bariatric Surgery COE) and the benefits of creating an NSCOE (Nutritional Support CoE). Description of the CoE in Bariatric Surgery and how this can be adapted to Nutritional Support. The report contains description of resources, how it was created the certification process and benefits of BSCoE	report^	Support Center of Excellence	creation of the Surgical Review Corporation (SRC).	for adaption of BSCoE to NSCoE The SRC • Formulate and establish guidelines and criteria for assessing bariatric surgical practices. • Evaluate and investigate applicants to ensure that they met the established standards to become a BSCOE. • Creating a national bariatric surgical database to collect, analyse, and disseminate		Support	can be adapted to NSCoE **Personnel** • Surgeons specific criteria for BSCoE **Infrastructure** • Specific to BSCoE **Equipment** • Not specifically outlined

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						data collected from the BSCOEs			
Shommu et al[41]	Canada	To develop a multi-disciplinary consensus of nutrition care priorities for implementation in an IBD nutrition CoE	Research article*	Inflammatory Bowel Disease Nutrition CoE	2019	Not reported	To provide excellent clinical care, conduct original research	Inflammatory Bowel Disease	Raised as a concern/barrier • Lack of infrastructure • Lack of staffing
Silver et al[42]	USA	To outline criteria for centers of excellence and suggested indications for referral in cases of suspected placenta accreta.	Other#	Accreta CoE	Not reported	Not reported	Optimal management of patients with placenta accreta	Placenta Accreta Intensive care unit	**Personnel** • Multi-disciplinary team with specialised staff for placenta accreta **Infrastructure** • Intensive Care unit and facilities
Steiner et al[43]	USA	To suggest criteria that the headache centres might be recognised as centres of excellence in the headache community. Set out recommendations for 10 suggested role and performance-defining standards.	Other#	Specialized headache centre	Not reported	Not reported	Providing specialist care to patients with primary or secondary headache disorders that are difficult to diagnose or treat, refractory or rare, or for other reasons require specialist intervention	Headache	**Personnel** • Multi-disciplinary care
Tapela et al[44]	Rwanda	Report program level description of implementing Butaro	Research article*	Butaro Cancer CoE	2012	Not reported	To deliver accessible cancer services in a resource-constrained setting	Cancer	Provided by Rwanda Ministry of Health. **Personnel**

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		Cancer CoE, its preliminary impact and challenges faced in order to share lessons and inform service delivery in similar setting					histology-based diagnosis, imaging, surgical, pall care, and socioeconomic supports		• Doctors and nurses received training **Infrastructure** • To support surgical procedures and palliative care **Equipment** • X-ray and ultrasounds imaging **Others** • Treatment protocol • Finance • Partnership with other services from USA
Thomas et al[45]	USA	Establishing Cardiometabolic CoE for secondary prevention in patients with T2D and CVD	Other#	Cardiometabolic Center of Excellence	2018	Not reported	To deliver patient-centred, collaborative model of care focused on aggressive and comprehensive secondary cardiovascular risk reduction in patients with T2D and CVD	T2DM + CVD	**Personnel** • Nurse navigator • Cardiometabolic Center Advisory Committee • Training
Vivian et al[46]	USA	To outline the framework for a Pancreas CoE	Research article*	Pancreas CoE	2013	Outlined framework using 3 developmental domains. • Establishing	To improve the care and outcomes of patients and families affected by pancreatic disease using a multidisciplinary team approach to deliver	Management of pancreatic disease	**Personnel** • Management – leadership support • Surgeons trained in robotic surgical approach

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						• the foundation • Formalising the program • Solidifying the CoE status	exceptional and compassionate care		• Multi-disciplinary staff trained • Specific – nurse navigator and dietician **Infrastructure** • To establish and maintain robotic surgical approach **Equipment** • Minimally invasive technology (robotic) • Advanced endoscopic technology • Clinical Information Systems - dashboards. **Others** • Certification
Williams[47]	USA	To discuss the evolution of the concept of Centers of Excellence and the components of an HCM center	Book Chapter	Hypertrophic Cardiomyopathy Centre	1971 for the first 15 centers	Adapted model from National Cancer Institute	Network of referral centres established for adult and paediatric HCM patients' regional centres, encourage consistency of treatment algorithms and outcomes access to world-class clinical care within driving distance, as well as collaborative research between institutions. Also a resource and offer second opinions for providers and patients.	Hypertrophic Cardiomyopathy	**Personnel** • Multi-disciplinary team that includes specialists in adult and paediatric cardiology, electrophysiology, interventional cardiology, cardiac surgery and genetic counselling, all with particular expertise in treating the patient with HCM. **Equipment**

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									• Cardiac imaging (echocardiography and cardiac magnetic resonance imaging) • Electrophysiology
Wirth et al[48]	Europe (Barcelona)	To develop the concept of the European Prostate Cancer Centers of Excellence with the specific aim to identifying European Centers characterised by high-quality care, research and education	Research article*	European Prostate Cancer Centres of Excellence	Criteria agreed upon in 2019	Created by authors	To enable high-quality management of prostate cancer in the fields of clinics, research and education	Prostate Cancer	Resources requirements are outlined in detail in the study and specific requirement **Personnel** • Core team, associated services and multi-disciplinary approach
Wu et al[49]	USA	To evaluate • Patient outcomes at nominated CoE • Whether the revamped designation criteria would result in improved patient outcomes.	Research article*	Blue Distinction Plus Centres	2016	Value framework	Not reported	Inpatient spinal surgery	Not reported
Yao and Zhou[50]	China	To describe the impact of the introduction of a mentor-based CoE program	Research article*	Peritoneal Dialysis CoE	2003	Created using mentor-mentee system	To become a best demonstrated practice unit	Peritoneal dialysis	**Personnel** • Physicians from mentor sites **Other** • Standardized teaching materials to deliver lectures, lead PD case discussions

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									and ward rounds, suggest key performance indicators, and initiate a continuous quality improvement program.

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Table 2: CoCE criteria description, processes outlined and monitoring protocols described in the initiatives.

1st Author	Country / Region	PROCESSES DESCRIBED		
		Criteria described	Processes used to establish a CoCE	Processes to monitor a CoCE
Bitzer et al[1]	Europe	• Staffing and infrastructure recommendations • Training and professional development opportunities • Formal links with academic institution	Not reported	In order to audit outcomes, the number of patients, gender, diagnoses, and interventions would be tracked, as well as patient follow-up and satisfaction. Lastly, a cost analysis is necessary.
Burkett et al[2]	Not reported	• High patient satisfaction • Lower utilization of medical services and medications • Low overall cost of care • Provide a quicker return to work or regular activity for patients. • Superior medical care with seamless coordination between disciplines • High volume of patients treated.	Not reported	Report that centers of excellence are held to specific quality metrics to maintain "center of excellence" designation, specific quality metrics not reported.
Campbell et al[3]	India	• High level of patient need • Good working relationship between organisations • Receptiveness and capacity of local government, hospitals, and medical societies • Political and economic environment consistent with the ability to provide care	Local government approached Operation Smile for assistance with treating its cleft backlog. Site visit to determine site suitability.	Not reported
Carvalho and Jill[4]	USA	• Must demonstrate adherence to all criteria below (each clearly described in source documents): • Personnel and staffing Equipment, protocols, and policies • Simulation and team training • Obstetric emergency management • Caesarean delivery and labour analgesia care • Recommendations and guidelines for implementation • Quality assurance and patient follow-up systems	Apply to the Society of Obstetric Anaesthesia and Perinatology applications reviewed and graded by the COE Subcommittee. If successful, granted CoE Designation	Re-certify every 4 years using the same process

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Casanueva et al [5] & Tritos[6]	International	• Provide the best standard of care to patients with pituitary tumors and disorders • Organise multi-D clinical management • Liaison between experienced neurosurgeons and expert neuroendocrinology • Specialised staff training • Provision of educational courses • Comprehensive patient information and data management • Sharing information with scientific bodies and administrators • Support endocrine units outside PTCoE • Advise health administrators and authorities on specific problems • Advance the science and scholarship of pituitary tumours • Include tumour data on national registries	Not reported	Currently, no formal accreditation for PTCOE exists. The external body may or may not perform the final step of validation of the centre
Chang et al[7] & Lymphatic Education & Research Network[8]	USA	• Minimum criteria for comprehensive centers of excellence: • Mandatory list of staffing including surgeons and therapist • Demonstrated proficiency in diagnosis, imaging, conservative management, assessment tools, interventional therapies, surgery	Applications will be reviewed by the LE&RN Global Oversight Committee (GOC). All applications will be scored, using the following three individual criteria: a. The quality of the overall application/services. b. Unique offerings or particular characteristics that add to the Lymphatic disease clinic. c. Miscellaneous (e.g., lymphatic disease community citizenship, research).	Designation is valid for 3 years
Choque-Velasquez et al[9]	Peru	Not reported	Not reported	Evaluated using volume of neurosurgery

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Coon et al[10]	USA	Comprised of: • Core clinical team • Additional subspeciality care • Longitudinal data collection • Support group involvement • Research opportunities • Additional support	Not reported	Not reported
Creehan et al[11]	USA	• Domains of ANCC model for the Magnet Recognition Program - transformational leadership - structural empowerment - exemplary professional practice - new knowledge, innovation and improvement	Not reported	Not reported
Daming et al[12]	USA	• Established in tertiary care hospital. • Created inpatient and outpatient protocol. • Has a set of criteria specific to maternal cardiac CoE and cardiac CoE and cardiovascular intensive care unit	Self-nominated as Centre of Excellence	• Monitoring productivity and streamlining communication between hospital • Management and stakeholders are the role of a program director.
Deshmukh et al[13]	India	CoE is an organisational environment that strives for and succeeds in developing high standards of conduct in a field of research, innovation and learning. • Capacity building for staff • Patient awareness • Increase in number of patients visiting the units and opting for treatment. • Research initiatives • Collaborations and networking Criteria for pillars of excellence (Academics, Research, Clinical, Faculty development, Technology, Social) – what consisted of the criteria was not described, however the outcome was outlined in	Not reported	Evaluation based on public health program evaluation criteria - assessing and documenting program implementation, outcomes, efficiency and cost-effectiveness of activities.

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		the study)		
Dietz et al[14]	USA	Suggestion of CoE criteria but did not expand • Multi-disciplinary care pathways and teams and evaluation of surgeon's credentials, • Electronic medical records • Patient data management and or tracking • Process metric	Not reported	Not reported
Distiller and Brown[15]	South Africa	• Integrated information technology systems • Aligned finances and responsibility • Care planning • Clinical engagement and leadership • Robust clinical governance • Multi-disciplinary team	Not reported	• Outcome-based monitoring protocol • Glycaemic control • Hospital admission • Microvascular disease outcomes
Draznin et al[16]	USA	• Focus on high-risk individuals and an open-door policy • Clear communication to guide care • Provision of comprehensive care • Ongoing focus on quality improvement • Ongoing monitoring of patient outcomes • Education and dissemination	Not reported	Not reported
El-Eshmawi et al[17]	USA	• Centers with surgeons that can achieve a very high likelihood of a durable valve repair • Dedicated multidisciplinary team (see staffing resources) • Transparent data management and quality assessment	Self-nominated -The center was formed and then discussed the criteria used in this study.	Monitoring of proportion of patients with successful valve repair; durability of valve repair
Elrod and Fortenberry [18]	USA	• Supplies an exceptionally high concentration of expertise and related resources centered on a particular area of medicine • Delivers care in a comprehensive, interdisciplinary fashion • Leads to best possible patient outcomes.	Overseen by organisation – an interdisciplinary committee vets the proposed Centre of excellence (assesses financial resources, culture and leadership support)	Not reported

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Ferguson and Froehlich[19]	USA	Not reported.	Self-nominated	• Length of stay • Increased Patient volume • Monthly snapshot of - financial (includes caseload, cost and labour/case) - Operational (includes length of stay, discharge to rehabilitation) - Patient experience - Quality (includes process measures, infections, falls, readmissions)
Frara et al[20]	Authorship team from Spain	• "Explicit and practical definitions for a degree of excellence have not yet been defined" • Require an integrated multidisciplinary group in a single location	Most are self-appointed without any formal acknowledgement	Discuss measuring effect via patient outcomes, cost of treatment, research outputs, and contribution to scientific events (e.g. scientific meetings, health registries)
Geetha et al[21]	USA	• Achieving a level of mastery related to • Patient care • Explicitly modelling this mastery to medical trainees • Collaborating with investigators to advance science and discovery	Not reported	Not reported
Haider et al[22]	LMIC	• Patient care: must provide safe, effective and accessible care to the highest possible standards depending on geography, resources, infrastructure, patient population and local culture with site-specific management guidelines • Training: provides leadership in best practices, research, support and training for focus area • Dissemination of knowledge is essential function of the centre	Not reported	Recommend data collection to quantify impact and identify areas for change
King, Jamieson and Berg[23]	USA	Reviewed criteria of designated Centres of Excellence within Solid organ Transplant Networks– common features include • Number of patients treated • Good patient and graft outcomes compared to national average	Formally designated by insurers and employers	Need to monitor quality of care: • Patient factors • Facility and program structure • Transplant centre processes

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		on Scientific Registry of Transplant Recipients • Centres of Medicare and Medicaid Services certified • +/- cost-effective care		• Waiting list management • Post transplant care • Clinical and patient centred outcomes • Cost effectiveness • Team experience • Organ donation environment
Kullar et al[24]	USA	• Sustained institutional leadership commitment and accountability (e.g. mission statement, letter of attestation from management, documentation of physician leadership) Drug expertise (evidence of infectious disease and pharmacy expertise) • Action (e.g. action plan, disease specific protocol) • Tracking (e.g. monitoring antibiotic use, demonstration of use of electronic health record as part of antimicrobial stewardship program) • Reporting (e.g. demonstrated participation in national reporting program) • Education (documented professional development program)	Infectious Diseases Society of America (IDSA) solicited applications. Centres required to submit documentation of core criteria. A committee of 6 ID pharmacists and physicians with extensive AMS experience reviewed applications.	CoE designation is valid for 2 years, after which the institution must re-apply
Lancellotti, Dulgheru and Sakalihasan [25] & Chambers et al[26]	Multiple European countries	• Specialist valve clinic acts as a hub between community, other hospitals and extracardiac departments, and between non-invasive cardiologists and surgeons and interventional cardiologists • Nominated cardiac experts with speciality skills • Regular case discussions • Systematic approach to reducing medical and surgical risks • Data review: Robust internal audit processes including repair rates, rates of residual regurgitation, complications, durability of repair and reoperation rate • Results available for review internally and externally • Involvement in national databases	Not reported	Have a high-volume operation rate on valvular heart disease, which is believed to be associated with better repair results and potentially improved outcome. This partly explains why there is no obligation to refer patients eligible for surgical repair in centres of excellence

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Li et al[27]	USA	• Variable - can be selected and overseen by insurance companies, medical professional societies, government organisations, employer professional associations, individual employers or hospitals themselves • Insurers (different criteria used between different companies) tend to use data and identify centres that perform well on structural outcomes such as use of protocols and outcome measures such as hospital readmissions, complication rates, and volume. Cost sometimes considered	Some insurers use of a panel of experts from national organizations who understand the insurer's objectives and help select hospitals to be part of the CoE network.	Not reported
Marinoff and Heiberger[28]	China	Not reported	Self-nominated following partnership between State University of New York College of Optometry and Wenzhou Medical University	Not reported
Martin et al[29]	various	• Standardization of protocols for the workup of suspected spinal cord compression across the regional hospital system to improve time to diagnosis, transport, and intervention. • Unified and standardized vendors and equipment across surgeons and the two departments to improve cost savings and resource utilization.	Not reported	Not reported
McLaughlin et al[30]	USA	Propose that centres fulfil the following • Provide multidisciplinary optimal clinical care to patients with pituitary tumours and related disorders • Provide residency, fellowship training and/or continuing medical education and patient support • Contribute to research in the field of pituitary disorders.	Not reported	Need to develop - suggested recognition or verification process be an ongoing process that is updated biannually
Nakov[31]	Bulgaria	Elements that should be considered: • Establish a dedicated team of multidisciplinary experts • Engage with patient advocacy group	Not reported	Not reported

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		• Initiate a specific training regime to continue education for new and existing members of the team • Source appropriate funding to ensure sustainability • Schedule regular team meetings to ensure an individual plan for patient diagnosis, treatment and follow up		
Piccini et al[32]	Not specifically identified	• Identification and referral of patients • Appropriate staffing and dedicated clinics that focus on AF patients • Developing a comprehensive care team • Specific treatment goals • Evaluating and improving symptoms • Rate and rhythm control • Stroke prevention • Treatment of risk factors • Development of team based care pathways • Quality improvement	Not reported	Not reported
Pronovost et al[33]	USA	• Provide frictionless access • Ensure coordinated compassionate navigation • Epply rigorous appropriateness criteria for all the expensive diagnostic studies and procedures • Engage the entire team around the purpose of providing high-value care • Ensure the site of service and surgeon optimal • Reduce variation and complications by using evidence-based protocols • Provide personalized care • Continually monitor, transparent report and improve performance	Not reported	Outcome-based evaluation process
Safer Care Victoria[34]	Australia	• Centres based on population health (e.g., acute, chronic and prevention, older people, women and children and funded program.	Not reported	Not reported

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		• Have 3 core functions: advocate and inform, guidance and advice and improvement. • Has a list of key groups that the centres partner with to plan and deliver work		
Sandhu et al[35]	USA	Focus area • Access to care • Stroke prevention • Education • AF quality improvement • AF barrier	Not reported	Not reported
Santos-Moreno et al[36-38]	South America	• 3 types of CoEs were defined based on structure, process and outcomes indicators - structure indicators - Evaluate the institutional capacity to deliver the expected results, adequate infrastructure, suitable personnel including rheumatologists and other professionals to ensure comprehensive attention, and the existence of complementary resources - process indicators (Adherence to management recommendations based on treatment strategy by objectives - outcome indicators (The achievement of the objectives proposed along the care or comprehensive patient must be evaluated. The progression of the disease, functional disability, and the achievement of remission goals must be quantified using clinimetric scales. • Different quality standards requirements for each CoE model and centres need to apply to get CoE. • 3 types of centre (must meet accreditation and meet minimum	Steps to implement CoE for RA **Step 1:** implementing an attention model for the patients diagnosed with rheumatoid arthritis, in accordance with the requirements of each type of center of excellence **Step 2:** filling the self-assessment form of each type of center of excellence and implementing improvement actions **Step 3:** requesting and preparing for a verification visit **Step 4:** receiving a verification visit **Step 5:** official notice of the results of the assistance and verification visit	The follow-up should take place according to the following characteristics: - Clinimetrics - Decision-making factors based on the results of the clinimetrics - Opportunities to access treatment or follow-up - Patient education - Clinical care guidelines - Evaluation system • Must be assessed and accredited cyclically based on standards, evaluators and evaluation and qualification process.

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		criteria for each type) - Standard - Optimum - Model		
Sheha and Iyer[39]	USA	Suggested to use Joint Commission certification that requires healthcare facility to comply with national starts, use of evidence based practice and collect performance measures. Also to partner with American Academy of Orthopaedic Surgeons to provide certifications to standardised CoE. Key tenets for CoE • **Creating value** - highest quality care at lowest cost is the overarching goal of CoE in ambulatory spinal care (is the confluence of safety, institutional processes, patient satisfaction and outcome measures, overall cost to patient, payer and society) • **Centralization of organization** - "one-stop shop" (integration of a variety of specialists under the umbrella of one hospital system gives CoE the ability to treat conditions that may complicate or arise from patient's episode of care) • **Multidisciplinary team building and protocol creation** (utilization of multidisciplinary meetings geared at creating value and improving outcomes by carefully scrutinizing patient treatment plans)	Not reported	Accreditation Association for Ambulatory Health Care have provided a set of criteria for certification as an ambulatory orthopaedic surgery CoE
Shikora, Delegge and Van Way III[40]	USA	Criteria that was described were used for BSCoE and to be adapted by NSCoE • Surgeon Specific Criteria to ensure surgeons have obtained the experience and training necessary to perform the appropriate surgical procedure	Based on BSCoE • Online application completed by surgeon or facility • Successful application results in provisional status • Within 2 years must seek full approval and pass	Recertification is required every 3 years and includes an online application followed by a site visit.

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		• Institute Specific Criteria to ensure that the facility is committed to the program	on-site inspection and indicates has excellent outcome • Mandatory submission of all patient data to a database	
Shommu et al[41]	Canada	Essential criteria of CoE that were divided into short (1-3 years) and long terms (>5 years) goals/ activities specific to IBD • Excellence in Clinical Care • Novel Discovery and Research • Knowledge translatio	Not reported	Not reported
Silver et al [42]	USA	Suggested Criteria • Multidisciplinary team • Intensive care unit and facilities • Blood services – blood bank with 24/7 service	Not reported	Not reported
Steiner et al[43]	USA	Suggested standards • Competence of staff - staffed by headache specialists • Provision of care – management of headache • Quality and evolution and assurance - monitors quality of care • Networks and collaborations - maintains quality of endeavour through networking, collaboration and the sharing of experience with other international and/or national centres. • Teaching - principal resource for national postgraduate training • Research - useful research output in the field of headache • Empirical support of existence	Agencies with appropriate competence and authority might use these standards as a basis for centre accreditation.	Not reported
Tapela et al[44]	Rwanda	Key attributes that made it possible • Meaning full partnership emphasising health systems strengthening • Innovative task and infrastructure shifting • Strong RMOH leadership coordinating efforts to embed services with the public sector	Not reported	Not reported

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		• An equity-driven agenda to serve those most in need		
Thomas et al[45]	USA	Not reported	Appears self-nominated	Outcome-based – site-specific patient outcomes (not benchmarked to other services)
Vivian et al[46]	USA	Objectives • Provide the highest standard of care, services and support to each patient • Communicate process improvements and data to key stakeholders in the pancreas domain • Analyse barriers and data to create better clinical pathways and care maps • Identify best practice guidelines and use them in our pancreas population • Identify quality and utilisation metrics used to analyse physician practices	Process outlined. • Establishing the foundation (leadership structure and purpose) • Formalising the program (clinical education training, MDT involvement) • Solidifying the CoE status (certification/accreditation by external institute)	Not reported
Williams[47]	USA	Key components of an HCM centre include. • HCM multi-disciplinary team and an administrative HCM coordinator. • Administrative support for marketing and programmatic development.	A centre must meet various criteria set forth by the NCI both in terms of clinical expertise and research capabilities	Not reported
Wirth et al[48]	Europe (Barcelona)	Criteria with specific requirements are outlined in the study • Core team • Associated services • Multi-disciplinary team • Diagnostic pathway • Therapeutic pathway	When an institution successfully achieves all the steps, it will be certified as an EPCCE.	The certification will be reviewed every 3 years, The accreditation team will be prespecified, and it will be composed of seven members of the EPCCCM.
Wu et al[49]	USA	The BDC+ program encompasses quality criteria on structure, process, and outcomes and cost criteria A cost threshold was set at 1.05 times the national average cost of surgery.	Not reported	Facilities receiving a value designation were associated with lower costs (16-19% lower) and equal or better quality outcomes, compared with all other facilities.

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		Facilities that met predetermined clinical requirements and had spine surgery costs below the threshold received the value designated BDC+ designation.		
Yao and Zhou[50]	China	Not reported	Mentee sites were selected based on • Using drop-out rate and time on therapy • Willingness to improve PD outcomes. • Mentor sites were selected based on • PD clinical outcome • Willingness to participate in the program	Continuous quality improvement in managing PD centre. Volume of patients.

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Conceptualising Centres of Clinical Excellence: A scoping review

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Supplemental material: Attached Supplemental file, Table S1, Table S2.

Word count: 3238 + 282 (Abstract)

Tables and Figures

ABSTRACT

Objectives

Centres of Clinical Excellence (CoCE) are healthcare facilities that provide excellent healthcare. However, despite their increasing prevalence, it is unclear how CoCE are identified and monitored. This paper explores how CoCE has been described in the literature, including its defining characteristics and selection and monitoring processes.

Design

Scoping review using Arksey and O'Malley's framework with enhancement from Levac. We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews.

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Data sources

A comprehensive search using MEDLINE Ovid, PubMed, Web of Science, CINAHL and Scopus was conducted to identify relevant literature from January 2010 to June 2022.

Eligibility criteria for selecting studies

We included published studies and grey literature that described how a CoCE was defined, established, monitored or evaluated.

Data extraction and synthesis

Two independent reviewers completed the title and abstract screening, reviewed the full texts and extracted data.

Results

Fifty records describing 45 initiatives were included. More than half were published in the USA (n=25, 56%). All but one initiative focussed on one clinical condition/population, most commonly cardiovascular disease (n=8, 17%), spinal surgeries (n=4, 9%), and pituitary tumours (n=4, 9%). Most initiatives (n=30, 67%) described a structured process to establish CoCE. The definitions of CoCE were not uniform. Common defining features included the volume of patients treated, medical expertise, a highly skilled multi-disciplinary team, high-quality care, and excellent patient outcomes. Identification as a CoCE varied from self-identification with no explicit criteria to application and assessment by an approval panel.

Conclusion

Despite a growing prevalence of CoCE, there are inconsistencies in how CoCE are established, identified, monitored and evaluated. Common (but not uniform) features of CoCE are highly skilled staff, high-quality care delivery and optimal patient outcomes.

Word count: 282 words

Strengths and Limitations of this study

- The study used inclusive search strategies (peer-reviewed journals and grey literature) and a stringent review process using two independent reviewers throughout the process.
- The study used Arksey and O'Malley's framework with enhancement from Levac and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews.
- We may have missed established CoCE that have not published any studies or reports or published in non-indexed sources.

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INTRODUCTION

Healthcare facilities worldwide have a shared goal to continually improve healthcare delivery, often using stringent standards and indicators.[1, 2] Improvements in healthcare delivery can take the form of defining best clinical practice or demonstrating important aspects of care, such as safety, access, affordability, equity, effectiveness and efficiency.

Most healthcare organisations must meet national quality and safety standards to address clinical practice and organisational performance.[1] Accreditation is instrumental in achieving a baseline standard of care, however, it is not usually designed to recognise excellent care or to optimise patient-reported outcomes and experience. Recognising this gap between care that meets accreditation standards and "excellent" care, some healthcare facilities are taking proactive steps to engage in self-improvement and seek recognition for delivering exceptional care.

Excellence within healthcare is often labelled 'clinical excellence'[3], and organisations that deliver exceptional patient care have been called Centres of Excellence or Centres of Clinical Excellence (CoCE).[4-6] Other dimensions of excellence that have been described in healthcare include 'research excellence',[7] 'service excellence'[8] and 'operational excellence'[9]. A recently published review[6] summarised evidence pertaining to Centres of Excellence in healthcare, education, research, industry and information technology. The authors of this review concluded that there are inconsistencies in how healthcare facilities are designated as Centres of Excellence and ambiguity between Centres of Excellence and regular healthcare facilities, with limited information on how these Centres were evaluated. Similarly, research excellence has been reviewed from education and clinical research perspectives, and frameworks are frequently not comprehensive,[6] with unclear methods used to determine excellence.

Attaining recognition as a CoCE could be a source of inspiration to facilities that are recognised as leads in healthcare provision.[10] Health professionals within the facilities can be inspired to pursue and maintain the best clinical care for their patients by promoting high-quality, up-to-date, evidence-based care to their community.[10] Additionally, CoCE can work with accreditation bodies to set higher benchmarks that encourage innovative patient-centred care. Accreditation bodies can adopt and maintain advanced standards of care over time, helping healthcare centres to continually raise the standards of patient outcomes. [11]

Despite the increasing use of the term CoCE, there is a lack of clarity about how this term is defined, how sites are nominated and selected as CoCE and how CoCE are evaluated and monitored. Therefore, the primary aim of this scoping review was to map evidence on CoCE in healthcare. We sought to explore and answer the following questions systematically:

1. What Centres of Clinical Excellence have been described in the literature?
2. What are the defining characteristics of Centres of Clinical Excellence?
3. How are Centres of Clinical Excellence selected or nominated?
4. What monitoring processes are employed to remain as Centres of Clinical Excellence?

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Through conducting this review, we planned to explore the multifaceted dimensions of Centres of Clinical Excellence.

METHOD

Protocol and Registration

We registered the scoping review protocol on Open Science Framework. We employed the scoping review framework proposed by Arksey and O'Malley[12] with the refinement outlined by Levac, Colquhoun and O'Brien[13] to evaluate the evidence on CoCE. We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR).[14]

Identifying relevant studies

We developed a search strategy with the support of a research librarian (Supplemental file). We searched MEDLINE Ovid, PubMed, Web of Science, CINAHL and Scopus to identify published records between January 2010 and June 2022. We also searched for grey literature (government reports, policies, protocols, conference proceedings, unpublished studies) and relevant websites using Google and Google Scholar. We also searched the reference lists of included records to check for further relevant records.

Inclusion and exclusion criteria are presented in Table 1. We included records that discussed CoCE that provided clinical care for people with any health condition in any setting (primary care, inpatient, outpatient or community). To be included, records had to describe how a CoCE was defined, established, monitored or evaluated. We excluded records that used the term "CoCE" without outlining any criteria. Centres of Excellence that were not designed to provide clinical care (such as Centres of Research Excellence) were excluded. Given the exploratory nature of the research questions, there was no limitation to study populations or interventions.

Insert Table 1

Study selection

The search results were imported into Covidence, and duplicates were removed. As recommended by Levac,[13] two reviewers independently screened titles and abstracts and reviewed full-text documents using the inclusion criteria (see Table 1). One reviewer (TK) conducted the online search for relevant websites (first 20 pages on Google search) and two reviewers (TK and LB) independently completed the screening and review of the grey literature. The inclusion and exclusion criteria were reviewed periodically throughout the title and abstract screening process to ensure the criteria facilitated the identification and inclusion of relevant studies.

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Charting the data

A data extraction form was developed for the study (Table S1 and Table S2). We pilot-tested the extraction form with the first 15 eligible records to ensure consistent data collection. Two reviewers (TK and EL) independently extracted data on all included studies using the extraction form on Covidence. Quality of individual records were not assessed due to the descriptive nature of the review aims.

Collating, summarising and reporting the results

We synthesised the research findings according to the research questions and presented data from all included studies in tables. Study characteristics were presented descriptively, and the research questions were presented narratively. Henceforth, the CoCE will be identified as initiatives and the search results will be defined as records. Each initiative will be described either as a theoretical centre (describing aspirational criteria/frameworks to develop a CoCE) or a physical centre where clinical care is provided. Initiatives that described a framework were classified as 'creating' a framework, 'using' or 'adapting' a pre-existing framework.

Patient and Public Involvement

Patients were not involved in the design or completion of this study.

Insert Figure 1

RESULTS

Selection of sources of evidence

Overall, 9077 records were identified from a database search, and 36 records were identified through a grey literature search. A further three records were identified by reviewing reference lists of included records. 50 records describing 45 CoCE initiatives were included in the analysis (Figure 1). The complete search results and strategies are available in the Supplemental file. Among the records excluded at full-text review, 25 (n=28%) records described or labelled a centre as a CoCE but did not provide any selection criteria or any details about how the centres were nominated or monitored.

Characteristics of sources of evidence

Most records (n=43, 86%) were published in or after 2015. Nearly all the included records (n=44, 88%) were published in peer-reviewed journals, but only 15 (30%) were research articles, the remaining 28 (56%) records were other article types such as editorials or case reports. Two websites were identified as additional records for initiatives identified through the literature search. See Tables 2 and 3.

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Insert Table 2

Synthesis of results

Less than half (n=20, 47%) of the identified initiatives were physical CoCE. With the exception of one CoCE which provided care for people with diabetes and cardiovascular disease [15], all identified CoCE treated a single clinical condition or population. The most commonly described conditions were cardiovascular disease[16-23] (n=8, 17%), spinal surgeries[24-27] (n=4, 9%), pituitary tumours[28-31] (n=4, 9%), diabetes[15, 32, 33] (n=3, 6%), and obstetrics[34, 35] (n=2, 4%).

Some CoCE (n=6, 13%) were located across several countries,[17, 21, 25, 28, 36, 37] whereas the majority were described as stand-alone clinical centres, such as wards, surgical centres or clinics. Eight CoCE (18%) were located in low-and middle-income countries.[20, 32, 38-43] More than half of the included CoCE were located in the USA (n=25, 53%). CoCE established in high-income countries were typically described in terms of high-quality of care delivery, such as standardised care and optimal outcome (n=12, 27%),[19, 21-23, 25, 33, 35, 38, 39, 44-46] comprehensive multi-disciplinary care (n=8, 18%)[16, 28, 31, 32, 40, 47-49] or accessible patient-centred care (n=7, 16%).[4, 15, 29, 36, 42, 50-52]

More than half of the initiatives (n=30, 67%) described a structured process to establish a CoCE. While many initiatives reported that the CoCE was established using a framework or series of developmental stages, details regarding the developmental stages were rarely available. Five initiatives reported using published frameworks (Elrod and Fortenberry,[29, 37, 45] Christmas[53] and National Cancer Institute[23]) to guide their process to establish the CoCE. See Table 3 for further details.

Insert Table 3

Defining characteristics of CoCE

Less than half (n=19, 42%) of the initiatives explicitly defined the characteristics of the CoCE. Seven (16%) initiatives[20, 24, 26, 29, 37, 45, 54] used the definition from Elrod and Fortenberry[4]: "a program within a healthcare institution which is assembled to supply an exceptionally high concentration of expertise and related resource centred on a particular area of medicine, delivering associated care in a comprehensive, interdisciplinary fashion to afford the best patient outcomes possible."[4(p.16)]

High volumes of patients treated or numbers of procedures performed, staffing, infrastructure, high quality of care and above-average patient outcomes were the most commonly described defining features of CoCE. Staffing components included medical expertise, highly skilled multi-disciplinary teams and staff-to-patient ratios. Other resources that were described as part of the CoCEs were infrastructure (n=15, 33%), such as building space and examination rooms, and specialised equipment (n=9, 20%). High quality of care

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delivery was described in terms of standardised care and optimal outcome (n=12, 27%),[19, 21-23, 25, 33, 35, 38, 39, 44-46] comprehensive multi-disciplinary care (n=8, 18%)[16, 28, 31, 32, 40, 47-49] or accessible patient-centred care (n=7, 16%)[4, 15, 29, 36, 42, 50, 51]. Availability of treatment protocols was described as an important feature in 7 initiatives (15%). See Table 3 for details.

There were differences noted in the defining characteristics of CoCE in low-, middle- and high-income countries. Universally, most CoCE had common features regarding staff expertise, equipment and patient outcomes. However, CoCE in low- and middle-income countries tended to provide a healthcare service that otherwise was not available in the region, for instance, neurosurgery in Peru[39] and comprehensive dental care in Guwahati, India[38].

Selection or nomination process of Centres of Clinical Excellence

No details were available about how sites were selected as CoCE in half (n=24, 53%) of the included initiatives. While 21 initiatives reported that there was a selection or nomination process to be recognised as a CoCE, the details of the selection or nomination process were inconsistently reported. When reported, processes used to select centres as CoCE were varied and included application and assessment by an approval panel (n=9, 45%)[4, 8, 23, 34, 43, 45, 54-56], self-identification as a CoCE with no explicit criteria or external assessment (n=6, 30%)[15, 16, 19, 29, 41, 50] and site visit by funding body to assess suitability (n=1, 5%)[18]. Only four (20%)[36, 46, 48, 57] initiatives presented the process used to select the CoCE in its entirety, which are presented in Table 4. The bodies providing oversight of the nomination or selection of the CoCE were professional bodies[23, 26, 34, 36, 48, 54], insurers[45, 55], and organisations[4, 38, 46].

Insert Table 4

Monitoring protocols to remain a designated Centre of Clinical Excellence

Only 24 (53%) of the included initiatives reported a monitoring process for the CoCE. Monitoring was mandatory for 6 (25%)[34, 36, 48, 52, 54, 57] initiatives through recertification process. Other initiatives reported the importance of monitoring outcomes such as productivity (n=5, 21%),[17, 19, 39, 43, 50] patient outcomes (n=9, 36%),[15, 16, 27, 29, 30, 32, 45, 47, 49] quality metrics (n=3, 13%)[24, 26, 37] and cost-effectiveness of the program (n=1, 4%),[40] but there was no evidence that this monitoring process was routinely performed or overseen by any parties.

DISCUSSION

Summary of evidence

To our knowledge, this is the first scoping review to summarise what is known about CoCE in healthcare.

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Despite identifying numerous CoCE initiatives, we were unable to identify selection processes used in more than half of the included initiatives. When selection processes were documented, they varied between initiatives. Further, there were inconsistencies in monitoring CoCE performance. Without consensus on what defines a CoCE, and without a recognised body to monitor the performance within each CoCE, there is no guarantee that care being delivered by sites claiming to be CoCE are delivering excellent (or even better-than-usual) healthcare.

The most common defining feature of CoCE included in this review was resource availability, specifically personnel, infrastructure and equipment. These findings are not surprising; it is well-established that there are associations between staffing levels, skill mix, infrastructure and patient outcomes.[58-62] For example, higher nursing staffing levels and employment of more skilled staff are associated with better patient outcomes such as reduced rates of pressure injuries, mortality and falls.[58, 60] Features such as infrastructure and specialised expertise are also key factors in Centres of Excellence in other industries.[8] The inclusion of these features within CoCE reinforces that the included CoCE were designed to align with what is known about healthcare delivery that leads to improved patient outcomes.

While frameworks or processes used to establish or describe CoCE may be valuable to guide others in the field, they may have limitations if these processes were developed for a specific healthcare facility, stakeholder cohort or disease group. For example, the Willis-Knighton Health System is a not-for-profit healthcare network in Louisiana, USA, that operates eleven self-nominated centres of excellence. The framework used to establish these centres of excellence was described by Elrod and Fortenberry and cited by authors of eight initiatives in our review to describe or establish their centres. Consideration should be given as to whether this framework is fit for purpose beyond the state of Louisiana and in countries with different healthcare models from the USA. Additionally, it is unclear whether this framework meets a universally agreed definition of excellence in healthcare. Empirical research to define "excellent care" from the perspectives of patients, healthcare facilities, or funders could increase the validity of the frameworks and, subsequently, the CoCE. A recent study (published after our review was completed) has identified defining criteria of "aspirational" (versus pragmatic, feasible or cost-effective) CoCE in stroke recovery and rehabilitation from the perspective of healthcare providers, survivors and caregivers and researchers. These criteria and the underpinning indicators could be used by facilities seeking recognition as CoCE in stroke healthcare provision.[63]

Selection procedures for CoCE were inconsistently reported and were unavailable for nearly half the included initiatives. The description of excellent care provided by the CoCE varied, seemingly associated with which agency was responsible for creating the definition. Descriptions of excellence encompassed patient-centric outcomes (e.g. optimising clinical outcomes and quality of life), service-centric outcomes (e.g. staff skill development, resource availability and meeting quality and safety accreditation) and economic outcomes (e.g. cost of treatment, length of stay). The concept of excellence was sometimes conflated with high

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volume of patients who received care at the centre. Excellence for some centres from low- and middle-income countries was defined (either by self-nomination or by the government or collaborating international institutions) in providing a particular healthcare service when none was previously available in the region. Many of these aspects of excellence reflect commonly measured quality indicators of healthcare in high-income countries, namely effectiveness, access, safety and efficiency.[64] However, cost is not included as a quality metric in countries such as Australia, Canada, or the UK, but it is included as a measure of quality in the US Commonwealth Fund framework.[64] The difference between healthcare systems that generate income and those that do not is likely to influence many aspects of excellence. The inclusion of cost as a feature of some CoCE could be reflective of the different funding models (e.g. fee-for-service versus universal healthcare) or healthcare priorities within the centres or by the bodies determining a site's excellence. Whilst cost is considered in universal healthcare funding models, it is rarely highlighted beyond ensuring that healthcare providers function within their budget, which markedly differs from financial models that seek to produce profit in fee-for-service healthcare systems. Indeed, the centres that reported economic outcomes as a measure of clinical excellence were predominantly located in the USA and were nominated by healthcare funders suggesting that cost and cost efficiency is overtly considered as an important facet of excellence in fee-for-service centres.[65, 66]

Benchmarking is a well-recognised process that identifies the best-performing healthcare facilities in terms of patient outcomes and system performance.[67] However, while there is an implicit assumption that CoCE will deliver care that is superior to another (non-excellent) centre, most of the included initiatives in our review did not benchmark with other services. Benchmarking allows tracking of performance over time while comparing performance against other facilities, thereby demonstrating what is feasible to achieve in terms of quality of care.[67] For the initiatives included in this review, without comparison to other healthcare facilities and without a standardised set of explicit, evidence-based and measurable criteria, it raises disparity and challenges on how these centres can claim to be legitimate CoCE.

It is recognised that healthcare performance can be variable,[67] so healthcare facilities should monitor and evaluate their programs to ensure continued excellence. This process needs to be feasible within the time and resource constraints. Just over half the initiatives included in this review reported monitoring their service, and described various processes including measuring patient outcomes, service productivity and quality metrics to maintain the designation of CoCE. Only six initiatives reported a structured process, where their ongoing performance was reviewed and assessed by an overseeing body to maintain their status as CoCE. Clearly more attention should be paid to demonstrate the sustainability of excellence initiatives.

CONCLUSION

Although CoCE are increasingly reported in the literature, there are inconsistencies in how these CoCE are established, monitored and evaluated. Processes used range from self-

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designation with no explicit criteria to using external evaluation and periodic recertifications. Features of CoCE centred around skilled medical and multi-disciplinary teams and other resources such as infrastructure and equipment. More work is required to develop transparent systems and processes to ensure that centres claiming to be "excellent" can demonstrate that they are delivering the highest quality care.

IMPLICATION FOR PRACTICE AND FUTURE RESEARCH

This review highlights the need for clear criteria healthcare facilities can use to identify or establish a CoCE. The processes used also need to be transparent so they are easily available for certification or auditing purposes. The concept of a healthcare centre promoting "excellence" can also vary depending on different perspectives: patient, systems or funding. There needs to be clear guidelines that highlight the impact of "excellence" from these perspectives to ensure transparency on why a centre was nominated as a CoCE, and the monitoring processes used. It is recognised that staff wellbeing and retention contribute to more consistent healthcare delivery and better patient outcomes, so including staff wellbeing into a CoCE framework may be of value. The findings from this review will contribute to international efforts to establish CoCE using robust, transparent criteria and key performance indicators.

STRENGTHS AND LIMITATIONS

The strengths of our scoping review include the inclusive search strategies (peer-reviewed journals and grey literature) and stringent review process using two independent reviewers throughout the process. There is a potential that there may be established CoCE that have not published any studies or reports, which we then have not identified. Whilst we sought assistance from an academic librarian to ensure the search strategies were clear and comprehensive, centres that describe excellence using different terms and relevant information published in non-indexed sources may have been missed. This is a particular challenge of this focus of work which straddles healthcare organisation, clinical practice and academic research.

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Table 1 Inclusion and Exclusion Criteria

Table 1: Eligibility criteria for article selection
Inclusion criteria ➢ Available in the English language ➢ Information on CoCE ➢ Healthcare organisations or services providing clinical care to people with any healthcare condition ➢ Published from January 2010 ➢ Any geographical location ➢ Studies describing the development/defining/monitoring/evaluation/frameworks of CoCE
Exclusion criteria ➢ Records that describe a study conducted at CoCE (e.g. using participants from CoCE) ➢ Centres that do not provide clinical care (e.g. Centres of Research Excellence or Centres of Leadership Excellence) ➢ Conference abstracts/papers, letters, NICE guidelines, JBI guidelines ➢ Only looking at costs associated within one CoCE (no comparator) ➢ Only looking at clinical outcomes for people receiving care at CoCE (no comparator) ➢ Using term "CoCE" without outlining the criteria

Abbreviation: CoCE- Centres of Clinical Excellence; NICE- National Institute for Health and Care Excellence; JBI- Joanna Briggs Institute

Table 2 Characteristics of included records

Types of literature from included records (n=50)	**N(%)**
Research articles	15 (30%)
Others (Editorial, reports, case reports) from peer reviewed journals	28 (56%)
Book chapters	3 (6%)
Websites	2 (4%)
Systematic review	1 (2%)
Government report	1 (2%)
Country of Centre or initiatives described (n=45)	
USA	25 (56%)
Others	20 (44%)
Clinical Conditions from initiatives described (n=45)	
Cardiovascular disease	8 (18%)
Spinal surgery	4 (9%)
Pituitary tumours	4 (9%)
Diabetes	3 (7%)
Pregnancy related	2 (4%)
Others	24 (53%)

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Table 3 Characteristics of CoCE initiatives

1st Author of main record describing initiative	Theoretical Centre (T) or Physical Centre (P)	Framework adapted / created	Resources			Processes used or suggested for CoCE		
			Personnel	Infrastructure	Equipment	Criteria described	Processes to establish a CoCE	Processes to monitor a CoCE
Bitzer et al[47]	T	X	X	X				X
Burkett et al[24]	T		X					X
Campbell et al[38]	P	X	X	X			X	
Carvalho and Jill[34]	T	X	X		X		X	X
Casanueva et al[28] & Tritos[31]	T	X	X					
Chang et al[48] & Lymphatic Education & Research Network[68]	P	X	X				X	X
Choque-Velasquez et al[39]	P		X		X			X
Coon et al[69]	P	X	X					
Creehan et al[70]	T	X	X			X		
Daming et al[19]	P	X	X	X		X	X	X
Deshmukh et al[40]	P	X	X			X		X
Dietz et al[44]	T	X	X		X	X		
Distiller and Brown[32]	P		X			X		X
Draznin et al[33]	T	X	X	X		X		
El-Eshmawi et al[16]	P	X	X	X		X	X	X
Elrod and Fortenberry[4]	P	X	X	X		X	X	
Ferguson and Froehlich[50]	P		X				X	X
Frara et al[29]	T	X	X	X		X	X	X
Geetha et al[53]	P	X				X		
Haider et al[37]	T	X	X			X		X
King, Jamieson and Berg[45]	P	X				X	X	X
Kullar et al[54]	P	X	X			X	X	X
Lancellotti, Dulgheru and Sakalihasan [17] & Chambers et al[18]	T		X	X		X		X
Li et al[55]	T					X	X	
Marinoff and Heiberger[41]	P		X	X			X	

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1st Author of main record describing initiative	Theoretical Centre (T) or Physical Centre (P)	Framework adapted / created	Resources			Processes used or suggested for CoCE		
			Personnel	Infrastructure	Equipment	Criteria described	Processes to establish a CoCE	Processes to monitor a CoCE
Martin et al[25]	T	X						
McLaughlin et al[30]	T		X		X			X
Nakov et al[20]	P		X					
Piccini et al[21]	T	X	X	X				
Pronovost et al[49]	T	X						X
Safer Care Victoria[51]	T	X						
Sandhu et al[22]	T	X	X					
Santos-Moreno et al[36, 71, 72]	P	X	X	X	X		X	X
Sheha and Iyer[26]	T		X					X
Shikora, Delegge and Van Way III[57]	P	X	X	X	X	X	X	X
Shommu et al[73]	T					X		
Silver et al[35]	T		X	X		X		
Steiner et al[74]	T		X			X	X	
Tapela et al[42]	P		X	X	X	X		
Thomas et al[15]	P		X				X	X
Vivian et al[46]	P	X	X	X	X	X	X	
Williams[23]	T	X	X		X	X	X	
Wirth et al[52]	T	X	X			X	X	X
Wu et al[27]	T	X				X		X
Yao and Zhou[43]	P	X	X				X	X
Total	**21 (P) 24 (T)**	**30**	**37**	**15**	**9**	**33**	**20**	**24**

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Table 4 Outline of Selection/Nomination Process of CoCE.

1st Author	Steps outlined
Chang et al[48] & Lymphatic Education & Research Network[68]	1. Applications will be reviewed by the LE&RN Global Oversight Committee (GOC). All applications will be scored, using the following three individual criteria: a. The quality of the overall application/services. b. Unique offerings or particular characteristics that add to the Lymphatic disease clinic. c. Miscellaneous (e.g., lymphatic disease community citizenship, research).
Santos-Moreno et al[36]	1. Implementing an attention model for the patients diagnosed with rheumatoid arthritis, in accordance with the requirements of each type of centre of excellence. 2. Filling the self-assessment form of each type of centre of excellence and implementing improvement actions. 3. Requesting and preparing for a verification visit. 4. Receiving a verification visit from REAL-PANLAR. 5. Official notice of the results of the assistance and verification visit.
Shikora, Delegge and Van Way III[57]	1. Online application completed by surgeon or facility. 2. Successful application results in provisional status. 3. Within 2 years must seek full approval and pass on-site inspection and indicates has excellent outcome. 4. Mandatory submission of all patient data to a database.
Vivian et al[46]	1. Establishing the foundation (leadership structure and purpose). 2. Formalising the Centre of Excellence program (clinical education training, multi-disciplinary team involvement). 3. Solidifying the Centre of Excellence status (certification/accreditation by external institute).

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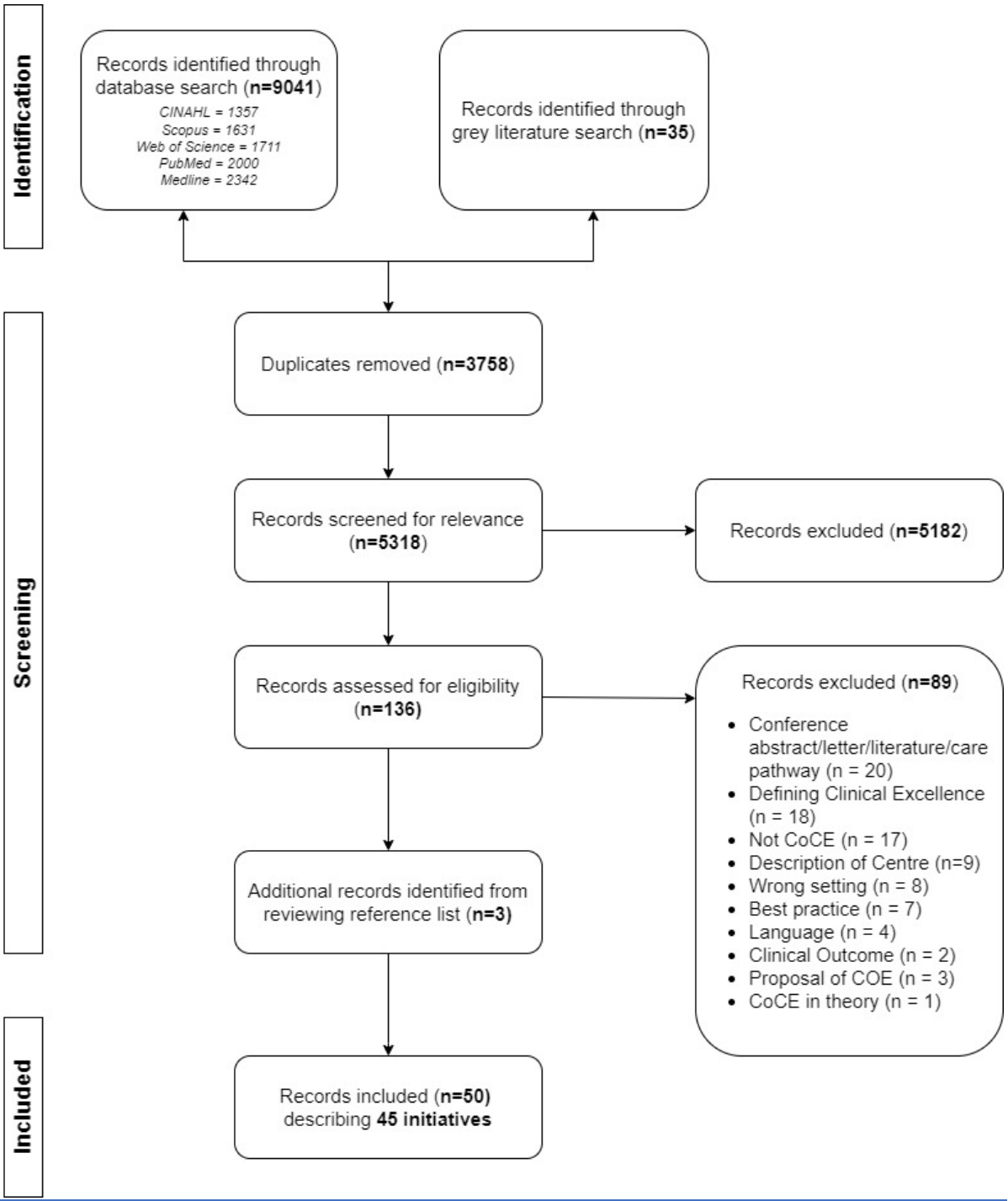

Figure 1 PRISMA flow diagram. *Abbreviation: CoCE- Centres of Clinical Excellence; COE- Centre of Excellence*

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Supplemental file

Search Strategy

Databases search: MEDLINE Ovid, PubMed, Web of Science, CINAHL and Scopus

Keywords used: "centre of clinical excellence" OR "networks of excellence" OR "best practice" OR "clinical exemplars" OR "integrated healthcare delivery" OR "excellence" OR "clinical protocols" OR "clinical competence" as search terms, subject headings, concepts or keywords.

MEDLINE Ovid
(((centre* or network* or best practice or institute*) adj3 clinical excellence) or center of excellence or centre of excellence).ti,ab,kf.

CoE – Centre of Excellence
*Research article in peer reviewed journal
#Other in peer reviewed journal
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Table S1: Description of the aim and type of publication and information on how CoCE were described in the initiatives.

1st Author	Country / Region	Aim of publication	Type of publication	How is CoCE described in the study					
				Name of CoCE	Year CoCE established	Framework adapted/created	Function of CoCE	Clinical focus area of CoCE	Resources
Bitzer et al[1]	Europe	Describing the framework and characteristics of an "ideal" CoE of Sexual Medicine and Sexual Therapy	Other#	Centre of Excellence for Sexual Medicine	Not reported	Created by authors	Diagnosis and treatment of Sexual dysfunction. Aim: • To provide a framework for patient-centred and relationship-based care. • To provide multidisciplinary diagnostic assessment, individualized therapeutic options, documentation and follow-up of patients. • Provide training for medical students, residents and fellows	Sexual medicine	**Personnel** • Multi-disciplinary team **Infrastructure** • A room for counselling/therapy • Examination room
Burkett et al[2]	Not reported	To present the concept of “centers of excellence” and how they are applied to spine care. Provided an overview of spinal CoE.	Book chapter	Spine Centre of Excellence	Not reported	Not reported	• To achieve exceptional quality of spine care at lower cost. • To establish a regional presence and a robust patient population. • To demonstrate that the organization meets high performance standards. • To stand out among other area institutions.	Spinal surgeries	**Personnel** • Specialties involved may include neurosurgery, orthopaedic surgery, rehabilitation, occupational therapy and physical therapy, pain management, specialized nursing, radiology, behaviour medicine, and psychiatry

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1st Author	Country / Region	Aim of publication	Type of publication	How is CoCE described in the study					
				Name of CoCE	Year CoCE established	Framework adapted/created	Function of CoCE	Clinical focus area of CoCE	Resources
Campbell et al[3]	India	Examines the evolution of a Centre of excellence as an innovative model for sustainable cleft care in the developing world	Research article*	Operation Smile Guwahati Comprehensive Cleft Care Center (GCCCC)	2009	Created by authors and collaborators from Operation Smile	To provide standardized and comprehensive cleft care at one institution, with vision of making Assam a cleft free state.	Cleft palate	**Personnel** • Healthcare professionals in multiple disciplines **Infrastructure** • Modern surgical suite and clinical space • Modern integrated operating suite, advanced surgical equipment, sophisticated anaesthesia and monitoring capabilities
Carvalho and Jill[4]	USA	To describe designation process of Centres of Excellence in obstetric ant	Other# & Website	CoE for Anaesthesia Care of Obstetric Patients	2018	The criteria for Centres of Excellence designation, which covers all aspects of obstetric anaesthesia care, were generated by expert consensus and incorporate evidence-based recommendations.	CoE designation process is designed to recognize institutions and programs that demonstrate excellence in obstetric anaesthesia care, to set a benchmark level of expected care to improve the standards nationally, and to provide a broad surrogate quality metric of institutions providing obstetric anaesthesia care.	Obstetric Anaesthesia and Perinatology	**Personnel** • Obstetric anaesthesiologist • 24/7 coverage of obstetric patients by at least 1 anaesthesiologist **Equipment** • Includes access to blood transfusion equipment and supplies, access to resuscitation and intubation equipment and supplies

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1st Author	Country / Region	Aim of publication	Type of publication	How is CoCE described in the study					
				Name of CoCE	Year CoCE established	Framework adapted/created	Function of CoCE	Clinical focus area of CoCE	Resources
Casanueva et al[5] & Tritos[6]	International	To describe the criteria for developing Pituitary Tumors CoE	Other#& Website	Pituitary Tumor Centers of Excellence (PTCOE)	Criteria disseminated 2017	Expert working group drafted framework. The draft was modified and approved by the Board of Directors of the Pituitary Society. The document was presented to international groups, modified and endorsed.	• Provide the best multidisciplinary care for patients with pituitary tumours and related pathologies. • Advance pituitary science • Provide adequate care, education and community outreach. • Act as a training centre for residents in the treatment of pituitary • Pathologies • Advise health administrators and authorities on specific problems.	Patients with pituitary tumours	**Personnel** • Medical specialists • Multidisciplinary supports • Basic requirements for surgical training and endocrinologist training listed.
Chang et al[7] & Lymphatic Education & Research Network[8]	USA	To describe the steps taken to establish standards for Centres of Excellence for Lymphatic Disease Described 5 categories of Centres of Excellence: • Comprehensive Centre of Excellence	Research article*, website	Lymphatic Education and research network CoE	Criteria published 2021	Lymphatic Education and Research Network initiated a Centres of Excellence program to designate institutions that provide services	• Provide multidisciplinary clinical care • Provide professional and lay education • Involvement in clinical research Work with local and international CoCEs to continually improve the lives of	Lymphatic disease	**Personnel** • Multi-disciplinary input • Suggested expertise requirements listed in detail **Resources** • Assessment tools listed

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1st Author	Country / Region	Aim of publication	Type of publication	How is CoCE described in the study					
				Name of CoCE	Year CoCE established	Framework adapted/created	Function of CoCE	Clinical focus area of CoCE	Resources
		• Network of Excellence • Referral Network of Excellence • Lymphatic Disease Surgery Centre of Excellence • Lymphatic Disease Conservative Care Centre of Excellence.				for lymphatic disease patients	people with LD and their families.		
Choque-Velasquez et al[9]	Peru	To describe the development of Neurosurgical Centre of Excellence in Peru	Research article*	Specialized Neurosurgical Centre of Excellence	2016	Not specified what process used	To improve the treatment of neurosurgical diseases in the region, thus optimising their outcomes and decreasing transfers to the neurosurgical departments in the capital district	Specialty neurosurgical centre, Peru	**Personnel** • Staff training by neurosurgeons and nurses from Finland **Equipment** • Equipment provided/repaired **Other** • Neurosurgical protocols developed

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1st Author	Country / Region	Aim of publication	Type of publication	How is CoCE described in the study					
				Name of CoCE	Year CoCE established	Framework adapted/created	Function of CoCE	Clinical focus area of CoCE	Resources
Coon et al[10]	USA	Introduced key aspects of coordinated care for patients with MSA and their caregivers, discuss various outcome measures, and share experiences from two centers with multidisciplinary clinics.	Other#	Multiple System Atrophy CoE	Multiple Centres discussed. Established between 2015 - 2019.	Created by authors but process not described	Not reported	Multiple System Atrophy	**Personnel** • Multi-disciplinary team
Creehan et al [11]	USA	Describe the development of a framework for Centres of Pressure Ulcer Prevention Excellence	Research article*	Centers for Pressure Ulcer Prevention Excellence	The process developed in 2014	Framework developed using Donabedian model. Systematic literature reviews, analysis of exemplars, and nominal group process techniques were used to create the framework, based on 4 Magnet Model domains.	Inspirational centre – to develop a framework. Aim to achieve and sustain reductions in avoidable hospital acquired pressure ulcers	Pressure ulcer	**Personnel** • Frontline staff engagement and hospital • Administrator • Leadership

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Daming et al[12]	USA	A guide for creating a center of excellence for prenatal care for women with cardiovascular disease.	Other#	Maternal Cardiac CoE	2014	Developed a 3 staged framework (vision-> design and development -> implement, monitor and review).	To manage pregnant women consistently and systematically with heart disease.	Maternal cardiac health	**Personnel** • Program coordinator • Multi-disciplinary team (recommendation provided for speciality **Infrastructure**: • Dedicated outpatient clinic
Deshmukh et al[13]	India	To evaluate the impact of the Centre of Excellence at Vidya Shikshan Prasarak Mandal Dental College and Research Centre	Research article*	Centre of Excellence at Vidya Shikshan Prasarak Mandal Dental College and Research Centre	2016	The present CoE model was planned and executed with consensus building for 12 months using several methods to involve stakeholder groups (staff, students and patients)	• To provide comprehensive oral healthcare for economically disadvantaged groups in rural India. • To foster organisational development through an integrated approach. • To stand out as a pioneer in Central Indian region in the fields of maxillofacial rehabilitation and oral implantology.	Oral healthcare	**Personnel** • Academic faculty, consultants and post-graduate students
Dietz et al[14]	USA	Summary of best practices for the prevention and	Case report^	Centers of Excellence in Addressing	Not reported	Creating a basis for framework within the	Centers of Excellence provide better overall outcomes and	Periprosthetic joint infection	**Personnel** • Multi-disciplinary teams

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#Other in peer reviewed journal
^Case report in peer reviewed journal

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		treatment of PJI within the context of a CoE.		Periprosthetic Joint Infection		literature, based on work on musculoskeletal infection symposium	lower financial, physical, and emotional costs to the patient, thus providing a greater value by decreasing variability, treatment pathways incorporating best practices based on evidence.		**Equipment** • Electronic medical records **Others** • Protocols for pre-operative screening and evaluation • Risk reduction protocols and processes
Distiller and Brown[15]	South Africa	Not reported	Book Chapter	Centres for Diabetes Excellence	1994	Not reported	To improve diabetes management and provide "one-stop shop" for patients. With all services in one place, and a well-managed appointment system, patients experienced minimal waiting and optimal consultation times.	Diabetes	**Personnel** • Trained medical staff (specialists, GPs or physicians) **Other** • every centre must provide a direct 24-h emergency telephone number ("Hotline")
Draznin et al[16]	USA	Proposing a framework to guide advancement for clinical CoE	Other#	Diabetes Center of Excellence	Not reported	6 domains or pillars to serve as guiding principles	To improve population health, patient care experience (including quality and satisfaction) and reducing healthcare costs. Diagnosis and management of diabetes.	Diabetes	**Personnel** • Adequate in terms of number, skills, experience • Multi-disciplinary professional teams guided by clinician diabetologists

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									experienced in managing complex, high-risk individuals **Infrastructure** • appropriate to qualify as a centre and technologies
El-Eshmawi et al[17]	USA	To define the structure of a mitral center of excellence and to review current clinical outcomes	Other#	Mitral Valve Center of Excellence	Not Reported	Description of functioning of self-nominated Centre of Excellence	Provides a structure for a multidisciplinary heart team to provide state of the art care for patients with degenerative mitral valve disease	Mitral valve disease	**Personnel** • Crucial - surgeons trained in mitral valve repair; anaesthesia team, intensive care team, interventional cardiologist **Infrastructure** • Mitral valve clinic; access to advanced cardiac imaging; data monitoring team
Elrod and Fortenberry[18]	USA	To guide healthcare establishments to replicate noted processes to realize their own CoE	Other#	Willis-Knighton Health System CoE (has 11 CoE in different clinical areas)	1980's	Based on information and insights gleaned from 1 healthcare provider's (Willis-Knighton Health	To deliver innovative, high-quality healthcare that would attract increasing number of patents	11 clinical areas by this healthcare provider	**Personnel** • Skilled and experienced personnel **Infrastructure**

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						System) experience assembling and operating Centers of Excellence.			• Appropriate accommodation necessary to deliver continuum of care
Ferguson and Froehlich[19]	USA	Describe the development of the program, its guiding principles, challenges and early results	Case report^	The Total Joint Centre	2010	Not reported. Intuitive quality improvement process with assistance from external consultant	To provide state-of-the-art, high quality, patient-centric, efficient healthcare	Joint replacements	**Personnel** • Multi-disciplinary team • Patient navigators employed
Frara et al[20]	Authorship team from Spain	Not reported. Discussion paper	Case report^	Pituitary tumors centers of excellence	Not reported	Adapted from Elrod and Fortenerry	To provide a high-level care for pituitary patients, to advance pituitary science.	Pituitary tumors	**Personnel** • Specialist medical staffing and nursing **Infrastructure** • Physical place availability
Geetha et al[21]	USA	Apply the definition of clinical excellence to nephrology	Other#	Miller-Coulson Academy of Clinical Excellence	2015	Adapted clinical excellence framework from Christmas	Not reported	Nephrology	Not reported

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Haider et al[22]	LMIC	• To explore the role of international urologic organisations in developing CoE in patient care, training and dissemination of knowledge. • To explore strategies used to improve the standard of care and outcomes of urologic conditions in LMIC. • To provide a roadmap on how similar international surgical organizations can contribute to developing CoE in LMIC through health system strengthening.	Case report^	Not reported	Not reported	Used Elrod and Fortenberry	To contribute to health system strengthening through international partnerships	Urology Surgery	**Personnel** • Staff with depth and breadth of knowledge and qualifications

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King, Jamieson and Berg[23]	USA	To use the example of transplant programs (with extensive national-level data) as examples of the strategic planning required to accomplish comprehensive. Interdisciplinary care affording the best possible outcomes, and rightfully claim to serve as centres of Excellence.	Other#	Presents 9 Centres of Excellence designations within solid-organ transplantation	Not reported	Elrod and Fortenberry	Providing best outcomes possible to people undergoing organ transplantation	Hepatology	Not reported
Kullar et al[24]	USA	• To describe the process and purpose of designating institutions as Antimicrobial Stewardship Centres of Excellence CoEs. • To provide awareness to clinicians on opportunities available through Infectious	Research article*	Antimicrobial Stewardship Centres of Excellence (program)	2017	Built on core elements of Centers for Disease Control and Prevention. Added aspects of meaningful differentiation by workgroup of infectious diseases	Effectively implement of antimicrobial stewardship programs	Infectious Disease	**Personnel** • Clinical expertise

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		• Diseases Society of America with this CoE designation				physicians and pharmacists.			
Lancellotti, Dulgheru and Sakalihasan[25] & Chambers et al[26]	Multiple European countries	Chambers: to discuss Standards for mitral and aortic valve multidisciplinary team practice within a 'Heart Valve Center of Excellence'.	Other#& Research article*	Heart Valve Centre of Excellence	Not reported	Not reported	To perform durable mitral valve repair at closed to no risk in patients with asymptomatic severe mitral regurgitation caused by prolapse. The intention was that invasive valve interventions should not occur outside Heart Valve Centres of Excellence.	Heart Valve Surgery	**Personnel** • Multi-disciplinary team (medical and nursing) proficient in diagnosing and treating all cardiac valve syndromes and disorders **Infrastructure** • Facilities to treat and refer patients for valvular surgery/intervention. • Access to expert imaging
Li et al[27]	USA	To evaluate the current status of defining and using CoE designation	Research article*	Not reported	Not reported	Not reported	Not reported	Multiple area	Not reported
Marinoff and Heiberger[28]	China	To share accomplishments and limitations from creating a Centre of Excellence in Low	Case report^	Center of Excellence in Low Vision and Vision Rehabilitation	2010	Not reported	Treatment of people with low vision	Low vision and vision rehabilitation	**Personnel** • Trained doctors and nurses **Infrastructure** • Occupies 6,240 square feet and is equipped with four

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		Vision rehabilitation in China							low vision examination rooms, a special testing room, an assistive technology room, a dispensing area, and a classroom, access to multiple low vision devices
Martin et al[29]	Various countries	Utilize available literature to better characterize the features of a spine COE at a tertiary care center and determine the impact of CoEs on patient satisfaction and outcomes.	Systematic Review & Case report^	Spine CoE	2021	The COE's (Midwest academic tertiary care) mission entails three primary emphases: value, quality, and accountability.	Standardisation of protocols for the works up of suspected spinal cord compression across the regional hospital system to improve time to diagnosis, transport, and intervention.	Spine	Not reported
McLaughlin et al[30]	USA	Review the literature supporting the establishment of pituitary CoEs, suggest criteria for COE recognition, consider the development of standards of care, and	Other#	Pituitary Centre of excellence	NA	Not reported for pituitary tumour, however provided examples of other models e.g., bariatric	Treatment of pituitary tumour and described primary missions and criteria for verification	Pituitary	**Personnel** • Multi-disciplinary approach related to pituitary tumours and hormonal disorders. • At least 1 neurosurgeon with transsphenoidal surgical experience • Training for team

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		discuss potential pitfalls.							**Equipment** • Equipment and instrumentation for endonasal cranial base surgery including endoscopic equipment **Others** • Clinical pathways and standard operating procedures
Nakov et al[31]	Bulgaria	Focus on the importance of performing the most appropriate testing strategies for ATTR amyloidosis and establishing a CoE for this rare disease. Highlights experience in establishing a CoE in Sofia, Bulgaria and define the fundamental steps needed to successfully launch a program.	Other#	CoE for ATTR amyloidosis	2016	Not reported	Treatment for Amyloidosis	Transthyretin Amyloidosis	**Personnel** • Dedicated team of experts specialized in the range of medical fields required to diagnose the patients effectively and education/training for staff

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Piccini et al[32]	Not specifically identified	HRS hopes to accelerate this evolution by reviewing the rationale for AF CoEs, the available evidence for integrated and multidisciplinary care, and future challenges and opportunities. The document also defines the key priorities to be used as a guide for HRS and its diverse stakeholders to build consensus on defining the core components of an AF CoE.	Other#	Atrial Fibrillation CoE	Not reported	Fundamentals of team-based integrated care models in atrial fibrillation	To improve outcomes by providing a better patient experience and delivery of high-quality, guideline recommended, state-of-the-art care	Atrial Fibrillation	**Personnel** • Multi- disciplinary team **Infrastructure** • Dedicated lab with fluoroscopy • Electrophysiology recording system • Emergency equipment **Others** • Complication standard operating procedure
Pronovost et al[33]	USA	Defines explicit criteria for provider-based CoEs and how to apply them within a healthcare organization	Case report^	General description of CoE	Not reported	Reported used a framework based on University Hospital, USA and listed the criteria used to establish CoE as a framework.	Have access to multiD team and seek to improve patient experience and outcomes and reduce costs	NA	Not reported specifically. Used examples from other CoE

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Safer Care Victoria[34]	Australia	Discuss approaches to engaging clinicians and consumers to improve the quality and safety of health care in Vitoria. Spells out the purpose, role and structure of the CoCE.	Website – grey literature	Safer Care Victoria Centres of Clinical Excellence	2021	Aligns with Safe Care Victoria Strategic Plan 2020-2023.	Contribute to the key strategic domains of leadership, partnership and planning, monitoring and improvement with the aim of improving healthcare across Victoria, so it is safe, more effective and person-centred.	Multiple setting	Not reported
Sandhu et al[35]	USA	To gain a better understanding from key stakeholder groups on current practices needs and potential barriers to implementing optimal integrated AF care.	Other#	Atrial Fibrillation CoE	2022	AF CoE task force provides recommendations on defining, developing, implementing and evaluating an AF CoE	To standardise the care of AF patients based on guideline directed care to achieve best outcomes.	Atrial Fibrillation	**Personnel** • Identified the need for multi-disciplinary team
Santos-Moreno et al[36-38]	South America	• To define the minimum standard of care. • To describe the history and current context of the CoE in comprehensive care in patients with RA with suggestions on	Research article* & Other#	Centre of Excellence in Rheumatoid Arthritis	Not stated	Created own framework and integrated healthcare models and endorsed by REAL-PANLAR Based on 3 pillars - the volume of	The ultimate goal of the CoE is to define a model of comprehensive care that meets the needs of the region in order to improve the accessibility, quality, and timeliness of care, and access to appropriate diagnosis and treatment. This is to facilitate	Rheumatoid Arthritis	Three CoE Modes were presented and each model (standard CoE, Optimal CoE, Model CoE) had different requirements of staff, equipment and infrastructure **Personnel (at minimum)** • Multi-disciplinary team led by rheumatologist

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		how to create CoE in RA • Proposed a systematic and progressive methodology that will help all the institutions to develop successful models without faltering in the process				patients with a specific condition or entity - continuous improvement - the quality of healthcare	access to better quality treatment, achieve disease remission, improve their quality of life and reduce long-term disability risk to RA patients.		**Infrastructure** • Access to radiology • Access to pathology **Equipment** • Standardised tools
Sheha and Iyer[39]	USA	General description of CoE and applying general principles of healthcare CoE to spine surgery	Other#	Spine CoE	Multiple centres that was previously established was discussed in the study	Not reported	An opportunity to accurately evaluate the true value of outpatient spine surgery	Ambulatory spinal surgery	**Personnel** • Multi-disciplinary team • Education
Shikora, Delegge and Van Way III[40]	USA	Describes the creation, implementation, and benefits of the BSCoE (Bariatric Surgery	Case report^	Nutrition Support Center of Excellence	2003 - creation of the Surgical Review	Consideration for adaption of BSCoE to NSCoE	Not reported	Nutritional Support	Specified BSCoE and how this can be adapted to NSCoE **Personnel**

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		COE) and the benefits of creating an NSCOE (Nutritional Support CoE). Description of the CoE in Bariatric Surgery and how this can be adapted to Nutritional Support. The report contains description of resources, how it was created the certification process and benefits of BSCoE			Corporation (SRC).	The SRC • Formulate and establish guidelines and criteria for assessing bariatric surgical practices. • Evaluate and investigate applicants to ensure that they met the established standards to become a BSCOE. • Creating a national bariatric surgical database to collect, analyse, and disseminate			• Surgeons specific criteria for BSCoE **Infrastructure** • Specific to BSCoE **Equipment** • Not specifically outlined

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						data collected from the BSCOEs			
Shommu et al[41]	Canada	To develop a multi-disciplinary consensus of nutrition care priorities for implementation in an IBD nutrition CoE	Research article*	Inflammatory Bowel Disease Nutrition CoE	2019	Not reported	To provide excellent clinical care, conduct original research	Inflammatory Bowel Disease	Raised as a concern/barrier • Lack of infrastructure • Lack of staffing
Silver et al[42]	USA	To outline criteria for centers of excellence and suggested indications for referral in cases of suspected placenta accreta.	Other#	Accreta CoE	Not reported	Not reported	Optimal management of patients with placenta accreta	Placenta Accreta Intensive care unit	**Personnel** • Multi-disciplinary team with specialised staff for placenta accreta **Infrastructure** • Intensive Care unit and facilities
Steiner et al[43]	USA	To suggest criteria that the headache centres might be recognised as centres of excellence in the headache community. Set out recommendations for 10 suggested role and	Other#	Specialized headache centre	Not reported	Not reported	Providing specialist care to patients with primary or secondary headache disorders that are difficult to diagnose or treat, refractory or rare, or for other reasons require specialist intervention	Headache	**Personnel** • Multi-disciplinary care

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		performance-defining standards.							
Tapela et al[44]	Rwanda	Report program level description of implementing Butaro Cancer CoE, its preliminary impact and challenges faced in order to share lessons and inform service delivery in similar setting	Research article*	Butaro Cancer CoE	2012	Not reported	To deliver accessible cancer services in a resource-constrained setting histology-based diagnosis, imaging, surgical, pa and socioeconomic supports	Cancer	Provided by Rwanda Ministry of Health. **Personnel** • Doctors and nurses received training **Infrastructure** • To support surgical procedures and palliative care **Equipment** • X-ray and ultrasounds imaging **Others** • Treatment protocol • Finance • Partnership with other services from USA
Thomas et al[45]	USA	Establishing Cardiometabolic CoE for secondary	Other#	Cardiometabolic Center of Excellence	2018	Not reported	To deliver patient-centred collaborative model of ca focused on aggressive a	T2DM + CVD	**Personnel** • Nurse navigator

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		prevention in patients with T2D and CVD					comprehensive secondary cardiovascular risk reduction in patients with T2D an		• Cardiometabolic Center Advisory Committee • Training
Vivian et al[46]	USA	To outline the framework for a Pancreas CoE	Research article*	Pancreas CoE	2013	Outlined framework using 3 developmental domains. • Establishing the foundation • Formalising the program • Solidifying the CoE status	To improve the care and outcomes of patients and families affected by pancreatic disease using a multidisciplinary team approach to deliver exceptional and compassionate care	Management of pancreatic disease	**Personnel** • Management – leadership support • Surgeons trained in robotic surgical approach • Multi-disciplinary staff trained • Specific – nurse navigator and dietician **Infrastructure** • To establish and maintain robotic surgical approach **Equipment** • Minimally invasive technology (robotic) • Advanced endoscopic technology • Clinical Information Systems - dashboards.

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									Others • Certification
Williams[47]	USA	To discuss the evolution of the concept of Centers of Excellence and the components of an HCM center	Book Chapter	Hypertrophic Cardiomyopathy Centre	1971 for the first 15 centers	Adapted model from National Cancer Institute	Network of referral centres established for adult and paediatric HCM patients; regional centres encourage consistency of treatment algorithms and outcomes, access to world-class clinical care within driving distance, as well as collaborative research between institutions. Also a resource and offer second opinions for providers and patients.	Hypertrophic Cardiomyopathy	**Personnel** • Multi-disciplinary team that includes specialists in adult and paediatric cardiology, electrophysiology, interventional cardiology, cardiac surgery and genetic counselling, all with particular expertise in treating the patient with HCM. **Equipment** • Cardiac imaging (echocardiography and cardiac magnetic resonance imaging) • Electrophysiology
Wirth et al[48]	Europe (Barcelona)	To develop the concept of the European Prostate Cancer Centers of Excellence with the specific aim to	Research article*	European Prostate Cancer Centres of Excellence	Criteria agreed upon in 2019	Created by authors	To enable high-quality management of prostate cancer in the fields of clinics, research, and education	Prostate Cancer	Resources requirements are outlined in detail in the study and specific requirement **Personnel**

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		identifying European Centers characterised by high-quality care, research and education							• Core team, associated services and multi-disciplinary approach
Wu et al[49]	USA	To evaluate • Patient outcomes at nominated CoE • Whether the revamped designation criteria would result in improved patient outcomes.	Research article*	Blue Distinction Plus Centres	2016	Value framework	Not reported	Inpatient spinal surgery	Not reported
Yao and Zhou[50]	China	To describe the impact of the introduction of a mentor-based CoE program	Research article*	Peritoneal Dialysis CoE	2003	Created using mentor-mentee system	To become a best demonstrated practice un	Peritoneal dialysis	**Personnel** • Physicians from mentor sites **Other** • Standardized teaching materials to deliver lectures, lead PD case discussions and ward rounds, suggest key performance indicators, and initiate a continuous

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1st Author	Country / Region	Aim of publication	Type of publication	How is CoCE described in the study					
				Name of CoCE	Year CoCE established	Framework adapted/created	Function of CoCE	Clinical focus area of CoCE	Resources
									quality improvement program.

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Table S2: CoCE criteria description, processes outlined and monitoring protocols described in the initiatives.

1st Author	Country / Region	PROCESSES DESCRIBED		
		Criteria described	Processes used to establish a CoCE	Processes to monitor a CoCE
Bitzer et al[1]	Europe	• Staffing and infrastructure recommendations • Training and professional development opportunities • Formal links with academic institution	Not reported	In order to audit outcomes, the number of patients, gender, diagnoses, and interventions would be tracked, as well as patient follow-up and satisfaction. Lastly, a cost analysis is necessary.
Burkett et al[2]	Not reported	• High patient satisfaction • Lower utilization of medical services and medications • Low overall cost of care • Provide a quicker return to work or regular activity for patients. • Superior medical care with seamless coordination between disciplines • High volume of patients treated.	Not reported	Report that centers of excellence are held to specific quality metrics to maintain "center of excellence" designation, specific quality metrics not reported.
Campbell et al[3]	India	• High level of patient need • Good working relationship between organisations • Receptiveness and capacity of local government, hospitals, and medical societies • Political and economic environment consistent with the ability to provide care	Local government approached Operation Smile for assistance with treating its cleft backlog. Site visit to determine site suitability.	Not reported
Carvalho and Jill[4]	USA	• Must demonstrate adherence to all criteria below (each clearly described in source documents): • Personnel and staffing Equipment, protocols, and policies • Simulation and team training • Obstetric emergency management • Caesarean delivery and labour analgesia care • Recommendations and guidelines for implementation • Quality assurance and patient follow-up systems	Apply to the Society of Obstetric Anaesthesia and Perinatology applications reviewed and graded by the COE Subcommittee. If successful, granted CoE Designation	Recertify every 4 years using the same process

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1st Author	Country / Region	PROCESSES DESCRIBED		
		Criteria described	Processes used to establish a CoCE	Processes to monitor a CoCE
Casanueva et al [5] & Tritos[6]	International	• Provide the best standard of care to patients with pituitary tumors and disorders • Organise multi-D clinical management • Liaison between experienced neurosurgeons and expert neuroendocrinology • Specialised staff training • Provision of educational courses • Comprehensive patient information and data management • Sharing information with scientific bodies and administrators • Support endocrine units outside PTCoE • Advise health administrators and authorities on specific problems • Advance the science and scholarship of pituitary tumours • Include tumour data on national registries	Not reported	Currently, no formal accreditation for PTCOE exists. The external body may or may not perform the final step of validation of the centre
Chang et al[7] & Lymphatic Education & Research Network[8]	USA	• Minimum criteria for comprehensive centers of excellence: • Mandatory list of staffing including surgeons and therapist • Demonstrated proficiency in diagnosis, imaging, conservative management, assessment tools, interventional therapies, surgery	Applications will be reviewed by the LE&RN Global Oversight Committee (GOC). All applications will be scored, using the following three individual criteria: a. The quality of the overall application/services. b. Unique offerings or particular characteristics that add to the Lymphatic disease clinic. c. Miscellaneous (e.g., lymphatic disease community citizenship, research).	Designation is valid for 3 years

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1st Author	Country / Region	PROCESSES DESCRIBED		
		Criteria described	Processes used to establish a CoCE	Processes to monitor a CoCE
Choque-Velasquez et al[9]	Peru	Not reported	Not reported	Evaluated using volume of neurosurgery
Coon et al[10]	USA	Comprised of: • Core clinical team • Additional subspeciality care • Longitudinal data collection • Support group involvement • Research opportunities • Additional support	Not reported	Not reported
Creehan et al[11]	USA	• Domains of ANCC model for the Magnet Recognition Program - transformational leadership - structural empowerment - exemplary professional practice - new knowledge, innovation and improvement	Not reported	Not reported
Daming et al[12]	USA	• Established in tertiary care hospital. • Created inpatient and outpatient protocol. • Has a set of criteria specific to maternal cardiac CoE and cardiac CoE and cardiovascular intensive care unit	Self-nominated as Centre of Excellence	• Monitoring productivity and streamlining communication between hospital • Management and stakeholders are the role of a program director.
Deshmukh et al[13]	India	CoE is an organisational environment that strives for and succeeds in developing high standards of conduct in a field of research, innovation and learning. • Capacity building for staff • Patient awareness • Increase in number of patients visiting the units and opting for treatment.	Not reported	Evaluation based on public health program evaluation criteria - assessing and documenting program implementation, outcomes, efficiency and cost-effectiveness of activities.

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1st Author	Country / Region	PROCESSES DESCRIBED		
		Criteria described	Processes used to establish a CoCE	Processes to monitor a CoCE
		• Research initiatives • Collaborations and networking Criteria for pillars of excellence (Academics, Research, Clinical, Faculty development, Technology, Social) – what consisted of the criteria was not described, however the outcome was outlined in the study)		
Dietz et al[14]	USA	Suggestion of CoE criteria but did not expand • Multi-disciplinary care pathways and teams and evaluation of surgeon's credentials, • Electronic medical records • Patient data management and or tracking • Process metric	Not reported	Not reported
Distiller and Brown[15]	South Africa	• Integrated information technology systems • Aligned finances and responsibility • Care planning • Clinical engagement and leadership • Robust clinical governance • Multi-disciplinary team	Not reported	Outcome-based monitoring protocol • Glycaemic control • Hospital admission • Microvascular disease outcomes
Draznin et al[16]	USA	• Focus on high-risk individuals and an open-door policy • Clear communication to guide care • Provision of comprehensive care • Ongoing focus on quality improvement • Ongoing monitoring of patient outcomes • Education and dissemination	Not reported	Not reported

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1st Author	Country / Region	PROCESSES DESCRIBED		
		Criteria described	Processes used to establish a CoCE	Processes to monitor a CoCE
El-Eshmawi et al[17]	USA	• Centers with surgeons that can achieve a very high likelihood of a durable valve repair • Dedicated multidisciplinary team (see staffing resources) • Transparent data management and quality assessment	Self-nominated -The center was formed and then discussed the criteria used in this study.	Monitoring of proportion of patients with successful valve repair; durability of valve repair
Elrod and Fortenberry[18]	USA	• Supplies an exceptionally high concentration of expertise and related resources centered on a particular area of medicine • Delivers care in a comprehensive, interdisciplinary fashion • Leads to best possible patient outcomes.	Overseen by organisation – an interdisciplinary committee vets the proposed Centre of excellence (assesses financial resources, culture and leadership support)	Not reported
Ferguson and Froehlich[19]	USA	Not reported.	Self-nominated	• Length of stay • Increased Patient volume • Monthly snapshot of - financial (includes caseload, cost and labour/case) - operational (includes length of stay, discharge to rehabilitation) - patient experience - quality (includes process measures, infections, falls, readmissions)
Frara et al[20]	Authorship team from Spain	• "Explicit and practical definitions for a degree of excellence have not yet been defined" • Require an integrated multidisciplinary group in a single location	Most are self-appointed without any formal acknowledgement	Discuss measuring effect via patient outcomes, cost of treatment, research outputs, and contribution to scientific efforts (e.g. scientific meetings, health registries)
Geetha et al[21]	USA	• Achieving a level of mastery related to • Patient care • Explicitly modelling this mastery to medical trainees	Not reported	Not reported

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1st Author	Country / Region	PROCESSES DESCRIBED		
		Criteria described	Processes used to establish a CoCE	Processes to monitor a CoCE
		• Collaborating with investigators to advance science and discovery		
Haider et al[22]	LMIC	• Patient care: must provide safe, effective and accessible care to the highest possible standards depending on geography, resources, infrastructure, patient population and local culture with site-specific management guidelines • Training: provides leadership in best practices, research, support and training for focus area • Dissemination of knowledge is essential function of the centre	Not reported	Recommend data collection to quantify impact and identify areas for change
King, Jamieson and Berg[23]	USA	Reviewed criteria of designated Centres of Excellence within Solid organ Transplant Networks– common features include • Number of patients treated • Good patient and graft outcomes compared to national average on Scientific Registry of Transplant Recipients • Centres of Medicare and Medicaid Services certified • +/- cost-effective care	Formally designated by insurers and employers	Need to monitor quality of care: • Patient factors • Facility and program structure • Transplant centre processes • Waiting list management • Post transplant care • Clinical and patient centred outcomes • Cost effectiveness • Team experience • Organ donation environment
Kullar et al[24]	USA	• Sustained institutional leadership commitment and accountability (e.g. mission statement, letter of attestation from management, documentation of physician leadership) Drug expertise (evidence of infectious disease and pharmacy expertise) • Action (e.g. action plan, disease specific protocol)	Infectious Diseases Society of America (IDSA) solicited applications. Centres required to submit documentation of core criteria. A committee of 6 ID pharmacists and physicians with extensive AMS experience reviewed applications.	The CoE designation is valid for 2 years, after which the institution must re-apply

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		Criteria described	Processes used to establish a CoCE	Processes to monitor a CoCE
		• Tracking (e.g. monitoring antibiotic use, demonstration of use of electronic health record as part of antimicrobial stewardship program) • Reporting (e.g. demonstrated participation in national reporting program) • Education (documented professional development program)		
Lancellotti, Dulgheru and Sakalihasan[25] & Chambers et al[26]	Multiple European countries	• Specialist valve clinic acts as a hub between community, other hospitals and extracardiac departments, and between non-invasive cardiologists and surgeons and interventional cardiologists • Nominated cardiac experts with speciality skills • Regular case discussions • Systematic approach to reducing medical and surgical risks • Data review: Robust internal audit processes including repair rates, rates of residual regurgitation, complications, durability of repair and reoperation rate • Results available for review internally and externally • Involvement in national databases	Not reported	...ve a high-volume operation rate on valvular heart ...ease, which is believed to be associated with better ...air results and potentially improved outcome. This partly ...plains why there is no obligation to refer patients eligible ... surgical repair in centres of excellence
Li et al[27]	USA	• Variable - can be selected and overseen by insurance companies, medical professional societies, government organisations, employer professional associations, individual employers or hospitals themselves • Insurers (different criteria used between different companies) tend to use data and identify centres that perform well on structural outcomes such as use of protocols and outcome	Some insurers use of a panel of experts from national organizations who understand the insurer's objectives and help select hospitals to be part of the CoE network.	N... reported

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1st Author	Country / Region	PROCESSES DESCRIBED		
		Criteria described	Processes used to establish a CoCE	Processes to monitor a CoCE
		measures such as hospital readmissions, complication rates, and volume. Cost sometimes considered		
Marinoff and Heiberger[28]	China	Not reported	Self-nominated following partnership between State University of New York College of Optometry and Wenzhou Medical University	Not reported
Martin et al[29]	various	• Standardization of protocols for the workup of suspected spinal cord compression across the regional hospital system to improve time to diagnosis, transport, and intervention. • Unified and standardized vendors and equipment across surgeons and the two departments to improve cost savings and resource utilization.	Not reported	Not reported
McLaughlin et al[30]	USA	Propose that centres fulfil the following • Provide multidisciplinary optimal clinical care to patients with pituitary tumours and related disorders • Provide residency, fellowship training and/or continuing medical education and patient support • Contribute to research in the field of pituitary disorders.	Not reported	Need to develop - suggested recognition or verification process be an ongoing process that is updated biannually
Nakov[31]	Bulgaria	Elements that should be considered: • Establish a dedicated team of multidisciplinary experts • Engage with patient advocacy group • Initiate a specific training regime to continue education for new and existing members of the team • Source appropriate funding to ensure sustainability	Not reported	Not reported

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1st Author	Country / Region	PROCESSES DESCRIBED		
		Criteria described	Processes used to establish a CoCE	Processes to monitor a CoCE
		• Schedule regular team meetings to ensure an individual plan for patient diagnosis, treatment and follow up		
Piccini et al[32]	Not specifically identified	• Identification and referral of patients • Appropriate staffing and dedicated clinics that focus on AF patients • Developing a comprehensive care team • Specific treatment goals • Evaluating and improving symptoms • Rate and rhythm control • Stroke prevention • Treatment of risk factors • Development of team based care pathways • Quality improvement	Not reported	Not reported
Pronovost et al[33]	USA	• Provide frictionless access • Ensure coordinated compassionate navigation • Epply rigorous appropriateness criteria for all the expensive diagnostic studies and procedures • Engage the entire team around the purpose of providing high-value care • Ensure the site of service and surgeon optimal • Reduce variation and complications by using evidence-based protocols • Provide personalized care • Continually monitor, transparent report and improve performance	Not reported	Outcome-based evaluation process

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1st Author	Country / Region	PROCESSES DESCRIBED		
		Criteria described	Processes used to establish a CoCE	Processes to monitor a CoCE
Safer Care Victoria[34]	Australia	• Centres based on population health (e.g., acute, chronic and prevention, older people, women and children and funded program. • Have 3 core functions: advocate and inform, guidance and advice and improvement. • Has a list of key groups that the centres partner with to plan and deliver work	Not reported	Not reported
Sandhu et al[35]	USA	Focus area • Access to care • Stroke prevention • Education • AF quality improvement • AF barrier	Not reported	Not reported
Santos-Moreno et al[36-38]	South America	• 3 types of CoEs were defined based on structure, process and outcomes indicators - structure indicators - Evaluate the institutional capacity to deliver the expected results, adequate infrastructure, suitable personnel including rheumatologists and other professionals to ensure comprehensive attention, and the existence of complementary resources - process indicators (Adherence to management recommendations based on treatment strategy by objectives - outcome indicators (The achievement of the objectives proposed along the care or comprehensive patient must be	Steps to implement CoE for RA **Step 1:** implementing an attention model for the patients diagnosed with rheumatoid arthritis, in accordance with the requirements of each type of center of excellence **Step 2:** filling the self-assessment form of each type of center of excellence and implementing improvement actions **Step 3:** requesting and preparing for a verification visit **Step 4:** receiving a verification visit	• The follow-up should take place according to the following 6 characteristics: 1. Clinimetrics 2. Decision-making factors based on the results of the clinimetrics 3. Opportunities to access treatment or follow-up 4. Patient education 5. Clinical care guidelines 6. Evaluation system

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1st Author	Country / Region	PROCESSES DESCRIBED		
		Criteria described	Processes used to establish a CoCE	Processes to monitor a CoCE
		evaluated. The progression of the disease, functional disability, and the achievement of remission goals must be quantified using clinimetric scales. • Different quality standards requirements for each CoE model and centres need to apply to get CoE. • 3 types of centre (must meet accreditation and meet minimum criteria for each type) - Standard - Optimum - Model	**Step 5:** official notice of the results of the assistance and verification visit	• Must be assessed and accredited cyclically based on standards, evaluators and evaluation and qualification process.
Sheha and Iyer[39]	USA	Suggested to use Joint Commission certification that requires healthcare facility to comply with national starts, use of evidence based practice and collect performance measures. Also to partner with American Academy of Orthopaedic Surgeons to provide certifications to standardised CoE. Key tenets for CoE • **Creating value** - highest quality care at lowest cost is the overarching goal of CoE in ambulatory spinal care (is the confluence of safety, institutional processes, patient satisfaction and outcome measures, overall cost to patient, payer and society) • **Centralization of organization** - "one-stop shop" (integration of a variety of specialists under the umbrella of one hospital system gives CoE the ability to treat conditions that may complicate or arise from patient's episode of care)	Not reported	Accreditation Association for Ambulatory Health Care have provided a set of criteria for certification as an ambulatory orthopaedic surgery CoE

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1st Author	Country / Region	PROCESSES DESCRIBED		
		Criteria described	Processes used to establish a CoCE	Processes to monitor a CoCE
		• **Multidisciplinary team building and protocol creation** (utilization of multidisciplinary meetings geared at creating value and improving outcomes by carefully scrutinizing patient treatment plans)		
Shikora, Delegge and Van Way III[40]	USA	Criteria that was described were used for BSCoE and to be adapted by NSCoE • Surgeon Specific Criteria to ensure surgeons have obtained the experience and training necessary to perform the appropriate surgical procedure • Institute Specific Criteria to ensure that the facility is committed to the program	Based on BSCoE • Online application completed by surgeon or facility • Successful application results in provisional status • Within 2 years must seek full approval and pass on-site inspection and indicates has excellent outcome • Mandatory submission of all patient data to a database	Recertification is required every 3 years and includes an online application followed by a site visit.
Shommu et al[41]	Canada	Essential criteria of CoE that were divided into short (1-3 years) and long terms (>5 years) goals/ activities specific to IBD • Excellence in Clinical Care • Novel Discovery and Research	Not reported	Not reported

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1st Author	Country / Region	PROCESSES DESCRIBED		
		Criteria described	Processes used to establish a CoCE	Processes to monitor a CoCE
		• Knowledge translatio		
Silver et al [42]	USA	Suggested Criteria • Multidisciplinary team • Intensive care unit and facilities • Blood services – blood bank with 24/7 service	Not reported	Not reported
Steiner et al[43]	USA	Suggested standards • Competence of staff - staffed by headache specialists • Provision of care – management of headache • Quality and evolution and assurance - monitors quality of care • Networks and collaborations - maintains quality of endeavour through networking, collaboration and the sharing of experience with other international and/or national centres. • Teaching - principal resource for national postgraduate training • Research - useful research output in the field of headache • Empirical support of existence	Agencies with appropriate competence and authority might use these standards as a basis for centre accreditation.	Not reported
Tapela et al[44]	Rwanda	Key attributes that made it possible • Meaning full partnership emphasising health systems strengthening • Innovative task and infrastructure shifting • Strong RMOH leadership coordinating efforts to embed services with the public sector • An equity-driven agenda to serve those most in need	Not reported	Not reported
Thomas et al[45]	USA	Not reported	Appears self-nominated	Outcome-based – site-specific patient outcomes (not benchmarked to other services)
Vivian et al[46]	USA	Objectives	Process outlined.	Not reported

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1st Author	Country / Region	PROCESSES DESCRIBED		
		Criteria described	Processes used to establish a CoCE	Processes to monitor a CoCE
		• Provide the highest standard of care, services and support to each patient • Communicate process improvements and data to key stakeholders in the pancreas domain • Analyse barriers and data to create better clinical pathways and care maps • Identify best practice guidelines and use them in our pancreas population • Identify quality and utilisation metrics used to analyse physician practices	• Establishing the foundation (leadership structure and purpose) • Formalising the program (clinical education training, MDT involvement) • Solidifying the CoE status (certification/accreditation by external institute)	
Williams[47]	USA	Key components of an HCM centre include. • HCM multi-disciplinary team and an administrative HCM coordinator. • Administrative support for marketing and programmatic development.	A centre must meet various criteria set forth by the NCI both in terms of clinical expertise and research capabilities	Not reported
Wirth et al[48]	Europe (Barcelona)	Criteria with specific requirements are outlined in the study • Core team • Associated services • Multi-disciplinary team • Diagnostic pathway • Therapeutic pathway	When an institution successfully achieves all the steps, it will be certified as an EPCCE.	The certification will be reviewed every 3 years, The accreditation team will be prespecified, and it will be composed of seven members of the EPCCCM.
Wu et al[49]	USA	The BDC+ program encompasses quality criteria on structure, process, and outcomes and cost criteria A cost threshold was set at 1.05 times the national average cost of surgery. Facilities that met predetermined clinical requirements and had	Not reported	Facilities receiving a value designation were associated with lower costs (16-19% lower) and equal or better quality outcomes, compared with all other facilities.

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1st Author	Country / Region	PROCESSES DESCRIBED		
		Criteria described	Processes used to establish a CoCE	Processes to monitor a CoCE
		spine surgery costs below the threshold received the value designated BDC+ designation.		
Yao and Zhou[50]	China	Not reported	Mentee sites were selected based on • Using drop-out rate and time on therapy • Willingness to improve PD outcomes. • Mentor sites were selected based on • PD clinical outcome • Willingness to participate in the program	Continuous quality improvement in managing PD centre. Volume of patients.

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