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Impact of nurse-surgeons on patient-centred outcomes: A systematic review

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ABSTRACT

Background: Nurse-surgeons have been performing surgeries for decades. Yet, their impact on perioperative clinical outcomes has not been explored in detail.
Objective: To investigate the impact of nurse-surgeons on patient-centred outcomes.
Design: Systematic review
Method: The Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram and checklist for systematic reviews were used as the screening and reporting guideline. CINAHL, Cochrane Library, MEDLINE, and PubMed databases were searched for articles that fit the review's eligibility criteria. A combination of Medical Subject Headings, keywords and filters for each database were used. Following screening and full text review, the Mixed Methods Appraisal Tool was used for quality assessment and the Grading of Recommendations, Assessment, Development and Evaluations framework for certainty and confidence assessment. Narrative synthesis was used to report the findings due to the design heterogeneity of the included studies.
Results: Forty-eight ($n = 48$) patient-centred outcomes were identified from 25 included studies. These outcomes were grouped into four categories: patient satisfaction and experience; waiting list; perioperative complications; and quality of surgical care. Patient satisfaction and experience was rated high to very high in 16 studies; none reported patient dissatisfaction. Waiting lists improved in eight studies. Perioperative complications were none to very low in nine studies. Mortality rates in the nurse-surgeon group were better than the physician group in three studies. The quality of care in the performance of surgeries by nurse-surgeons was either similar or better than physicians in ten studies.
Conclusions: Nurse-surgeons performed safe, satisfactory, and high-quality surgeries with minimal perioperative complications similar to physicians. The use of nurse-surgeons has significantly reduced waiting lists regardless of surgical speciality. Policies around nurse-surgeon practice needs to be developed at national and international levels to streamline the delivery of much needed surgical services amidst the coronavirus pandemic in the areas of cancer diagnostic surgeries, emergency surgeries, minor surgeries, and remote and rural health.

What is already known?

1. Nurse-surgeons have been performing surgeries worldwide for at least 70 years.

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2. Nurse-surgeons are effective in cancer diagnostic surgeries, emergency surgeries, minor surgeries, and rural and remote health.

What this paper adds

1. Nurse-performed surgeries result in positive patient-centred outcomes including high to very high patient satisfaction, significant reduction in the surgical waiting list times, minimal or similar perioperative complications to physician-performed surgeries, and similar or better quality of surgical care than physician-performed surgeries.

2. Surgical specialties of nurse-surgeons include urology, paediatric urology, gastroenterology, ophthalmology, oncology, obstetrics, gynaecology, otolaryngology, vascular, dermatology, cardiothoracic, orthopaedics, hand, trauma, neurosurgery, and general surgery.

3. There is a clear need to develop policies to regulate nurse-surgeons as a way to expand and sustain the currently overburdened surgical workforce.

1. Background

Access to surgery was a problem faced by an estimated five billion people worldwide in 2015 (Alkire et al., 2015). Of these five billion people, at least 18 million were reported to die annually from conditions that could have been treated by surgery (Reddy et al., 2020). Low to middle-income countries typically represent the majority of these mortality estimates (Bath et al., 2019) which illustrates the stark disparity in surgical care between the poor and more developed nations. However, this changed dramatically from the outset of the coronavirus pandemic in late 2019 (Wiersinga et al., 2020). Many high-income countries are now struggling to provide surgical care with millions of patients in their surgical backlogs due to the coronavirus lockdown restrictions (Carr et al., 2021; COVIDSurg Collaborative, 2020). The billions of people in low to middle-income countries, and the millions in high-income countries requiring surgery, and the adverse patient outcomes that ensued from the delays in surgery are reasons enough to consider surgical care as a priority public health issue.

Surgical care is a critical component of universal health coverage (World Health Organisation, 2014) and with the harrowing effects of the coronavirus pandemic placing the less developed nations on heightened adversity and the developed nations on serious setbacks, finding a viable innovation in the delivery of surgical services is paramount. One such candidate that has been holding promise for more than 70 years is the utilisation of nurse-surgeons (White et al., 1987).

Nurse-surgeons can be defined as nurses who perform surgeries autonomously (Grota et al., 2021; White et al., 1987). Other terms to describe this role include nurse endoscopist, nurse cystoscopist, nurse hysteroscopist, nurse biopsy, physican extender, nurse practitioner, clinical nurse specialist, perioperative specialist practitioner, and surgical care practitioner (Grota et al., 2021). These nurses emerged from the desperate need of many health systems to resolve their ballooning surgical waitlists amidst the ongoing chronic shortage and maldistribution of surgeons (Holmer et al., 2015). Recently, many first world countries have also enacted legislations to restrict the unhealthy and unreasonable hours worked by junior physicians to avoid burnout and permanent attrition in the medical workforce (Campaner, 2019). This resulted in major gaps that further aggravated surgical capacities particularly in the areas of diagnostic and cancer surgeries. Nurse-surgeons have been filling these gaps for decades.

A historical overview of the term “nurse-surgeon” dates back to the early 16th century when King Henry VIII appointed a nurse-surgeon named William Bullein (Duffin, 2017). Bullein was instrumental in the treatment of pleurisy and the “English sweating sickness” – an epidemic that killed thousands in 1517 (Furdell, 2001). The term “nurse-surgeon” has further been used to describe nurses who performed surgeries in the 1950s when African nurses were trained by an American surgeon to undertake caesarean sections, supracervical hysterectomies, and laparotomies (White et al., 1987). Three decades later, in 1983, two Stanford University physicians wrote an article entitled “Nurse Surgeons: A New Role for Nurses” where they proposed the introduction of Certified Registered Nurse Surgeon in the United States to undertake minor surgical procedures on the written order of a licensed physician (Litt and Brodsky, 1983). In 2007, the term “nurse surgeon” was used to exemplify the rapidly changing surgical practices in Europe (Mitchell, 2007; Zorn, 2005). By 2009, nurse surgeons were recognised as qualified non-medical surgeons who can practice surgery within the public health system of the United Kingdom (Mickute, 2009).

In the last decade, nurse-surgeons have been reported to perform major and minor general, vascular, orthopaedic, ophthalmological, urological, colorectal, and gynaecological surgeries (Eddy and Duffy, 2019; Judd, 2013; Marsh, 2005; Wise, 2021). These surgeries include caesarean section, lapatoromy, appendicectomy, herniorrhaphy, endoscopy, hysteroscopy, cystoscopy, biopsy, and carpal tunnel release (Grota et al., 2021; Kingsnorth, 2005). Nurse-surgeons are now employed in many countries in Europe, Africa, Asia, and North America (Grota et al., 2021; Kowalewski and Jahn, 2001; Zorn, 2005).

A 2021 study led to an understanding that the contributions of nurse-surgeons in many health systems worldwide have been positive particularly in the areas of cancer diagnostic surgeries, emergency surgeries, minor surgeries, and remote and rural health (Grota et al., 2021). Additionally, Johal and Dodd (2017); Salibian et al. (2016) and Joseph et al. (2015) described the roles and positive contributions of nurse-surgeons in many surgical specialties. However, due to the fragmentation of research data from the ambiguous nursing titles, confusing nurse-surgeon origins and timelines ensued. Therefore, a more targeted research approach should be taken to explore nurse-led surgery. “Nurse-surgeon” as an all-encompassing terminology should be utilised to encapsulate this

emerging and timely advanced nursing practice. To date, no studies have been conducted to investigate the contributions of "nurse-surgeons" in clinical outcomes. Therefore, a gap in literature exists particularly in the exploration of nurse-surgeons' impact on patient-centred outcomes – a specific set of clinical outcomes that is both "meaningful and important to patients and caregivers" (Frank et al., 2014, p. 1513).

Extant research around patient-centred outcomes recognises the importance of including end-user perspectives, such as healthcare workers and patients themselves, to enhance the quality of research and the applicability of research outcomes to decision-making, and ultimately improve the likelihood that patients achieve their desired health outcomes (Frank et al., 2014). In recognition of its importance, significant investment in the development and validation of patient-centred outcomes occurred across the many healthcare disciplines (Algurén et al., 2020; Gambling and Long, 2019; Riordain et al., 2021). Nurse-surgeons can contribute substantially to the development of patient-centred care research and exploring the impact nurse-surgeons have on patient-centred outcomes is one facet of this. In agreement with the importance of including the perspectives of patients and health providers in making relevant decisions around surgical care, the authors selected patient-centred outcomes as the group of clinical outcomes to be investigated in this review. Ergo, the aim of this systematic review is to investigate the impact of nurse-surgeons on patient-centred outcomes.

2. Methods

The Preferred Reporting Items for Systematic Reviews and Meta-analyses statement checklist (Page et al., 2021) was the reporting guideline used for this systematic review.

2.1. Definition of terms

For clarity and consistency, the authors have provided a list of terminologies below which were defined based on contemporary literature.

2.1.1. Access to surgery (variants – surgical access, patient access to surgery, patient access, access)

noun: a measure of "surgical capacity, safety, timeliness, and affordability" (Alkire et al., 2015, p. e316) in a given health system.

2.1.2. Global surgery

noun: a "rapidly developing multidisciplinary field aiming to provide improved and equitable surgical care across international health systems" (Bath et al., 2019, p. 1).

2.1.3. Surgery

noun: the authors adapted the World Health Organisation definition of surgery as any invasive procedure that is performed aseptically, and usually with the use of appropriate anaesthesia, by trained surgeons, other physicians, nurses, and other non-physicians to investigate and/or treat surgical conditions (Debas et al., 2006).

2.1.4. Waiting list (variants – waitlist, waiting times)

noun: a queue for patients requiring specific health services which indicates "excess demand over supply, unmet needs, and inadequate resources" (Amoko et al., 1992, p. 18).

2.1.5. Perioperative

adjective: "the days and weeks immediately preceding and following a surgical intervention" (McQueen et al., 2015, p. 265). It is divided into three stages, which are "preoperative (from the decision to operate to entry into the theatre suite), intraoperative (from entry into the theatre suite to leaving the recovery area), and postoperative (following transfer from the recovery area)" (Chazapis et al., 2018, p. 52 and 55)

2.2. Eligibility criteria

A set of eligibility criteria (Aromataris and Munn, 2020) was developed by the authors for this review (see Supplementary material 1), using the Population Intervention Comparison Outcome framework (Schiavenato and Chu, 2021). The population was patients undergoing surgery, and the intervention was nurse-surgeon, regardless of title or surgical speciality. The comparison was standard surgery performed by physicians, and the outcome measure was patient-centred outcomes. Settings included, but were not limited to, perioperative department, operating room, operating theatre, day surgery unit, outpatient clinic, community clinic, endoscopy unit, catheterisation laboratory or interventional radiology, and nurse-led surgical service or clinic. Articles included were quantitative, qualitative, mixed methods, and dissertation studies published in the English language without any date restrictions. Search dates were not restricted to include all data on nurse-surgeons. Grey literature and non-research papers such as systematic reviews, editorials, letters to the editor and opinions were excluded. Any surgical assisting roles were also excluded as they do not perform surgeries independently.

2.3. Search strategy

A search strategy (Aromataris and Munn, 2020) was developed by the authors and the search initiated in September 2021. A combination of Medical Subject Headings, keywords and filters for each database were used (see Supplementary material 2). Given the relatively limited use of nurse-surgeons in published research, the authors used terms that are similar to the term "nurse-surgeon". These include nurs*, nurse-led, nurse-led surg*, theatre nurs*, operating room nurs*, nurse practitioner, perioperative nurs*, surgical nurs*, nurse endoscopist, nurse hysteroscopist, nurse colonoscopist, nurse cystoscopist, perioperative specialist practitioner. The sources of information were CINAHL, Cochrane Library, MEDLINE, PubMed, and handsearching.

2.4. Selection process

The retrieved articles from the electronic databases and handsearching were imported to the online application called Covidence® to streamline the stages of the systematic review (Covidence, 2021). This application was also utilised as the automation tool for detecting any duplicate studies. One author (TG) conducted the initial title and abstract screening of all the articles. Two of four authors (TG, VB, AB, EJ) reviewed the articles for full text eligibility. Disagreements were resolved by discussion or a third reviewer (one of VB, AB, EJ) where necessary. Immediately prior to quality assessment, another layer of screening was conducted by one author (TG) to ensure that the articles fit the World Health Organisation definition of surgery (see Definition of terms), which was an eligibility criterion of this review.

2.5. Quality assessment

The Mixed Methods Appraisal Tool (Hong et al., 2018) was used to assess the quality of each study. Each remaining article that passed the full text screening was critically appraised by two of four authors (TG, VB, AB, EJ) in Covidence® (2021). The tool was also used as an inclusion criterion wherein two of the four authors (TG, VB, AB, EJ) decided to include or exclude the studies based on the screening questions of the tool. Consensus was required to complete the quality assessment and inclusion of each article. Disagreements were resolved by discussion, or a third reviewer (one of VB, AB, EJ) where necessary.

2.6. Certainty assessment

Certainty assessment was conducted in accordance with item 15 of the 2020 reporting checklist by the Preferred Reporting Items for Systematic Reviews and Meta-analyses (Page et al., 2021). While quality assessment is necessary to appraise the quality of each included article (Hong et al., 2018), certainty assessment is equally important to measure the confidence in these included articles when they are amalgamated for the purpose of answering the four specified outcomes of this review (Schünemann et al., 2013). The authors have rated patient satisfaction and experience as the critical outcomes of this review. Waiting list, postoperative complications and quality of perioperative care were rated as the important outcomes of this review.

The Grading of Recommendations, Assessment, Development and Evaluations framework was used to assess the certainty of evidence available in this review and consequently, provide a strength of recommendation in line with the result of the certainty assessment (Schünemann et al., 2013). The GRADEpro® automated software (GRADE Working Group, 2020) was used to tabulate the results of the Grading of Recommendations, Assessment, Development and Evaluations certainty assessment (Schünemann et al., 2013). Certainty assessment was done by one author (TG), which was then evaluated by a second author (one of VB, AB, EJ). Disagreements were resolved by discussion or a third reviewer (one of VB, AB, EJ) where necessary.

2.7. Data extraction and synthesis

The included studies were extracted for the following data: author/s; publication year; country; study design; aim; setting; participant; inclusion and exclusion criteria; method of participant recruitment; surgical speciality; number and type of surgeries performed by nurse-surgeons; patient-orientated outcomes; findings; peer review; and conflict of interest. Data extraction was performed by two of four authors (TG, AB, VB, EJ) in Covidence® (2021). Disagreements were resolved by discussion or a third reviewer (one of VB, AB, EJ) where necessary. The final extracted data was exported from Covidence® (2021) as a comma-separated values file and converted into an excel spreadsheet. Considering the heterogeneity in the design and characteristics of the included studies, meta-analysis was not possible (Deeks et al., 2021; Ryan and Cochrane Consumers and Communication Review Group, 2013). Therefore, all authors agreed upon narrative synthesis as the most suitable approach in reporting the findings of this review (Ryan and Cochrane Consumers and Communication Review Group, 2013). One author (TG) synthesised the final extracted data from Covidence® (2021). This was then evaluated en masse by the three remaining authors (VB, AB, EJ) throughout the extraction and synthesis stages of this review.

3. Results

3.1. Search results

Fig. 1 illustrates the search results using the Preferred Reporting Items for Systematic Reviews and Meta-analyses flow diagram (Page et al., 2021). Initial searches yielded 5878 results. Upon importation to Covidence® (2021), the application found 2026

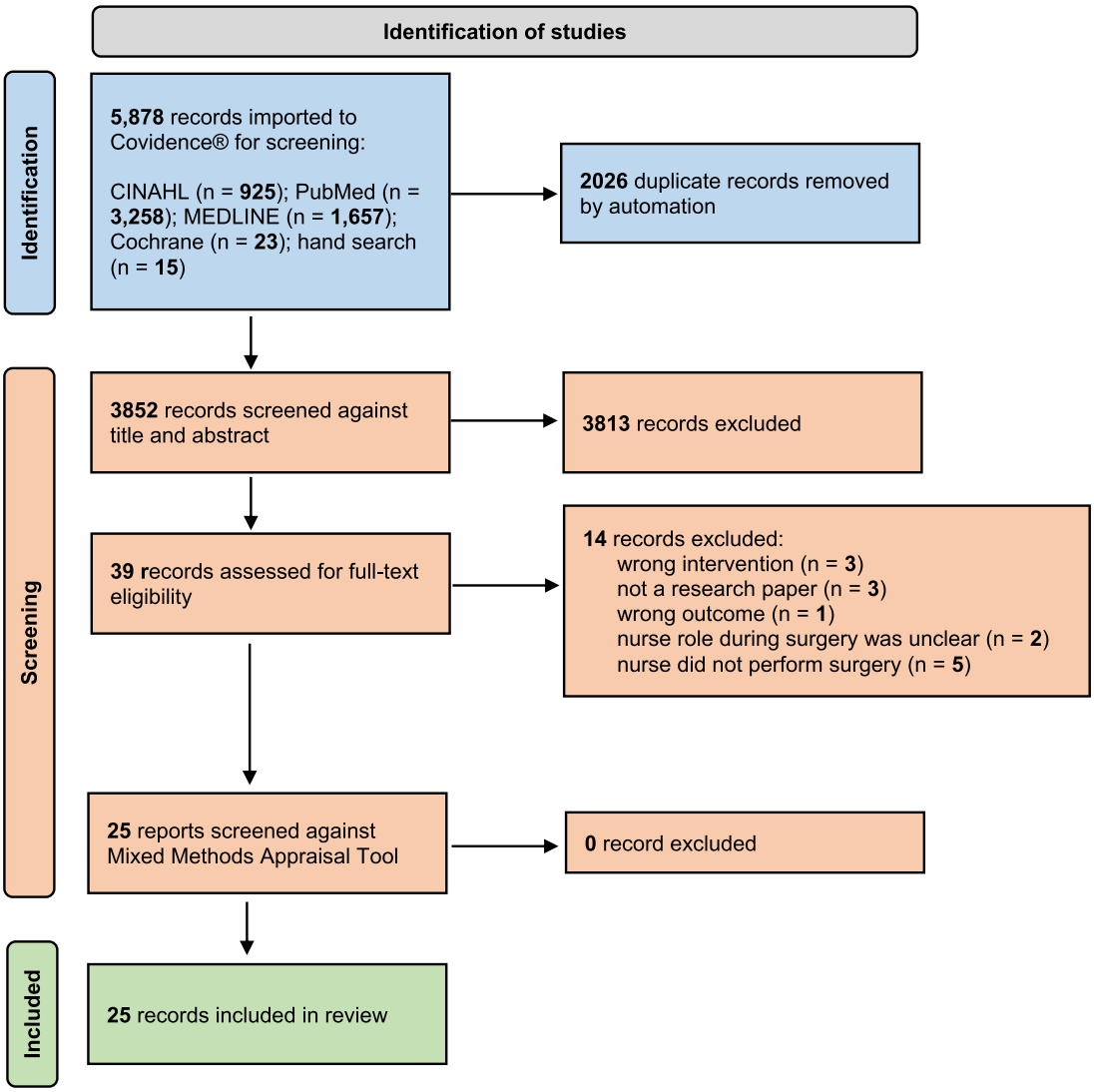

Fig. 1. . Preferred reporting items for systematic reviews and meta-analyses flow diagram.

duplicates which were immediately removed. The remaining 3852 studies were screened against titles and abstracts. A total of 3813 studies were excluded on title and abstract review. The remaining 39 studies were assessed for full-text eligibility (see Supplementary material 3). Following full text review, 14 articles were excluded due to the following reasons: wrong intervention (Alexandrou et al., 2014; Currie et al., 2004; Rochester et al., 2008); not a research paper (Pearce, 2013; Spencer and Winkels, 1978; Yalamanchi et al., 2021); wrong outcome (Grose et al., 1995); the role of the nurse during surgery was unclear (Beaulieu-Jones et al., 2020; Changole et al., 2010); and the nurse did not perform surgery (Beard et al., 2014; Moore, 2018; Pandian et al., 2011; Van Calster et al., 2019; Wagonfeld and Murphy, 2006). Twenty-five articles (Bodle et al., 2008; Bolme et al., 2020; Chan et al., 2020; Collins, 2010; Chu et al., 2011; Duncan et al., 2017; Gallagher, 2017; Giramonti and Kogan, 2018; Godsell, 2005; Hickey and Cooper, 2009; Hui et al., 2015; James and McPhail, 2008; Jejeebhoy et al., 2011; Kelly et al., 2008; Laker-Oketta et al., 2015; Lawson et al., 1999; Malata, 2018; Martin, 2002; Michelotti et al., 2014; Newey et al., 2006; Palmquist, 2010; Sapre et al., 2012; Sturgess et al., 1996; White et al., 1987; Williams et al., 2020) remained for quality assessment. Immediately, prior to quality assessment, the 25 articles were screened against the parameters of surgery as defined by the World Health Organisation (see Supplementary material 4); none of the 25 articles were removed.

3.2. *Result of quality and certainty assessment*

Twenty-five studies remained for quality assessment in Covidence® (2021) as shown in Table 1. The designs of the 25 studies were quantitative randomised controlled trials (Bolme et al., 2020; Hui et al., 2015), quantitative non-randomised controlled trials (Bodle

Table 1
Quality assessment.

Author, year	Reviewer	Overall appraisal	Category of study design																						
			1. Qualitative					2. Quantitative RCT					3. Quantitative non-RCT					4. Quantitative descriptive					5. Mixed methods				
			1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	4.4	4.5	5.1	5.2	5.3	5.4	5.5
Malata (2018)	TG, AB	Include																Y	Y	Y	C	Y					
Jejeebhoy et al. (2011)	TG, AB	Include											Y	Y	Y	C	Y										
Chan et al. (2020)	TG, AB	Include																Y	Y	Y	Y	Y					
Duncan et al. (2017)	TG, AB	Include																Y	Y	Y	C	Y					
Gallagher (2017)	TG, AB	Include																Y	Y	Y	C	Y					
Hickey and Cooper (2009)	TG, AB	Include																Y	Y	C	Y	C					
James and McPhail (2008)	TG, AB	Include																Y	Y	Y	C	Y					
Martin (2002)	TG, AB	Include																Y	Y	Y	C	C					
Giramonti and Kogan (2018)	TG, EJ	Include											Y	Y	Y	C	Y										
Michelotti et al. (2014)	TG, EJ	Include																Y	Y	Y	Y	Y					
Lawson et al. (1999)	TG, EJ	Include																Y	Y	Y	Y	Y					
Bolme et al. (2020)	TG, EJ	Include						Y	Y	Y	C	Y															
Laker-Oketta et al. (2015)	TG, EJ	Include											Y	Y	Y	Y	Y										
Chu et al. (2011)	TG, EJ	Include																Y	Y	Y	N	Y					
Sturgess et al. (1996)	TG, EJ	Include																Y	Y	Y	Y	Y					
Sapre et al. (2012)	TG, EJ	Include																Y	Y	Y	Y	Y					
Palmquist (2010)	TG, EJ	Include																Y	Y	Y	Y	Y					
Bodle et al. (2008)	TG, VB	Include											Y	Y	C	Y	Y										
Kelly et al. (2008)	TG, VB	Include											Y	Y	Y	Y	Y										
	TG, VB	Include											Y	Y	C	C	Y										

(*continued on next page*)

Table 1 (*continued*)

Author, year	Reviewer	Overall appraisal	Category of study design																						
			1. Qualitative					2. Quantitative RCT					3. Quantitative non-RCT					4. Quantitative descriptive					5. Mixed methods				
			1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	4.4	4.5	5.1	5.2	5.3	5.4	5.5
White et al. (1987)																											
Hui et al. (2015)	TG, VB	Include						Y	Y	N	N	Y															
Collins (2010)	TG, VB	Include																Y	Y	Y	Y	Y					
Godsell (2005)	TG, VB	Include																Y	Y	Y	Y	Y					
Williams et al. (2020)	TG, VB	Include											Y	Y	Y	Y	Y										
Newey et al. (2006)	TG, VB	Include											Y	Y	Y	C	Y										

Y – yes, **N** – no, **C** – can't tell, **RCT** – randomised controlled trial.

1.1. Is the qualitative approach appropriate to answer the research question? **1.2.** Are the qualitative data collection methods adequate to address the research question? **1.3.** Are the findings adequately derived from the data? **1.4.** Is the interpretation of results sufficiently substantiated by data? **1.5.** Is there coherence between qualitative data sources, collection, analysis, and interpretation? **2.1.** Is randomization appropriately performed? **2.2.** Are the groups comparable at baseline? **2.3.** Are there complete outcome data? **2.4.** Are outcome assessors blinded to the intervention provided? **2.5.** Did the participants adhere to the assigned intervention? **3.1.** Are the participants representative of the target population? **3.2.** Are measurements appropriate regarding both the outcome and intervention (or exposure)? **3.3.** Are there complete outcome data? **3.4.** Are the confounders accounted for in the design and analysis? **3.5.** During the study period, is the intervention administered (or exposure occurred) as intended? **4.1.** Is the sampling strategy relevant to address the research question? **4.2.** Is the sample representative of the target population? **4.3.** Are the measurements appropriate? **4.4.** Is the risk of nonresponse bias low? **4.5.** Is the statistical analysis appropriate to answer the research question? **5.1.** Is there an adequate rationale for using a mixed methods design to address the research question? **5.2.** Are the different components of the study effectively integrated to answer the research question? **5.3.** Are the outputs of the integration of qualitative and quantitative components adequately interpreted? **5.4.** Are divergences and inconsistencies between quantitative and qualitative results adequately addressed? **5.5.** Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?.

et al., 2008; Giramonti and Kogan, 2018; Jejeebhoy et al., 2011; Kelly et al., 2008; Laker-Oketta et al., 2015; Newey et al., 2006; White et al., 1987; Williams et al., 2020), and quantitative descriptive (Chan et al., 2020; Collins, 2010; Chu et al., 2011; Duncan et al., 2017; Gallagher, 2017; Godsell, 2005; Hickey and Cooper, 2009; James and McPhail, 2008; Lawson et al., 1999; Malata, 2018; Martin, 2002; Michelotti et al., 2014; Palmquist, 2010; Sapre et al., 2012; Sturgess et al., 1996). The authors of this review did not calculate an overall score for each study. This decision was based on the recommendation provided in the Mixed Methods Appraisal Tool (Hong et al., 2018).

3.2.1. Quality of the quantitative randomised controlled trials

Of the two quantitative randomised controlled trials (Bolme et al., 2020; Hui et al., 2015), both were randomised appropriately with comparable groups at baseline and participants that were adherent to their assigned intervention. One study (Bolme et al., 2020) presented a complete outcome data while the other (Hui et al., 2015) had incomplete outcome data from the 787 study participants. Blinding of the outcome assessors in both studies was either omitted or unclear.

3.2.2. Quality of the quantitative non-randomised controlled trials

Eight (Bodle et al., 2008; Giramonti and Kogan, 2018; Jejeebhoy et al., 2011; Kelly et al., 2008; Laker-Oketta et al., 2015; Newey et al., 2006; White et al., 1987; Williams et al., 2020) of the included studies were quantitative non-randomised controlled trials. All had participants that represented the target population. All had appropriate measurements regarding the study outcomes and interventions. Six (Giramonti and Kogan, 2018; Jejeebhoy et al., 2011; Kelly et al., 2008; Laker-Oketta et al., 2015; Newey et al., 2006; Williams et al., 2020) of the eight studies had complete outcome data; the other two (Bodle et al., 2008; White et al., 1987) were unclear. Four (Bodle et al., 2008; Kelly et al., 2008; Laker-Oketta et al., 2015; Williams et al., 2020) of the eight studies described the confounders in the study design and analysis; the other four (Giramonti and Kogan, 2018; Jejeebhoy et al., 2011; Newey et al., 2006; White et al., 1987) did not. All had interventions administered or outcomes occurred as intended during the study period.

3.2.3. Quality of the quantitative descriptive studies

Fifteen (Chan et al., 2020; Collins, 2010; Chu et al., 2011; Duncan et al., 2017; Gallagher, 2017; Godsell, 2005; Hickey and Cooper, 2009; James and McPhail, 2008; Lawson et al., 1999; Malata, 2018; Martin, 2002; Michelotti et al., 2014; Palmquist, 2010; Sapre et al., 2012; Sturgess et al., 1996) of the included studies were quantitative descriptive. All had relevant sampling strategies that addressed the study research question. All had samples that represented the target population. Fourteen of the 15 studies had appropriate study measurements (Chan et al., 2020; Collins, 2010; Chu et al., 2011; Duncan et al., 2017; Gallagher, 2017; Godsell, 2005; Hickey and Cooper, 2009; James and McPhail, 2008; Lawson et al., 1999; Malata, 2018; Martin, 2002; Michelotti et al., 2014; Palmquist, 2010; Sapre et al., 2012; Sturgess et al., 1996); one was unclear (Hickey and Cooper, 2009). Nine of the 15 studies had low nonresponse risk of bias (Chan et al., 2020; Collins, 2010; Godsell, 2005; Hickey and Cooper, 2009; Lawson et al., 1999; Michelotti et al., 2014; Palmquist, 2010; Sapre et al., 2012; Sturgess et al., 1996), five were unknown (Duncan et al., 2017; Gallagher, 2017; James and McPhail, 2008; Malata, 2018; Martin, 2002) and the remaining one (Chu et al., 2011) had a high nonresponse risk of bias. Thirteen of the 15 studies were deemed to have appropriate statistical analysis methods to answer the study research question (Chan et al., 2020; Collins, 2010; Chu et al., 2011; Duncan et al., 2017; Gallagher, 2017; Godsell, 2005; James and McPhail, 2008; Lawson et al., 1999; Malata, 2018; Michelotti et al., 2014; Palmquist, 2010; Sapre et al., 2012; Sturgess et al., 1996); the remaining two were unclear (Hickey and Cooper, 2009; Martin, 2002).

The overall outcome of the appraisal of all 25 studies using the Mixed Methods Appraisal Tool (Hong et al., 2018) were “include”. No studies were excluded due to low methodological quality as recommended by Hong et al. (2018). A final sample of 25 articles was included for certainty assessment, data extraction, and data synthesis.

3.3. Certainty assessment

The results of the certainty assessment are outlined in Table 2, which was downloaded from the GRADEpro® software (GRADE Working Group, 2020). The table was based on the Grading of Recommendations, Assessment, Development and Evaluations framework (Schünemann et al., 2013), which has four levels of certainty. Very low or a score of 1 means very little certainty in the available evidence. Low or a score of 2 means limited certainty in the available evidence. Moderate or a score of 3 means moderate confidence in the available evidence. High or a score of 4 means strong confidence in the available evidence.

Using the Grading of Recommendations, Assessment, Development and Evaluations approach (Schünemann et al., 2013) and the assessment scoring generated by the GRADEpro® software (GRADE Working Group, 2020), the authors’ confidence in the body of evidence available in this review for the critical and important outcomes are the following: moderate or a score of 3 for patient satisfaction and experience; low or a score of 2 for waiting list; moderate for postoperative complications; and moderate for quality of perioperative patient care. The primary factor in this decision was the lack of studies with randomised controlled trial design. Of the 25 included studies, only two were randomised controlled trials (Bolme et al., 2020; Hui et al., 2015). This markedly downgraded the level of certainty in each critical or important outcome despite the risk of bias, inconsistency, indirectness, and imprecision being generally negligible across the included studies.

3.4. Study characteristics

Table 3 outlines the characteristics of the included studies. The majority of studies were conducted in the United Kingdom (Bodle

Table 2
GRADEpro® certainty assessment (narrative table).

Certainty assessment							Narrative description	Certainty	Importance
No of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations			
Patient satisfaction and experience									
16	Mixed (1 RCT, 4 quantitative non-RCT, 11 quantitative descriptive)	not serious	not serious	not serious	not serious	publication bias strongly suspected all plausible residual confounding would reduce the demonstrated effect[a]	All studies reported high to very high patient satisfaction to surgeries performed by nurse-surgeons. None reported dissatisfaction to nurse-performed surgeries. All studies reported positive patient experience with the nurse-surgeons. None reported any negative experience with the nurse-surgeons.	⨁⨁⨁◯ Moderate	CRITICAL
Waiting list									
9	Mixed (2 quantitative non-RCT, 7 quantitative descriptive)	not serious	not serious	not serious	not serious	publication bias strongly suspected all plausible residual confounding would reduce the demonstrated effect[a]	All studies reported an improvement in the waiting list through reduction of patient waiting time to have their surgery.	⨁⨁◯◯ Low	IMPORTANT
Perioperative complications									
14	Mixed (2 RCT, 5 quantitative non-RCT, 7 quantitative descriptive)	not serious	not serious	not serious	not serious	publication bias strongly suspected all plausible residual confounding would reduce the demonstrated effect[a]	Perioperative complications were reported as adverse events in 6 studies, mortality rate in 4 studies, complication rates in 3 studies, and length of stay pre and postoperatively in 1 study. All studies indicated low or rare occurrence of adverse events.	⨁⨁⨁◯ Moderate	IMPORTANT
Quality of surgical care									
10	Mixed (2 RCT, 2 quantitative non-RCT, 6 quantitative descriptive)	not serious	not serious	not serious	not serious	publication bias strongly suspected all plausible residual confounding would reduce the demonstrated effect[a]	All studies reported that the quality of surgical care was either maintained or improved.	⨁⨁⨁◯ Moderate	IMPORTANT

RCT – randomised controlled trial.
Certainty rating.
⨁◯◯◯ very low – the true effect is probably markedly different from the estimated effect.
⨁⨁◯◯ low – the true effect might be markedly different from the estimated effect.
⨁⨁⨁◯ moderate – The authors believe that the true effect is probably close to the estimated effect.
⨁⨁⨁⨁ high – The authors have a lot of confidence that the true effect is similar to the estimated effect.
Explanations.
[a] Not reported or unclear.

Table 3
Characteristics of included studies.

Author, year	Study design/aim	Participant details, study dates (clinical setting)	Inclusion and exclusion criteria	Surgical speciality	Patient-orientated outcome	Findings	Peer review/ conflict of interest/funding sources
Bodle et al. (2008), United Kingdom	Quantitative non-RCT/to investigate the effect of the introduction of nurse hysteroscopists on patient satisfaction at an outpatient hysteroscopy clinic in the United Kingdom	139 and 102 females who underwent hysteroscopy in 2000 and 2005, respectively (University Teaching Hospital)	Inclusion: Consecutive patients were approached to complete an anonymous structured questionnaire after their hysteroscopy during the two 6-month periods in 2000 and 2005. Exclusion not stated	Gynaecology	Waiting times; Communication; Professional skills/ intervention; overall satisfaction	1. Waiting time 1.1. Median appointment waiting time fell from 8 ± 6 weeks in 2000 to 2 ± 2 weeks in 2005 ($p < 0.001$)/ 1.2. Median time waiting in the clinic decreased from 10 ± 30 min in 2000 to 2 ± 10 min in 2005 ($p = 0.005$)/1.3. Patient satisfaction with appointment waiting time increased from 64.3% in 2000 to 87.3% in 2005 ($p < 0.001$) 2. Overall satisfaction with the clinic was 94% in 2000 compared with 95% in 2005	Yes/not stated/ not stated
Bolme et al. (2020), Norway	Quantitative randomised controlled trial/to test if task shifting of intraocular injections to nurses in a real-world setting can result in similar visual function outcome with equal safety profile.	342 patients receiving anti-vascular endothelial growth factor, March – May 2016 (Tertiary ophthalmology department)	Inclusion: having either age related macular degeneration, retinal vein occlusion or diabetic macular oedema eligible for anti-vascular endothelial growth factor treatment. Both treatment-naive patients and patients earlier treated with anti- vascular endothelial growth factor. Exclusion: Not being able to give an informed consent	Ophthalmology	Primary - change in best-corrected visual acuity Secondary - adverse events, the number of intraocular injections, the length of intervals between injections and the success of masking	"Primary - Nurse-administered intraocular injections were noninferior to physician-administered injections with 0.7 and 1.6 letters gained, respectively (95% CI of the mean difference, 2.9 – 1.0; $p = 0.019$, one-sided *t*-test). Secondary - eleven participants died during the study period: 4 in the nurse and 7 in the physician-administered injection group. Ocular adverse events in three eyes of three different participants were registered in the nurse group. Six participants lost≥30 letters during the study and five of these belonged to the nurse-administered injection group	Not stated/none declared/Funded by St. Olavs Hospital, Trondheim, Norway
Chan et al. (2020), United States	Quantitative descriptive/ to provide an update on how Advanced Practice Providers impact healthcare delivery in the	36 paediatric otolaryngology hospital chiefs, July 2017 – July 2018 (Hospital-based paediatric otolaryngology)	Inclusion and exclusion criteria not stated	Otolaryngology	Improvement in patient care and patient access	Most academic paediatric otolaryngology chiefs found the Advanced Practice Provider model to be beneficial in improving patient care, patient access	Yes/none declared/not stated

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Table 3 (*continued*)

Author, year	Study design/aim	Participant details, study dates (clinical setting)	Inclusion and exclusion criteria	Surgical speciality	Patient-orientated outcome	Findings	Peer review/ conflict of interest/funding sources
	academic paediatric otolaryngology setting					and faculty productivity. Recognised AAP use as an opportunity for increased productivity, acknowledged onboarding processes and continuing medical education needed to support this	
Chu et al. (2011), Somalia	Quantitative descriptive/ to reduce mortality due to complications of pregnancy and childbirth and from violent and non-violent trauma.	1602 Somalian patients, October 2006 – December 2009 (Operating Room, Istarlin Hospital,)	Inclusion: Somalian patients who had surgeries grouped into the following categories: obstetric emergencies, infection, neoplasm, accidental injury, violence-related injury, and other. Exclusion not stated	Obstetrics	Perioperative mortality	Perioperative mortality was lower (0.2%, 2 cases) between 2008 and 2009 compared to 2006–2007 (1.7%, 6 cases), $P < 0.001$).	Yes/none declared/not stated
Collins (2010), United Kingdom	Quantitative descriptive/ to identify patients' experience of a bone marrow procedure performed by the lymphoma clinical nurse specialist, particularly in relation to the pain relief used and the quality of the samples obtained	The first 50 patients who required a bone marrow procedure after competency confirmation were included in the audit, February – July 2006 (Nurse-led bone marrow procedure clinic)	Inclusion: patients requiring bone marrow procedure. Exclusion not stated	Surgical oncology	Pain relief and patient satisfaction	38/50 responded to the questionnaire. Of the 38 who returned questionnaires, 37 (97 per cent) thought the staff had done everything they could to help with any pain or discomfort related to the procedure. All patients reported receiving the right amount of pain relief and $n = 37$ (97%) of patients reported receiving the right amount of information regarding pain relief."	Yes/not stated/ not stated
Duncan et al. (2017), Australia	Quantitative descriptive/ to explore Monash Health's experience with the introduction of a nurse endoscopist	40 patients requiring endoscopy, January – July 2013 (Hospital endoscopy unit)	Inclusion: Colonoscopy only, Category 1, 2, or 3 (National Bowel Cancer Screening Program - positive faecal occult blood test), Polyp recalls Surveillance -existing family history, patients younger than 80 years, no cancer follow-ups or colorectal resection follow-ups, low anaesthetic risk. Exclusion: Clinically complex patients, patient preferring a medical proceduralist	Gastroenterology	Patient experience and satisfaction, waiting list	80% of patients ($n = 32$) reported that overall, they had a very good experience with the nurse endoscopist trainee. A nurse endoscopist initiative can facilitate the expansion of endoscopy services to meet the growing need within the community. 80% of patients reported no pain or discomfort during the procedure, 95% of patients reported the personal manner of the Nurse Endoscopist trainee was very good or excellent, 80% of patients rated the	Yes/none declared/Health Workforce Australia & Victoria Department of Health

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Table 3 (*continued*)

Author, year	Study design/aim	Participant details, study dates (clinical setting)	Inclusion and exclusion criteria	Surgical speciality	Patient-orientated outcome	Findings	Peer review/ conflict of interest/funding sources
						explanation and information given by the Nurse Endoscopist trainee at the start was very good or excellent, 68% of patients rated the trainee's knowledge about their problem and medical history as very good to excellent, and 70% of patients reported not being anxious during the procedure. Waiting list - This project allowed Monash Health to successfully address the large procedural wait time through extensive audit and waitlist process redesign and instil sustainable practices for the ongoing wait-list management. In particular, the treatment of Category 2 and 3 patients by the trainee significantly eased the pressure on the service wait-lists.	
Gallagher (2017), United Kingdom	Quantitative descriptive/ to determine the patient satisfaction of 100 patients having nurse-led intravitreal therapy injections.	100 patients receiving intravitreal therapy, June – December 2015 (Princess Alexandra Eye Pavilion – National Health Service)	Inclusion and exclusion criteria not stated	Ophthalmology	Patient experience of procedure patient satisfaction	Most (99%) of patients thought that the nurse considered and respected their wishes. Significantly, all thought that the nurse took time to listen to their concerns or questions and explained the procedure as it progressed. Most significantly, all were satisfied by the service they received from the nurse, overall reflecting high-quality care. Despite a minority of concerns, all of the nurse-treated patients were satisfied with the care they received.	Yes/none declared/not stated
Giramonti and Kogan (2018),	Quantitative non-randomised controlled trial/to show that with	100 paediatric patients ages 6 months – 13 years,	Families with boys requesting either a circumcision or revision of	Paediatric urology	Surgical complications, post-operative complications and return	There were no operative complications, nor any documented emergency	Yes/none declared/none

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Table 3 (*continued*)

Author, year	Study design/aim	Participant details, study dates (clinical setting)	Inclusion and exclusion criteria	Surgical speciality	Patient-orientated outcome	Findings	Peer review/ conflict of interest/funding sources
United States	proper training an Advanced Practice Provider could safely perform a circumcision in the OR	study dates not stated (Operating Room)	circumcision were scheduled with the NP. Exclusion not stated		rates to the Operating Room	room or urgent care visits in the immediate post-operative period. There were no early returns to the OR and only 1 scheduled follow-up procedure for a penile skin bridge	
Godsell (2005), United Kingdom	Quantitative descriptive/ aim not stated but in title' The development of the nurse biopsy role'.	Nurse trained to perform biopsies, January – December 2004 (Dermatology Department, Queen's Medical Centre)	Inclusion and exclusion criteria not stated	Dermatology	Waiting time, patient satisfaction, surgical technique of nurse	The waiting time for a biopsy was reduced from 8 weeks to 0 weeks. The waiting time for a simple excision by a doctor, if the lesion turned out to be malignant, was reduced from 8 weeks to 2 weeks. A patient satisfaction survey showed that patients were happy to have their surgery performed by a nurse. An audit of the histology reports from the specimens obtained by the nurses showed that a diagnosis was obtained in 100% of the cases, indicating that the surgical technique of the nurses was good.	Yes/not stated/ not stated
Hickey and Cooper (2009), United Kingdom	Quantitative descriptive/ to assess whether a Surgical Care Practitioner operating at an advanced level could make a major contribution to day-case varicose vein surgery.	Patients requiring vascular surgery, August 2003 – July 2007 (Operating Theatre)	Inclusion and exclusion criteria not stated	Vascular	Waiting list, quality of care, patient safety	A suitably qualified and trained SCP can safely perform varicose vein surgery to an advanced level, and this had a positive effect on the efficiency of day case varicose vein lists. The SCP input was reported to improved quality of care and patient safety. Patient feedback confirmed that the SCP was more thorough than the consultant in obtaining informed consent	Not stated/not stated/not stated
Hui et al. (2015), Hong Kong	Quantitative randomised controlled trial/to test the hypothesis that trained nurse endoscopists are not inferior to medical endoscopists in finding	787 subjects volunteered to participate in a local colorectal cancer screening programme and were scheduled to receive ambulatory colonoscopy, 15-month period March	Inclusion: Asymptomatic subjects between the ages of 50 and 70 years. Exclusion: Subjects who had undergone colonoscopy in the past 5 years, prior colorectal surgery, a personal history of	Gastroenterology	Primary - colon adenoma detection rate. Secondary - caecal intubation rate, intubation time, total procedural withdrawal time, complication rate,	Nurse endoscopist group had a significantly higher adenoma detection rate per procedure (43.8% vs 32.7%) which was associated with a proportion difference of +11.1% (95% CI 4.1% –	Yes/none declared/none

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Table 3 (*continued*)

Author, year	Study design/aim	Participant details, study dates (clinical setting)	Inclusion and exclusion criteria	Surgical speciality	Patient-orientated outcome	Findings	Peer review/ conflict of interest/funding sources
	adenomas during colonoscopy	2012 – June 2013 (Combined Endoscopy Unit)	inflammatory bowel disease, colonic adenoma or CRC, a family history of familial adenomatous polyposis syndrome or familial non-polyposis syndromes, pregnant or lactating women and unable to provide consent		subject's pain score and satisfaction score.	18.1%). The nurse endoscopist had a lower caecal intubation rate (97.3% vs 100%, $p = 001$), received better post-procedural pain scores (0.6 vs 0.8, $p = 0.021$), and higher overall satisfaction (4.5 vs 4.3, $p = 0.001$)	
James and McPhail (2008), United Kingdom	Quantitative descriptive/ to describe the work involved in implementing a one-stop, nurse-led clinic for suspected prostate cancer	Male patients with suspected prostate cancer, July – December 2007 (Nurse-led clinic)	Male patients with suspected prostate cancer. Exclusion not stated	Urology	Patient satisfaction, quality, and patient safety	Patients were satisfied with the one-stop service, although some patients were surprised at the nurse-led aspect of the service. They are supportive of the nurse-led concept and would not prefer to see a doctor. Patients appreciate the rapid journey time. Cancer pickup rates (43 per cent) are at the high end of the range of published data from doctor-performed biopsies. The quality of biopsy material was judged to be excellent by the receiving pathologist. Prostatic tissue was found in 100% of samples. Complication rates were acceptable by comparison with published data. The procedure was tolerated very well by patients	Yes/not stated/ not stated
Jejeebhoy et al. (2011), India	Quantitative non-RCT/to assess the safety and efficacy of manual vacuum evacuation performed by nurses in comparison to physicians using an equivalence design.	897 pregnant women, July 2009 – January 2010 (Non-government organisation clinical settings)	Inclusion: A positive uterine pregnancy of ≤10 weeks gestational age as measured by a urine pregnancy test for human chorionic gonadotropin and a pelvic examination, haemoglobin measuring ≥ 9 g/dL, no attempts in the previous week to terminate the pregnancy, resided within an hour of the study site, willing to return 7 days later for a follow-up check-up and	Obstetrics	Assessment of abortion completeness, failure rates, complication rates, adverse symptoms, satisfaction	Results show that manual vacuum evacuation can be provided with equal safety and effectiveness, according to the study's definition of equivalence, by nurses as by physicians. Nurses were as skilled as physicians in assessing gestational age, performing manual vacuum evacuation, and assessing completed abortion status. Overall failure and complication rates were low	Yes/none declared/ David and Lucille Packard Foundation

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Author, year	Study design/aim	Participant details, study dates (clinical setting)	Inclusion and exclusion criteria	Surgical speciality	Patient-orientated outcome	Findings	Peer review/ conflict of interest/funding sources
			undergo two pelvic examinations and indicated no other contraindications for abortion. Exclusion: Women who made unsafe attempts at termination of pregnancy			and equivalent between the two provider types. 0.2% difference in failure rate (95% CI); 0.0% difference in complication rate (95% CI). Adverse symptoms were rarely experienced and client satisfaction and perceptions of quality of care were high and identical amongst both groups of providers, with all clients who underwent an MVA procedure by a nurse indicating their willingness to seek abortion from nurses in future if needed.	
Kelly et al. (2008), United Kingdom	Quantitative descriptive/ to review the outcomes of nurse specialist led flexible sigmoidoscopy in an outpatient setting between 1999 and 2004	Patients requiring flexible sigmoidoscopy, 1999 – 2004 (Nurse specialist-led flexible sigmoidoscopy outpatient clinic)	Inclusion and exclusion criteria not stated	Gastroenterology	Post op bleeding; depth of insertion of the sigmoidoscope	The depth of insertion of the sigmoidoscope was as follows: rectum in 85 patients, sigmoid colon in 595 patients, descending colon in 1969 patients, splenic flexure in 958 patients and transverse colon in 311 patients. Two patients sustained an iatrogenic rectal perforation.	Yes/not stated/ not stated
Laker-Oketta et al. (2015), Uganda & Kenya	Quantitative non-randomised controlled trial/aim not stated	Patients, January 2007 – July 2013 (Clinics - 2 in Uganda and 1 in Kenya)	Inclusion: Patients who underwent punch skin biopsy from January 2007 to July 2013. Exclusion not stated	Surgical oncology	Patient satisfaction, complication	The procedure has been both uncomplicated to perform and well tolerated by patients (statistical data not available). There were no reports of recurrent bleeding after initial haemostasis or subsequent wound infection after the biopsy	Yes/none declared/ National Institutes of Health
Lawson et al. (1999), United Kingdom	Quantitative descriptive/ to assess the feasibility of training nurse practitioners to perform bone marrow aspiration and trephine biopsy, and to compare the quality of these samples with those obtained by medical staff	30 patients, August 1996 – February 1997 (Haematology Day unit)	Inclusion and exclusion criteria not	Surgical oncology	Patient satisfaction	In the nurse practitioner group of patients, 70% would prefer a nurse to repeat the test and 30% had no preference between a nurse and a doctor. Among the patients who had the procedure carried out by a doctor, 82% favoured having a doctor again and 18% had no preference.	Not stated/not stated/not stated

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Author, year	Study design/aim	Participant details, study dates (clinical setting)	Inclusion and exclusion criteria	Surgical speciality	Patient-orientated outcome	Findings	Peer review/ conflict of interest/funding sources
Malata (2018), United Kingdom	Quantitative descriptive/ to explore the impact of the nurse led crosslinking service on patient care.	95 patients requiring crosslinking, January – December 2016 (outpatient clinic)	Inclusion and exclusion criteria not stated	Ophthalmology	Waiting times, length of stay pre and post procedure, and patient satisfaction	93% satisfied - (25% satisfied, 72% very satisfied); waiting times significantly reduced, length of stay pre and post procedure significantly reduced	Yes/ not stated/ not stated
Martin (2002), United Kingdom	Quantitative descriptive/ aim not stated	19 patients, study dates not stated (Nurse-led Clinic at National Health Service Trust)	Inclusion and exclusion criteria not stated	Dermatology	Patient satisfaction	20% had not expected the nurse practitioner to perform the procedure; 80% expected either the consultant or another doctor to perform the procedure; 100% were very satisfied to be seen by the nurse practitioner; 100% found it acceptable to be operated upon by the nurse practitioner; 89% would be prepared to see the nurse practitioner again; 100% were happy with the overall treatment received from the nurse practitioner.	Not stated/not stated/not stated
Michelotti et al. (2014), United Kingdom	Quantitative descriptive/ aim not stated	Patients requiring intravitreal therapy, June 2012 – November 2013 (Operating Theatres in two NHS hospitals)	Inclusion and exclusion criteria not stated	Ophthalmology	Waiting time, adverse events	The service improvement reduced patient waiting time. 12 minor adverse events reported (corneal abrasions, subconjunctival haemorrhage; rate 0.36%). Adverse events were recorded prospectively. There were no cases of serious adverse events (vision-threatening adverse events, such as endophthalmitis, retinal tear, retinal detachments, or vitreous haemorrhage).	Not stated/none declared/Authors received conference travel support from Novartis and Alcon
Newey et al. (2006), United Kingdom	Quantitative non-randomised controlled trial/to describe the outcome of a nurse-led service to manage patients with a presumptive diagnosis of carpal tunnel syndrome.	305 patients with diagnosis of carpal tunnel syndrome, September 1999 – September 2001 (Nurse led outpatient clinic)	Inclusion and exclusion criteria not stated	Hand	Waiting time, standard and quality of care Patient satisfaction	Waiting times improved considerably whilst the standard and quality of care was maintained	Yes/not stated/ not stated

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Author, year	Study design/aim	Participant details, study dates (clinical setting)	Inclusion and exclusion criteria	Surgical speciality	Patient-orientated outcome	Findings	Peer review/ conflict of interest/funding sources
Palmquist (2010), United States	Quantitative descriptive/ to determine if an influx of NPs is warranted and feasible by examining and comparing the roles of the providers, their productivity, and whether patient satisfaction levels are maintained	2380 patients, January 2004 – December 2007 (6 outpatient surgery clinics)	Inclusion: Patients seen in normally scheduled surgical outpatient clinics at the Veterans Administration from 2004 to 2007. Exclusion: Those patients who are acutely ill, need to be admitted for advanced treatments, are sent to the ER, or are seen as an unscheduled patient were not included in the study	Cardiothoracic, Urology, Orthopaedics, Vascular, Ear, Nose, and Throat, and General Surgery		All clinics' results for the difference were statistically significant, the MDs (n = 1376, M = 82.76, SD = 26.02) patients' satisfaction was less than NPs (n = 1004, M = 90.34, SD = 18.54), t (2376.759) = −8.289, p < 0.01	Not stated/not stated/not stated
Sapre et al. (2012), Australia	Quantitative descriptive/ to present our initial experience implementing a nurse-led flexible cystoscopy service in a Victorian tertiary hospital and our initial results from that service	272 patients, October 2009 – June 2011 (Nurse-led flexible cystoscopy service in a day surgery setting)	Inclusion: All patients undergoing surveillance flexible cystoscopy at the Royal Melbourne Hospital from October 2009 to June 2011. This included patients with non-muscle-invasive bladder cancer, upper tract transitional cell carcinoma, patients who have had radiotherapy or other bladder preservation surgery for bladder cancer, as well as patients with an augmented bladder or neobladder needing cystoscopic surveillance. Exclusion not stated	Urology	Patient satisfaction and waiting list	There was a 65% reduction in the waiting list for surveillance flexible cystoscopy after introduction of the service. Of 60 patients who completed the feedback questionnaire, 95% reported that they were given enough information by the nurses, 92% had all their questions answered satisfactorily and 97% had enough confidence and trust in the nurse. In all, 90% had a positive perception of the service overall and 93% were happy to have a flexible cystoscopy performed by a nurse rather than a doctor	Yes/none declared/not stated
Sturgess et al. (1996), United Kingdom	Quantitative descriptive/ to evaluate the success rate and complications of percutaneous endoscopic gastrostomy insertion performed with an endoscopy nurse practitioner, rather than a second doctor, carrying out percutaneous gastric puncture.	100 patients, study dates not stated (Endoscopy unit in a district general hospital - Aintree Hospitals Trust)	Inclusion: unselected routine percutaneous endoscopic gastrostomy insertions. Exclusion not stated	Gastroenterology	Successful placement; immediate complication; 30-day mortality rate, outcome at 3 months Fatality and live birth	Successful Percutaneous Endoscopic Gastrostomy placement by nurse (50/50) vs physician (49/50); immediate complication in nurse group (n = 2) vs physician group (n = 2); 30-day mortality rate was 8% in nurse group and 12% in physician group, outcome at 3 months was similar in both groups except for a slightly lower incidence of stomal infection in the nurse group	Yes/not stated/ not stated

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Table 3 (*continued*)

Author, year	Study design/aim	Participant details, study dates (clinical setting)	Inclusion and exclusion criteria	Surgical speciality	Patient-orientated outcome	Findings	Peer review/ conflict of interest/funding sources
White et al. (1987), Congo	Quantitative non-randomised controlled trial/to describe obstetric operations performed by specially trained nurses in rural areas of a developing country	390 pregnant women, January 1985 – June 1986 (Operating room)	Inclusion: Pregnant. Exclusion not stated	Obstetrics and Gynaecology		Lives saved; 326 women had surgery performed by nurses with 7 deaths.	Yes/not stated/ not stated
Williams et al. (2020), United States	Quantitative non-randomised controlled trial/to describe the outcomes of the Nurse Practitioner-led newborn circumcision clinic. Specifically, the study describes parent/family satisfaction, clinical and demographics characteristics and outcomes of patients, and charge differences between circumcision in the newborn circumcision clinic and in the operating room	234 newborns undergoing circumcision, August 2016 – April 2018 (Nurse Practitioner-led neonatal circumcision clinic)	Inclusion: Healthy infants (at least 24 h old and in a stable, healthy state) who are less than 12 weeks old and weigh less than 5.5 kg (12 pounds). Exclusion: Patients who are medically unstable or ill, evidence of infection or rash at the surgical site, a family history of bleeding anomalies, or presence of congenital anomalies of the penis including but not limited to: congenital buried penis, chordee>30, penile torsion, epispadias, or hypospadias.	Paediatric urology	Parent or family satisfaction	Results of the patient satisfaction survey revealed 89.8% of patients rated the overall quality of care as excellent or very good. The median length of procedure was 20 min. No patients experienced penile amputations, infections, strictures, intraoperative bleeding, or wounds. Ten patients (4.3%) had bleeding events during the recovery period which were treated with a topical medication (StatSeal). Two patients (0.9%) had bleeding after discharge requiring Emergency Department evaluation and application of a pressure dressing. Two patients (0.9%) required circumcision revision.	Yes/not stated/ Boston Children's Hospital Rosemary H. Grant Urology Innovation and Research Fund; USA

Table 4
Summary of surgeries performed by nurse-surgeons.

Author, year	Country	Surgical speciality of the nurse-surgeon	Surgeries performed by the nurse-surgeon	Number of nurse-performed surgeries	Title of the nurse-surgeon
Bodle et al. (2008)	United Kingdom	Gynaecology	Hysteroscopy	69	Nurse Hysteroscopist
Bolme et al. (2020)	Norway	Ophthalmology	Intravitreal therapy	1076	Nurse
Chan et al. (2020)	United States	Otolaryngology	Ear and nasal foreign body removal (96%), tongue tie lysis (58%), nasopharyngoscopy (54%), flexible laryngoscopy (50%), functional endoscopic evaluation of swallowing (15%), simple laceration repair (12%), drainage of peritonsillar abscess (8%), stroboscopy (4%) and nasal cautery (4%)	Unclear from the 2777 outpatient visits conducted	Advanced Practice Providers (Nurse practitioners and Physicians Assistants)
Chu et al. (2011)	Somalia	Obstetrics	Mostly emergency obstetrics and minor operations, Caesarean sections and uterine evacuations	314	Surgical Nurse
Collins (2010)	United Kingdom	Surgical oncology	Bone marrow aspiration and trephine biopsy	50 trephine biopsy and 22 aspirations	Lymphoma clinical nurse specialist
Duncan et al. (2017)	Australia	Gastroenterology	Colonoscopy and polypectomy	212	Nurse Endoscopist
Gallagher (2017)	United Kingdom	Ophthalmology	Intravitreal therapy	100	Nurse
Giramonti and Kogan (2018)	United States	Paediatric urology	Sleeve circumcision procedure/ revision of circumcision	100	Nurse Practitioner
Godsell (2005)	United Kingdom	Dermatology	Punch biopsy, incision biopsy, and excision biopsy	1500	Skin Cancer Nurse Specialist
Hickey and Cooper (2009)	United Kingdom	Vascular	Sapheno-femoral ligation, long saphenous vein stripping, varicose vein avulsions (phlebectomies), and independent groin wound closures	152 independent saphenofemoral disconnections, 91 independent avulsions, 191 independent groin wound closures. Total = 474	Surgical Care Practitioner
Hui et al. (2015)	Hong Kong	Gastroenterology	Colonoscopy and polypectomy	Three nurses performed 590 (prior to the study) and 364 (during the study)	Nurse endoscopist
James and McPhail (2008)	United Kingdom	Urology	Transrectal ultrasound and biopsy	Not stated	Nurse
Jejeebhoy et al. (2011)	India	Obstetrics	Manual vacuum aspiration	433	Nurse
Kelly et al. (2008)	United Kingdom	Gastroenterology	Flexible sigmoidoscopy	3956	Nurse specialist
Laker-Oketta et al. (2015)	Uganda & Kenya	Surgical oncology	Skin punch biopsy	1735 (62% of 2799)	Nurse
Lawson et al. (1999)	United Kingdom	Surgical oncology	bone marrow aspirate and biopsy	Not stated	Nurse Practitioner
Malata (2018)	United Kingdom	Ophthalmology	Corneal crosslinking	128	Nurse
Martin (2002)	United Kingdom	Dermatology	removal of minor skin lesions (suspicious moles, lipomas, sebaceous cysts, papilloma)	Over 200	Nurse Practitioner
Michelotti et al. (2014)	United Kingdom	Ophthalmology	Intravitreal therapy	3355	Ophthalmic nurse, Nurse Practitioner, Nurse Injector
Newey et al. (2006)	United Kingdom	Hand	Carpal tunnel decompressions	395	Nurse Practitioner
Palmquist (2010)	United States	Cardiothoracic, Urology, Orthopaedics, Vascular, Ear, Nose, and Throat, and General Surgery	Non-exhaustive list of category 1 basic Nurse Practitioner functions: needle aspiration of joints and bursae, joint injections, skin tag removals, punch biopsies, and skin scrapings. Incision and drainage of abscesses, removing lipomas, wound care, including (but not limited) to	Not specified from the 118,617 patient visits for the period 2004–2007 at 6 clinics	Nurse Practitioner

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Table 4 (*continued*)

Author, year	Country	Surgical speciality of the nurse-surgeon	Surgeries performed by the nurse-surgeon	Number of nurse-performed surgeries	Title of the nurse-surgeon
			debridement, irrigation, and drain removal, destruction of skin, including but not limited to lesions by cryotherapy and chemicals, pap smears. The list of category 1 basic Nurse Practitioner functions within the Veterans Health Administration system continues for ten pages. Even more broad and unlimiting is category two specific/specialized Nurse Practitioner functions which include an entire page of blank spaces in which very specialized or highly trained functions can be listed. For example, if a Nurse Practitioner works in general surgery and would like to be trained by a surgeon on removing lipomas in the outpatient clinic setting then this can be listed after training and competence is determined (usually when the surgeon demonstrates the procedure and then the Nurse Practitioner demonstrates the procedure on a patient). The guidelines are very open and determined to be at the discretion of the Nurse Practitioner, their comfort level, and the supervising surgeon		
Sapre et al. (2012)	Australia	Urology	Flexible cystoscopy	720	Nurse
Sturgess et al. (1996)	United Kingdom	Gastroenterology	Gastroscopy & percutaneous endoscopic gastrostomy insertion	50	Nurse Practitioner
White et al. (1987)	Congo	Obstetrics and Gynaecology	Caesarean section, laparotomy, and hysterectomy for ruptured uterus	326 total c-sections and laparotomies (of these, 13 laparotomies for uterine rupture (9 hysterectomies and 4 tubal ligation repair)	Nurse-surgeon
Williams et al. (2020)	United States	Paediatric urology	Circumcision	239 (234 in analysis)	Nurse Practitioner

et al., 2008; Collins, 2010; Gallagher, 2017; Godsell, 2005; Hickey and Cooper, 2009; James and McPhail, 2008; Kelly et al., 2008; Lawson et al., 1999; Malata, 2018; Martin, 2002; Michelotti et al., 2014; Newey et al., 2006; Sturgess et al., 1996) followed by the United States (Chan et al., 2020; Giramonti and Kogan, 2018; Palmquist, 2010; Williams et al., 2020) and Australia (Duncan et al., 2017; Sapre et al., 2012). India (Jejeebhoy et al., 2011), Norway (Bolme et al., 2020), Uganda, Kenya (Laker-Oketta et al., 2015), Somalia (Chu et al., 2011), Congo (White et al., 1987), and Hong Kong (Hui et al., 2015) each had one study included in this review. Eleven of the 25 studies were published in the last ten years (Bolme et al., 2020; Chan et al., 2020; Duncan et al., 2017; Gallagher, 2017; Giramonti and Kogan, 2018; Hui et al., 2015; Laker-Oketta et al., 2015; Malata, 2018; Michelotti et al., 2014; Sapre et al., 2012; Williams et al., 2020), and eleven in the past eleven to twenty years ((Bodle et al., 2008; Collins, 2010; Chu et al., 2011; Godsell, 2005; Hickey and Cooper, 2009; James and McPhail, 2008; Jejeebhoy et al., 2011; Kelly et al., 2008; Martin, 2002; Newey et al., 2006; Palmquist, 2010). The remaining three articles were published in 1999 (Lawson et al., 1999), 1996 (Sturgess et al., 1996) and 1987 (White et al., 1987).

Seventeen of the 25 studies were conducted in an outpatient clinic setting (Bodle et al., 2008; Bolme et al., 2020; Chan et al., 2020; Collins, 2010; Gallagher, 2017; Godsell, 2005; James and McPhail, 2008; Jejeebhoy et al., 2011; Kelly et al., 2008; Laker-Oketta et al., 2015; Lawson et al., 1999; Malata, 2018; Martin, 2002; Newey et al., 2006; Palmquist, 2010; Sapre et al., 2012; Williams et al., 2020), five in an operating room or operating theatre (Chu et al., 2011; Giramonti and Kogan, 2018; Hickey and Cooper, 2009; Michelotti et al., 2014; White et al., 1987), and three in an endoscopy unit (Duncan et al., 2017; Hui et al., 2015; Sturgess et al., 1996). A total of 14,629 surgeries were performed by nurse-surgeons across all the 25 studies (see Table 4). This does not include the unspecified number of surgeries performed by nurse-surgeons during the 121,394 patient visits reported in two studies (Chan et al., 2020; Palmquist, 2010). The surgeries in the included studies can be categorised into 13 surgical specialties, namely urology (Giramonti and Kogan, 2018; James and McPhail, 2008; Palmquist, 2010; Sapre et al., 2012; Williams et al., 2020), gastroenterology (Duncan et al., 2017; Hui et al., 2015; Kelly et al., 2008; Sturgess et al., 1996), ophthalmology (Bolme et al., 2020; Gallagher, 2017; Malata, 2018; Michelotti et al., 2014), oncology (Collins, 2010; Laker-Oketta et al., 2015; Lawson et al., 1999), obstetrics (Chu et al., 2011; Jejeebhoy et al., 2011; White et al., 1987), gynaecology (Bodle et al., 2008; White et al., 1987), otolaryngology (Chan et al., 2020;

Palmquist, 2010), vascular (Hickey and Cooper, 2009; Palmquist, 2010), dermatology (Godsell, 2005; Martin, 2002), cardiothoracic (Palmquist, 2010), orthopaedics (Palmquist, 2010), hand (Newey et al., 2006) and general surgery (Palmquist, 2010). Of the five studies on nurse-performed urological surgeries, two ($n = 2$ Giramonti and Kogan, 2018; Williams et al., 2020) were under the highly specialised paediatric urology subspecialty. Eight unique nurse-surgeon titles were used across the 25 studies (see Table 4). The most common titles were Nurse (Bolme et al., 2020; Chu et al., 2011; Gallagher, 2017; James and McPhail, 2008; Jejeebhoy et al., 2011; Laker-Oketta et al., 2015; Malata, 2018; Michelotti et al., 2014; Sapre et al., 2012) and Nurse Practitioner (Chan et al., 2020; Giramonti and Kogan, 2018; Lawson et al., 1999; Martin, 2002; Michelotti et al., 2014; Newey et al., 2006; Palmquist, 2010; Sturgess et al., 1996; Williams et al., 2020) followed by Nurse Specialist (Collins, 2010; Godsell, 2005; Kelly et al., 2008), and Nurse Endoscopist (Duncan et al., 2017; Hui et al., 2015). Surgical Care Practitioner (Hickey and Cooper, 2009), Nurse Injector (Michelotti et al., 2014), Nurse Hysteroscopist,(Bodle et al., 2008) and Nurse-surgeon (White et al., 1987) were also used once.

3.5. Patient outcomes

Forty-eight patient-orientated outcomes were reported across the 25 included studies (see Table 3). These outcomes were grouped by the authors (TG, VB, AB, EJ) into four categories: (1) patient satisfaction and experience; (2) waiting list; (3) perioperative complications; and (4) quality of surgical care. Of the 48 reported outcomes, 16 (33%) were around patient satisfaction and experience, 14 (29%) around perioperative complications, ten (21%) around quality of surgical care, and eight (17%) around waiting lists.

3.5.1. Patient satisfaction and experience

Of the sixteen studies that measured patient satisfaction (see Table 3), all reported high to very high satisfaction of the surgical services provided by nurse-surgeons (Bodle et al., 2008; Collins, 2010; Duncan et al., 2017; Gallagher, 2017; Godsell, 2005; Hickey and Cooper, 2009; Hui et al., 2015; James and McPhail, 2008; Jejeebhoy et al., 2011; Laker-Oketta et al., 2015; Lawson et al., 1999; Malata, 2018; Martin, 2002; Palmquist, 2010; Sapre et al., 2012; Williams et al., 2020). Six of these studies had higher overall patient satisfaction ratings of "very satisfied", "very good", and "excellent" as compared to "satisfied" (Bodle et al., 2008; Duncan et al., 2017; Jejeebhoy et al., 2011; Malata, 2018; Martin, 2002; Williams et al., 2020). None of the 16 studies reported dissatisfaction to nurse-performed surgeries. Furthermore, every study reported positive patient experience with the nurse-surgeons. Two of the 16 studies noted that the nurse-surgeons "explained the procedure well, considered and respected their wishes, and took time to listen to their concerns and questions" (Gallagher, 2017) and "had done everything they could to help with any pain or discomfort related to the procedure" (Collins, 2010). One study highlighted that the nurse-surgeon "was more thorough than the consultant in obtaining the informed consent" (Hickey and Cooper, 2009). None reported a negative experience with the nurse-surgeons. Four of the 16 studies reported patient willingness to have their surgery performed by a nurse-surgeon again (Jejeebhoy et al., 2011; Lawson et al., 1999; Martin, 2002; Sapre et al., 2012) with two of these four studies indicating patient preference on having their surgery performed by nurse-surgeons instead of physicians (James and McPhail, 2008; Sapre et al., 2012). Two comparative studies reported a higher overall patient satisfaction on nurse-surgeons than physicians (Hui et al., 2015; Palmquist, 2010).

3.5.2. Waiting list

Eight studies measured patient access to surgery through waiting lists (Bodle et al., 2008; Duncan et al., 2017; Godsell, 2005; Hickey and Cooper, 2009; Malata, 2018; Michelotti et al., 2014; Newey et al., 2006; Sapre et al., 2012). All studies reported an improvement in the waiting list through reduction of patients' waiting time to have their surgery. This resulted in the clearing of a backlog of patients needing surgeries in one Australian study (Duncan et al., 2017) that would have remained in the waiting list for several years. Another Australian study (Sapre et al., 2012) reported a 65% reduction in the list of patients requiring surveillance surgery. One British study (Bodle et al., 2008) recorded a 5-year decline in appointment waiting time from 8 ± 6 weeks to 2 ± 2 weeks ($p < 0.001$), and a 5-year decline in clinic waiting time from 10 ± 30 min to 2 ± 10 min ($p = 0.005$). Another British study (Godsell, 2005) reported a sharp decrease in patient waiting time for a biopsy from eight weeks to zero weeks, and for a simple excision procedure, usually performed by a doctor, from eight weeks to two weeks.

3.5.3. Perioperative complications

Fourteen perioperative complications were reported as adverse events (Bolme et al., 2020; Giramonti and Kogan, 2018; Jejeebhoy et al., 2011; Kelly et al., 2008; Laker-Oketta et al., 2015; Michelotti et al., 2014), mortality rate (Bolme et al., 2020; Chu et al., 2011; Sturgess et al., 1996; White et al., 1987), complication rates (Giramonti and Kogan, 2018; Jejeebhoy et al., 2011; Sturgess et al., 1996), and length of stay pre and postoperatively (Malata, 2018). Of the six studies that reported adverse events, five indicated a very low number of serious adverse events (Giramonti and Kogan, 2018; Jejeebhoy et al., 2011; Kelly et al., 2008; Laker-Oketta et al., 2015; Michelotti et al., 2014) wherein one study (Kelly et al., 2008) reported two iatrogenic adverse events in a sample of 3956 patients and another one which measured early return to theatre rates but did not report any (Giramonti and Kogan, 2018).

Of the four studies that reported patient deaths, three (Bolme et al., 2020; Sturgess et al., 1996; White et al., 1987) indicated a higher mortality rate in the physician group than the nurse-surgeon group, while one study (Chu et al., 2011) compared mortality rates in two periods where deaths were statistically lower ($p < 0.001$) between 2008 and 2009 compared to 2006–2007. Of the three studies that reported complication rates, two (Jejeebhoy et al., 2011; Sturgess et al., 1996) studies returned low and similar complications between the nurse-surgeons and physicians, while one (Giramonti and Kogan, 2018) study reported no patient complications intra-operatively and immediately after surgery. One study (Malata, 2018) reported a significant reduction in the length of stay of patients pre and postoperatively, following the introduction of nurse-performed surgeries.

3.5.4. Quality of surgical care

Ten studies (Bodle et al., 2008; Bolme et al., 2020; Chan et al., 2020; Godsell, 2005; Hickey and Cooper, 2009; Hui et al., 2015; James and McPhail, 2008; Jejeebhoy et al., 2011; Kelly et al., 2008; Newey et al., 2006) reported the quality of perioperative care provided by nurse-surgeons to patients undergoing surgery (see Table 3). All of these studies reported that the standard of care was either maintained or improved. Four studies (Bolme et al., 2020; James and McPhail, 2008; Jejeebhoy et al., 2011; Newey et al., 2006) concluded that the nurse-surgeons were as skilled as physicians in performing surgeries, with one (Bolme et al., 2020) of these four studies showing evidence of statistical significance ($p = 0.019$) in the context of nurse-surgeons' noninferiority to physician-performed surgeries. Three studies (Bolme et al., 2020; Godsell, 2005; Hui et al., 2015) reported that the quality of surgery by nurse-surgeons is better than physicians, with one (Hui et al., 2015) of these four studies indicating that nurse-surgeons had significantly higher cancer detection rates than surgeons (95% CI 4.1%–18.1%). Seven studies (Bodle et al., 2008; Bolme et al., 2020; Godsell, 2005; Hui et al., 2015; James and McPhail, 2008; Jejeebhoy et al., 2011; Kelly et al., 2008) concurred that nurse-surgeons had excellent surgical technique as evidenced by high quality tissue sampling (Godsell, 2005), successful case completion rates (Jejeebhoy et al., 2011), and better ($p = 0.021$) postoperative pain scores than physicians (Hui et al., 2015).

4. Discussion

To the authors' best knowledge, this study is the first to consolidate the evidence on the impact of nurse-surgeons on patient-centred outcomes within the perioperative continuum.

4.1. Countries of nurse-surgeon practice

The majority of the studies were conducted in the United Kingdom followed by the United States, Australia, Hong Kong, and Congo. This aligns with Grota et al. (2021) who reported similar findings of countries where nurse-surgeons practice. In addition, there are a number of other countries that surfaced in this review. These were India, Norway, Uganda, Kenya, and Somalia. One included study also mentioned the use of nurse-surgeons in Cambodia, Ethiopia, Nepal, Vietnam, and South Africa (Jejeebhoy et al., 2011). Clearly, despite the limited literature reporting nurse-surgeon outcomes, nurse-surgeons are active in many different countries.

4.2. Roles of nurse-surgeons

This review found 13 surgical specialties within which nurse-surgeons practice. These were urology, gastroenterology, ophthalmology, obstetrics, oncology, gynaecology, otolaryngology, vascular, dermatology, cardiothoracic, orthopaedics, hand, and general surgery (see Table 4).

This review reports nurse-surgeons performing the same type of surgeries identified by Grota et al. (2021), with the addition of carpal tunnel surgery, circumcision, revision of circumcision, corneal crosslinking, manual vacuum aspiration, ear and nasal foreign body removal, tongue tie lysis, nasopharyngoscopy, flexible laryngoscopy, functional endoscopic evaluation of swallowing, simple laceration repair, drainage of peritonsillar abscess, stroboscopy, nasal cautery, removal of minor skin lesions such as suspicious moles, lipomas, sebaceous cysts, papillomata, and bone marrow aspirations (see Table 4).

One study discussed the substitution of ophthalmic surgeons by nurses in yttrium aluminium garnet laser capsulotomy treatments and chalazion surgeries (Michelotti et al., 2014). One study reported a non-exhaustive list of surgeries that nurse-surgeons performed at the Veterans Health Administration in the United States (Palmquist, 2010). This list as Palmquist (2010) noted was unlimiting and highly dependent on the discretion and comfort level of the Nurse Practitioners to learn surgeries. Considering the 118,617 recorded patient visits from 2004 to 2007, it would be interesting to follow up on Palmquist (2010) study and evaluate how the list of nurse-performed surgeries and the number of patient visits in this health system have grown, well over ten years after the study concluded.

4.3. Impact of nurse-surgeons on patient satisfaction and experience

Of the 16 studies that reported patient satisfaction and experience related to nurse-surgeon intervention (see Table 3), all indicated an overwhelmingly positive or categorically high-level support for nurse-surgeons. No studies reported any dissatisfaction or bad experience with nurse-surgeons performing their surgery. The patients in two studies felt that the nurse-surgeons were more thorough in explaining the procedure and obtaining the informed consent than physicians (Hickey and Cooper, 2009), and that the nurse-surgeons "considered and respected their wishes" (Gallagher, 2017). These findings are the very essence of patient-centred outcomes research (Frank et al., 2014). The thoroughness of nurse-surgeons in explaining the procedure and obtaining consent can be attributed to the way nurse-surgeons were traditionally trained in Nursing schools to become patient advocates (Choi, 2015).

Completion of informed consent, which includes thorough explanation of the procedure to the patient, is an indicator of safe surgery as per the World Health Organisation Surgical Safety Checklist (Haynes et al., 2009). However, although systems are in place to prevent any communication-related sentinel events from occurring, they do still occur (Cramer et al., 2020). Sentinel events are a preventable subset of patient adverse events (Patra and De Jesus, 2021). A few examples include incomplete and incorrect informed consent, retention of foreign items in the patients' body, wrong site of surgery, and intraoperative medication errors (Cramer et al., 2020).

A study by Gillespie et al. (2010) found that 70% of sentinel events can be avoided by effective communication. This translates

directly to optimal patient experience and clinical outcomes as evidenced by the six studies (Bolme et al., 2020; Giramonti and Kogan, 2018; Jejeebhoy et al., 2011; Kelly et al., 2008; Laker-Oketta et al., 2015; Michelotti et al., 2014) in this review that reported marginal serious adverse events. One of these six studies study (Kelly et al., 2008) further reported two iatrogenic sentinel events in 3956 patients representing 0.05% of the sample population. However, a deeply ingrained disparity in the way surgeons and nurses were trained to communicate exists in the operating theatres. While nurses were taught to provide broad, easy-to-understand, and patient-centric narratives, surgeons on the other hand, were trained to always communicate direct to the point when describing clinical scenarios to their colleagues (Gillespie et al., 2010). This communication style of surgeons' cascades to their interaction with patients as evidenced by this review, which may explain why patients in the included studies expressed high satisfaction of nurse-surgeons, patient preference on nurse-surgeons over surgeons, and how patients felt that nurse-surgeons "considered and respected their wishes".

4.4. Impact of nurse-surgeons on the waiting lists

Waiting lists represent the timeliness of patient-centred perioperative care, and the capacity of a given surgical workforce in a health system to provide vital surgical services, in the hope that these translate to improvement in surgical access (Amoko et al., 1992). Nine studies highlighted the positive impact of nurse-surgeons on the waiting lists in 13 surgical specialties (see Table 3).

This review demonstrates that the implementation of nurse-surgeon models of care have greatly expedited patient access to surgical care in a global context. A prime example of this was the statistically significant ($p < 0.001$) reduction of appointment waiting time in an outpatient hysteroscopy clinic in the United Kingdom where hysteroscopy appointment waiting times decreased from 8 ± 6 weeks in 2000 to 2 ± 2 weeks in 2005 – a surgical capacity improvement of at least four to six weeks (Bodle et al., 2008).

4.5. Impact of nurse-surgeons on postoperative complications

The impact on postoperative complications were reported in fourteen ($n = 14$) of the 25 studies included in this review. All fourteen studies reported that complications arising from the nurse-surgeon group were either similar or less than the physician group. None reported a higher incidence of perioperative mortality in the nurse-surgeon group in comparison with the physician group. This may be due to the tight restrictions on the type of patients which nurse-surgeons see, as high-risk patients are all referred to surgeons. Despite this, these findings indicate that nurse-surgeons perform surgeries as safely as their medical counterparts, if adequate and proper training is given.

4.6. Impact of nurse-surgeons on the quality of surgical care

The quality of surgical care as an outcome was reported in nine of the 25 studies in this review. All nine studies concluded that the nurse-surgeons' quality of care in terms of surgical skills, knowledge, and technique was either similar to or better than the physicians. Similar to perioperative complications, surgical care quality is also an important indicator of safe surgery. Considering that the nurse-surgeons are predominantly trained and supervised by a highly experienced senior surgeon or consultant (Grota et al., 2021), the quality of surgeries performed by these nurse-surgeons would naturally be expected to be at a high level. In many countries worldwide, a surgeon spends thousands of rigorous clinical hours operating on patients before receiving the title of "consultant" (BMA Central Consultants and Specialists Committee, 2008), and this model of achieving expertise in performing surgery was the most sensible route for nurse-surgeon training given that this is the gold standard in surgical training for physicians since the advent of modern surgery (Bhatti and Cummings, 2007). This resulted in a high level of surgical care quality rendered by the nurse-surgeons. Accordingly, this review reinforces the direct impact of training by appropriately qualified and experienced practitioners, on the quality of surgery performed by nurse-surgeons.

4.7. Limitations of the study

The authors acknowledge the moderate to low methodological quality of the studies included in this review following quality assessment using the Mixed Methods Appraisal Tool (Hong et al., 2018), and certainty assessment using the Grading of Recommendations, Assessment, Development and Evaluations framework (Schünemann et al., 2013). Therefore, prudence should be applied when interpreting and extrapolating the findings of this review. Furthermore, the authors acknowledge the lack of studies on nurse-surgeons and their impact on patient-centred outcomes, as reported in only 25 studies in this review. This is likely due to the novelty of the review topic; however, it clearly demonstrates that nurse-surgeons are still under reported in the scientific community despite being documented as early as the 1950s (White et al., 1987).

Additionally, this review was limited by an eligibility criterion that excluded non-research papers, grey literature, and reviews. This resulted in the exclusion of articles with confirmed nurse-surgeons during the title-abstract and full text screening. Inclusion of these articles could have diversified the countries and surgical specialties of nurse-surgeons. One excluded Canadian systematic review (Johal and Dodd, 2017) discussed the presence of nurse-surgeons in the specialties of trauma, cardiac surgery, general surgery, orthopaedic surgery, urology, and neurosurgery. However, trauma and neurosurgery as specialties were not identified in this review. Furthermore, two excluded American articles (Yalamanchi et al., 2021; Salibian et al., 2016) reported nurse-performed otolaryngological surgeries. This sets otolaryngology as a relatively common surgical speciality for nurse-surgeons in the United States. The reasons for excluding Yalamanchi et al. (2021) and Salibian et al. (2016) were "non-research paper" and "did not measure

patient-centred outcomes", respectively. Finally, a further excluded study (De Bruijn-Geraets et al., 2018) reported multi-speciality surgeries that nurse-surgeons perform in Netherlands. This further expands the role and practice of nurse-surgeons in Europe. De Bruijn-Geraets et al. (2018) was excluded as it did not measure patient-centred outcomes.

4.8. Grading of recommendations, assessment, development, and evaluation

The certainty of evidence found in this review was moderate for patient satisfaction and experience (critical outcome), moderate for perioperative complications (important outcome), moderate for quality of surgical care (important outcome), and low for waiting list (important outcome). These ratings were derived from the pre-programmed calculations generated by the GRADEpro® software and the collective decisions made by the authors based on the Grading of Recommendations, Assessment, Development and Evaluations guidelines (Schünemann et al., 2013). Using the abovementioned factors, the authors' recommendation and confidence as to the strength of evidence in this review is conditional, dependent on the availability of surgical resources and the setting of the individual health system looking at adapting this review for policy development (Schünemann et al., 2013). A strong recommendation will only be achieved with the emergence of more high-quality studies in the future, particularly randomised controlled trials that will assess the impact of nurse-surgeons on patient-centred outcomes.

4.9. Implications for future research

This review found multiple low methodological quality studies on the positive benefits to patient-centred outcomes through the use of nurse-surgeons. Randomised controlled trials assessing nurse-surgeon practice should be conducted to strengthen the evidence around this unique role. This review included all research articles of quantitative, qualitative, and mixed-methods study design, which meant that in accordance with the guidelines set by the Grading of Recommendations, Assessment, Development and Evaluations, the certainty of the evidence will never be high as compared to a review that only includes randomised controlled trials (Schünemann et al., 2013). For future studies however, if the aim is to completely encompass the global nurse-surgeon impact, practice, and roles, it would be more appropriate to conduct a scoping review that will include research articles, non-research articles, and grey literature.

4.10. Implications for practice

The practice of surgery has traditionally been the "territory" of physicians. However, this review proves that nurse-surgeons can practice surgery effectively, with overwhelmingly positive patient-centred outcomes. The findings in this review can be used by hospitals without nurse-surgeons as basis to introduce or expand this emerging field of nursing practice. Doing so will have a four-fold effect. First, patients will have faster access to urgent surgery as the long and complex waiting lists will be apportioned into smaller and achievable lists. Second, surgeons will have increased capacity to perform more complicated surgeries where their skills and experience are more appropriately needed, while nurse-surgeons perform minor surgeries in the face of chronic medical workforce shortage. Third, health systems will have a cost-effective measure to provide surgical care given the known economic implications of nurse-led services (Randall et al., 2017). Fourth, nursing workforce recruitment and retention will be improved, as empowered nurses aspiring to specialise in surgery will no longer need to leave the nursing profession to do so. The nursing workforce is ageing (International Council of Nurses, 2021) and introducing innovative concepts of clinical nursing practice such as nurse-led surgery can be a way to attract the highly ambitious and challenge-seeking younger generation (Keith et al., 2021) to enter the profession.

4.11. Implications for policy

The majority of the studies included in this review developed nurse-led surgical services locally, without direct involvement from their national governments. Policies surrounding the emergence of these innovative clinical nursing practices were grounded upon the drastic need to strengthen local surgical capacity to meet specific surgical demands, namely cancer diagnostic surgeries, emergency surgeries, rural and remote health, and minor surgeries in 13 surgical specialties (see Table 4). Grota et al. (2021) suggested the same areas of surgery where nurse-surgeons could practice and be of best use in the context of productivity and value. As evidenced by the studies included in this review (see Table 3), the micro-level policies to institute nurse-led surgical services have been effective in addressing the problem of surgical capacity within local service areas.

Hence, it is logical that the next step will be macro-level negotiations through national and international platforms to explore the full potential of nurse-surgeons. This will provide opportunities for advocacy with key stakeholders when developing policies of relevance to nurse-surgeon practice regulation. Consequently, the regulation of nurse-surgeon practice on a national level would streamline care provision in cancer diagnostic surgeries, emergency surgeries, minor surgeries, and rural and remote health – the surgical areas where nurse-surgeons are most needed and most effective.

The coronavirus pandemic has further aggravated the already compromised state of global surgical care needed by billions of people pre-pandemic, with most of these patients coming from medium to low-income countries (Bath et al., 2019). However, high-income countries are now struggling as well with the backlog of surgeries reaching record-high levels caused by the multiple cancellations of surgeries across all the specialties brought about by the pandemic (Carr et al., 2021; COVIDSurg Collaborative, 2020). Cancer and trauma surgeries in particular have been heavily impacted – an area where nurse-surgeons have already been practicing (COVIDSurg Collaborative, 2020). Therefore, it is critical for national policymakers to develop recovery policies that will not just recover the pre-existing status but expand and sustain the already overburdened surgical workforce in the decades to come. This

review proves that nurse-surgeons improve access to surgery and therefore could be a viable candidate in sustaining the surgical workforce amidst the devastating effects of coronavirus to global surgery (see Definition of terms).

5. Conclusions

This systematic review aimed to investigate the impact of nurse-surgeons on patient-centred outcomes in the perioperative context. Forty-eight ($n = 48$) patient-orientated outcomes were found across the 25 included studies. These were grouped into four categories: patient satisfaction and experience; waiting list; perioperative complications; and quality of surgical care. Many studies reported high to very high satisfaction of the surgical services provided by nurse-surgeons. This was attributed to the difference in the way nurses and physicians are trained to communicate clinical scenarios, which as evidenced by this review, cascaded to physician interactions with patients. Improvement in waiting list times, and low to very low instances of adverse events were noted. Three studies identified a higher mortality rate in the physician group than the nurse-surgeon group. Many reported the standard of care experienced was either maintained or improved by nurse-surgeons. These findings indicate that nurse-surgeons perform safe and high-quality surgeries. For future research, the authors recommend development of randomised controlled trials to elevate the certainty of evidence. Implementation of nurse-led surgical services will provide patients timely access to urgent surgery, surgeons the capacity to perform more complicated cases, and nurses an expanded career pathway. National policymakers must develop policies to expand and then sustain the currently overburdened surgical workforce. This review proved that nurse-surgeons improve access to surgery and therefore could be a viable candidate in strengthening the surgical workforce amidst the devastating effects of coronavirus to global surgery.

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Registration and protocol

This systematic review was not registered

Availability of data, code, and other materials

See Supplementary material 5.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ijnsa.2022.100086.

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