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SCOPING REVIEW

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Roles of nurse-surgeons in global surgical care: A scoping review

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Abstract

Aim: To identify the roles of nurse-surgeons in the provision of surgical care.

Design: Scoping review.

Methods: This scoping review adhered to the JBI guideline for scoping reviews and EQUATOR Network's PRISMA-ScR checklist. Searches were performed from May 2022 to July 2022 using a combination of MeSH headings, keywords and filters via database and hand searching based on the eligibility criteria. Keywords included nurse-surgeon, nurse endoscopist, nurse hysteroscopist and nurse cystoscopist. Data sources were CINAHL, Cochrane, Google Scholar, PubMed and Scopus. Descriptive analysis was used to report the findings.

Results: Ninety-six included records indicated nurse-surgeon practice in 26 countries. Forty-one nurse-surgeon titles were found, the majority of which were types of nurse practitioner. A total of 5,684,198 surgeries were performed by nurse-surgeons varying from laparotomies to biopsies. Nine records reported that nurse-surgeons perform surgeries safely and on par with physicians with zero to minimal complications. Nineteen records reported improved surgical care efficiency by nurse-surgeons in terms of patient access to surgery, waiting times, surgery times, patient show rates, patient education, physician workload and junior physicians' training. Seven records reported high patient satisfaction. Nurse-surgeons were cost-effective according to five records. Thirteen records recommended the standardization of nurse-surgeon practice.

Conclusion: Nurse-surgeons performed millions of surgeries worldwide assisting in easing the global surgical burden. This review identified the roles and benefits nurse-surgeons play in global surgical care. Research gaps on nurse-surgeon roles were discovered including the ambiguity in nurse-surgeon titles and the need to regulate nurse-surgeon practice.

Impact: This research addressed the clinical safety, quality, contribution to timely surgical access and cost efficiency of nurse-surgeon performed surgeries, as well as the need to standardize nurse-surgeon practice and use a more consistent nurse-surgeon title to ensure role identification and monitoring.

Protocol Registration: This scoping review is accessible at https://doi.org/10.17605/OSF.IO/SJ2WU.

KEYWORDS
advanced practice, day surgery, empowerment, endoscopy, nurse practitioners, nurse roles, surgical nursing, systematic reviews and meta-analyses, theatre nursing, workforce issues

1 | INTRODUCTION

Surgeries are invasive procedures performed under aseptic technique with or without anaesthesia by surgical providers such as physicians, nurses and other non-physicians to diagnose and/or treat surgical conditions (Debas et al., 2006). Access to surgery is crucial in achieving universal healthcare (World Health Organization, 2014). In countries with a fee for service, access to surgery is even more dire. Countries, such as the USA have seen an increase in travel tourism for persons without health insurance (Stoney et al., 2022). Yet, 5 billion people representing more than 60% of the world's population have no access to surgery (Alkire et al., 2015; Chamie, 2020; Meara et al., 2015). From this number, 18 million people die every year from illnesses that could have been managed by surgery (Reddy et al., 2020). Therefore, access to surgery should be prioritized as a global health agenda.

Access to surgery is a problem faced by both high-income countries and low- and lower-middle-income countries. In low- and lower middle-income countries, the longstanding scarcity of skilled surgical providers hinders the delivery of timely surgeries (Hoyler et al., 2014). To address this scarcity, the World Health Organization introduced the Task Shifting strategy in 2008 with the intention to improve patient access to essential healthcare services such as surgery (World Health Organization, 2008). Task Shifting refers to the extension of the scope of practice of less qualified healthcare workers by training them to perform clinical tasks that are traditionally performed by higher qualified healthcare workers only (World Health Organization, 2008). The clinical tasks are then equally redistributed among the healthcare workers which in turn ameliorates patient access to healthcare. In the surgical context, surgeries are redistributed, whereby nurses are trained to perform simple yet essential surgeries so the higher qualified surgeons can focus on more complicated surgeries. This results in a more efficient delivery of surgical care, and therefore, timely patient access to surgery in areas where surgeons are limited.

Conversely, in high-income countries, multiple factors can be attributed to the delay in patient access to surgery. These are the ageing healthcare workforce (OECD iLibrary, 2019), the setting of restrictions in the clinical hours worked by junior physicians (Abraham et al., 2016; Philibert et al., 2002), and the longstanding maldistribution of surgeons in urban and rural settings (Phillips, 2022). Additionally, some health systems in high-income countries do not allow universal health coverage to their citizens and are heavily reliant on service fees and insurance (Venkatesh et al., 2019). This ultimately disadvantages people especially those from the lowest socio-economic backgrounds.

Nurse-surgeons are nurses who perform surgery independently with current nurse-surgeon titles including nurse cystoscopist, physician extender, perioperative specialist practitioner, nurse endoscopist, surgical care practitioner, nurse hysteroscopist, biopsy nurse, nurse practitioner and clinical nurse specialist (Grota et al., 2021). The first usage of the term "nurse-surgeon" dates back to the early 1600s when King Henry VIII appointed a private nurse-surgeon named William Bullein (Duffin, 2017). The earliest known contemporary use of the term "nurse-surgeon" that describes nurses who perform surgeries independently was in the 1950s when a group of nurse-surgeons performed obstetric and gynaecological surgeries in Zaire, the predecessor of the Democratic Republic of Congo (White et al., 1987). Three decades later, two American physicians developed a proposal to train current registered nurses as Certified Registered Nurse Surgeons to undertake surgeries under a surgeon's written order (Litt & Brodsky, 1983). Nurses advocated for this proposal in 1985 (Judy, 1985).

"Nurse-surgeons" recognition and use steadily increased globally into the 21st century. From early 2000s onwards, "nurse-surgeons" performed major and minor general, vascular, orthopaedic, ophthalmological, urological, colorectal, obstetric and gynaecological surgeries (Kingsnorth, 2005; Kowalewski & Jahn, 2001; Marsh, 2005; Zorn, 2005). By 2009, nurse-surgeons have been recognized in the United Kingdom as duly qualified non-physician surgeons who can safely practice surgery (Mickute, 2009). "Nurse-surgeon" practice continued to increase over the past decade as they performed caesarean section, laparotomy, appendicectomy, herniorrhaphy, endoscopy, hysteroscopy, cystoscopy, biopsy and carpal tunnel release (Eddy & Duffy, 2019; Grota et al., 2021; Judd, 2013; Wise, 2021). Today, the practice of nurse-surgeons is widespread, with report practice in Europe, Oceania, Africa, Asia and North America (Grota et al., 2021; Kowalewski & Jahn, 2001; Zorn, 2005).

The inception of the modern "nurse-surgeons" may be ascribed to Task Shifting (World Health Organization, 2008). However, evidence suggests that nurse-surgeons precede Task Shifting by at least 60 years with the independent performance of caesarean sections and hysterectomies by African nurses in the 1950s (White et al., 1987). Regardless, the establishment of Task Shifting to improve surgical outcomes from 2008 onwards, and the training of nurses to perform obstetric surgeries in the 1950s were formulated from similar reasons – supply and demand. The desperate need of the health systems laid the foundation for the innovation of surgical capacity (supply) to meet surgical demands (Bath et al., 2019; World Health Organization, 2014). Similar with how nurse-surgeons were incepted in low- and lower-middle income countries, nurse-surgeons in high-income countries also emerged from supply and demand challenges (Grota et al., 2022). The provision of surgical services required innovation to meet ballooning surgical demands and achieve positive surgical outcomes amidst the ageing healthcare population (OECD iLibrary, 2019), the restrictions to ensure that junior physicians do not work unsafe hours (Abraham et al., 2016;

Philibert et al., 2002), and the uneven distribution of surgeons in rural and urban settings (Phillips, 2022).

Globally, nurse-surgeons have reduced surgical waiting times, improved patient access to surgery and prevented deaths from surgically treatable illnesses (Grota et al., 2021; Grota et al., 2022). The contributions of nurse-surgeons have been invaluable in decreasing the unnecessary treatment delays in various surgical specialties (Johal & Dodd, 2017; Joseph et al., 2015; Salibian et al., 2016). Grota et al. (2022) further confirmed the categorically positive global impact of nurse-surgeons in surgical outcomes particularly in emergency surgeries, diagnostic surgeries, minor surgeries and rural health. Therefore, considering the potential of nurse-surgeons in easing the surgical burden globally, initial mapping and scoping of the roles of this group of advanced practice nurses is necessary in the hopes of formally regulating their credentialing pathway and clinical practice. To the author's best knowledge, there is no known scoping review that explored the roles of nurse-surgeons as one category of advanced practice nurses in the provision of surgical care worldwide.

2 | THE REVIEW

2.1 | Aim(s)

The aim of this scoping review was to identify the roles of nurse-surgeons in the provision of surgical care.

3 | METHODS/METHODOLOGY

3.1 | Design

The authors' decision to conduct a scoping review was based on the JBI guidance for scoping reviews specifying the appropriateness of using scoping reviews to clarify a concept or body of literature exhibiting heterogeneity that is inapplicable to a more clear-cut systematic review (Peters et al., 2020; Peters et al., 2021). Heterogeneity of nurse-surgeon practice as a concept is therefore exhibited by the absence of a scoping review that examines nurse-surgeons as one category of advanced practice nurses. As there was limited literature focusing on the roles of nurse-surgeons in surgical care, a broad definition of "surgery" by the World Health Organization (Debas et al., 2006) was adopted which encompasses all service providers performing invasive surgical procedures independently regardless of surgical specialty and setting. This scoping review was registered on Open Science Framework and is accessible at https://doi.org/10.17605/OSF.IO/SJ2WU.

3.2 | Search methods

A search strategy was developed by the four authors (TG, VB, AB and EJ) which involved a combination of MeSH Headings, keywords and filters for each database (Appendix S1). The data sources were CINAHL, Cochrane Library, Scopus, PubMed and hand searching. Hand searching in scoping reviews involves manually identifying relevant studies and documents by systematically searching through sources beyond electronic databases (Arksey & OMalley, 2005). During database searching, peer-reviewed studies and reviews were searched. During hand searching, grey literature, government documents, organizational reports, white papers, evaluations, news articles, blogs, theses, text and opinion pieces, letters and editorials were searched. The searched articles were imported to Covidence®, a software-as-a-service platform for managing reviews (Covidence, 2022). Covidence® was also the tool that automatically detected any duplicate studies. One author (TG) conducted the initial title-abstract screening. Immediately prior to full text review, another layer of screening was conducted by one author (TG) to ensure that the articles fit the World Health Organization definition of surgery, which was an eligibility criterion of this review. Following screening, two of four authors (TG, VB, AB and EJ) reviewed the full text of the studies. Conflicts were resolved by discussion or via a third reviewer (one of VB, AB, EJ) where necessary.

3.3 | Inclusion and/or exclusion criteria

The Population, Concept, Context framework from the Updated JBI Guidance for Scoping Reviews (Peters et al., 2021) was adopted to develop the eligibility criteria for this scoping review (Table 1). The Population was patients undergoing surgery. The Concepts were nurse-surgeons and surgery. Nurse-surgeon definition is any nurse performing surgeries independently (Grota et al., 2022; White et al., 1987). Surgery as defined by the World Health Organization is any invasive procedures performed under aseptic technique and usually with anaesthesia by surgical providers such as physicians, nurses and other non-physicians to diagnose and/or treat surgical conditions (Debas et al., 2006). The Contexts were any health area in which surgery was performed including the perioperative department, operating room, medical centre, community clinic and nurse-led surgical service/clinic. Studies that were published in non-English language were excluded. No date restrictions were applied in the searches. Any surgical assisting roles where nurses do not perform surgeries independently were also excluded. As recommended by the JBI guidance on scoping reviews (Peters et al., 2021) and the PRISMA-ScR checklist (Tricco et al., 2018), published and unpublished articles were included.

3.4 | Search outcome

Eight thousand four hundred eighty-two references were identified from database and manual hand searches ($n = 8482$). Automated deduplication found 942 duplicates and manual deduplication found one duplicate which were removed, leaving 7539 references for title

TABLE 1 Eligibility criteria for the scoping review.

Inclusion criteria	Exclusion criteria
Population	Surgical assisting roles
Patients undergoing surgery	Non-nurse roles
Concept	
Nurse-surgeon	
Surgery (as per WHO definition)	
Context	
Any area in which surgery is performed, including perioperative department, operating room, operating theatre, day surgery unit, day procedure unit, endoscopy unit, hospital, medical centre, health service, practice, outpatient clinic, community clinic, catheterization laboratory or interventional, radiology and nurse-led surgical service/clinic	
English language	
Primary research papers	
Qualitative study, quantitative study, mixed-methods study, dissertation study	
Reviews	
Systematic review, scoping review, rapid review, narrative review, meta-analysis	
Non-research papers	
Editorial, letter, text, opinion, grey literature	
Government document, organizational report, white paper, evaluation	

and abstract screening. After title-abstract screening, 7394 references were excluded. One hundred forty-five records were assessed as eligible for full-text review. Following full text review, 49 records were excluded and 96 records were included for data extraction (see Figure 1).

3.5 | Quality appraisal

Quality appraisal was not undertaken as this was deemed unnecessary due to the study's aims/scope being exploratory only.

3.6 | Data abstraction

Following identification of the 96 included records, the relevant data from each record were extracted onto a data extraction form that was consensually approved by the four authors (TG, VB, AB and EJ) and created by one author (TG) in Covidence® (2022). Data abstraction for each record, also referred to as data charting in scoping reviews (Peters et al., 2021) was completed by two of four authors (TG, VB, AB and EJ) in Covidence® (2022). Disagreements were resolved by discussion, or a third reviewer (one of VB, AB, EJ) where necessary. Using the data extraction form, the 96 included records were extracted for the following data: title, author/s; publication year; DOI; country; study design; aim; start and end dates; population description; inclusion and exclusion criteria; method of participant recruitment; total number of participants; nurse-surgeon title; surgery performed by nurse; surgical specialty; number of surgeries performed by nurse; findings; funding sources; peer review; and conflict of interest (see Appendix S2).

3.7 | Synthesis

The completed data extraction form was exported by one author (TG) from Covidence® (2022) as a comma-separated values file and converted into an excel spreadsheet where data analysis occurred. The data obtained from this scoping review utilized a descriptive data analysis approach as the JBI guidance (Peters et al., 2021) noted that scoping reviews do not generally synthesize the results or outcomes of the included records and the data analysis of the extracted data should only involve basic descriptive analysis. One author (TG) analysed the final extracted data from the 96 included records via the Excel-converted spreadsheet which was then evaluated collectively by the three remaining authors (VB, AB and EJ) during the extraction and analysis stages of this scoping review.

4 | RESULTS

The presentation of the results of this scoping review was based on the JBI Manual for Evidence Synthesis (Peters et al., 2021) and PRISMA 2020 statement (Page et al., 2021).

4.1 | Descriptive findings

A total of 96 records were included in this scoping review (see Table 2). Forty-eight (50%) were primary research studies which included descriptive studies, non-randomized controlled trials, mixed methods studies, randomized controlled trials and a qualitative study. The other 48 (50%) did not describe primary research studies which included texts and opinions, reviews, discussion papers, editorials, reports and one news article. Fifty-three (55%) of the total records were published from 2011 to 2022, 38 (40%) from 1991 to 2010, and five (5%) from 1974 to 1990. The included records were conducted in 26 countries from Australia, Belgium, Burkina Faso, Canada, Comoros Islands, Congo, Ghana, Hong Kong, India, Ireland, Kenya, Korea, Malawi, Mozambique, Netherlands, New Zealand, Nigeria, Rwanda, South Africa, Sudan, Thailand, Uganda, United Kingdom, United States, Zambia and Zimbabwe. The majority of the included records were from Africa ($n = 14$) (54%) followed by Asia ($n = 4$) (15%), Europe ($n = 4$) (15%), North America ($n = 2$) (8%) and Oceania ($n = 2$) (8%). A world map of the countries where nurse-surgeons practice and the World Bank (2022) income classification of these countries are depicted in Figure 2.

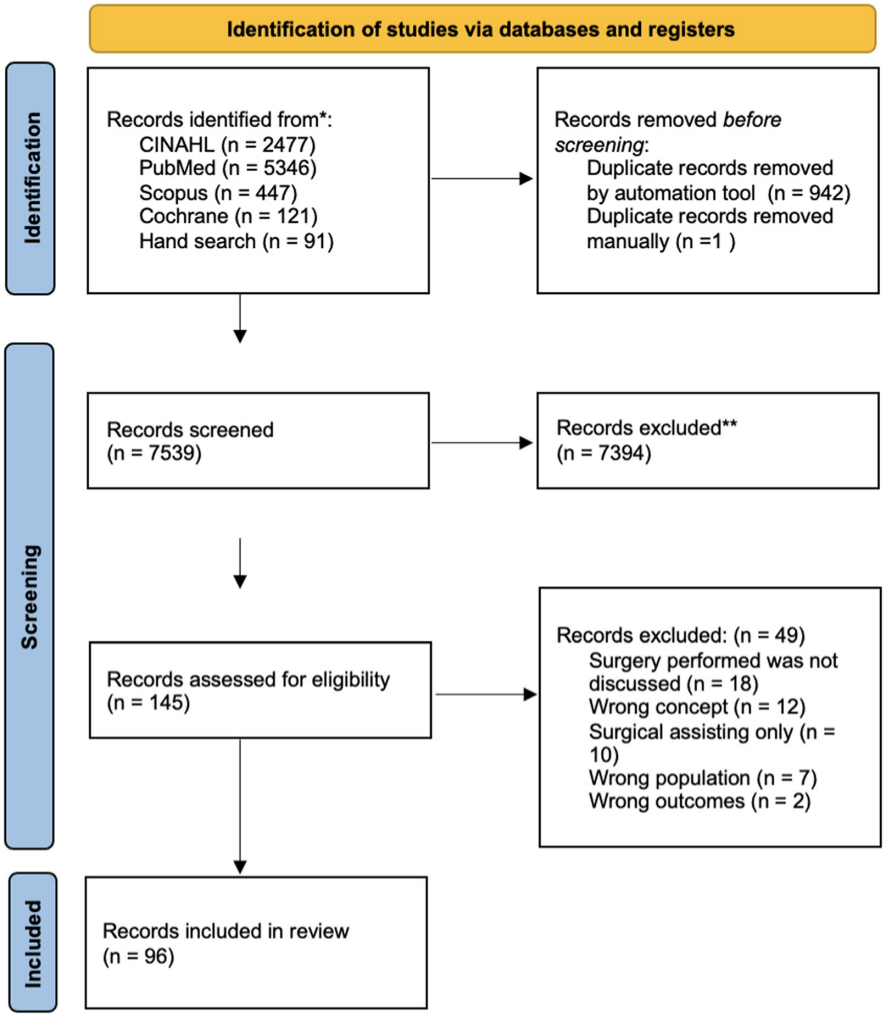


FIGURE 1 PRIMSA 2020 flow diagram (Page et al., 2021).

4.2 | Nurse-surgeon titles

There were 41 nurse-surgeon titles mentioned in the 96 included records (see Table 3). Titles mentioned at least twice were nurse practitioner, nurse endoscopist, nurse, surgical care practitioner, nurse-surgeon, advanced nurse practitioner, clinical nurse specialist, nurse cystoscopist, acute care nurse practitioner, advanced practice provider, non-physician, nurse-midwife, registered nurse, registered nurse first assistant and surgical first assistant (see Table 3). There were other unique nurse-surgeon titles that were mentioned in one or two records such as mid-level provider, nurse consultant, rural nurse specialist, nurse hysteroscopist and non-physician endoscopist (see Table 3 for the full list).

4.3 | Surgeries performed by nurse-surgeons

One hundred different types of surgeries in 24 surgical specialties and subspecialties were performed by nurse-surgeons in the included records (see Table 3). The surgical specialties were plastic surgery, general surgery, obstetrics, gynaecology, orthopaedics, dermatology, gastroenterology, pulmonology, urogynaecology, otorhinolaryngology, urology, oculo-plastics, ophthalmology, interventional radiology, vascular surgery, cardiothoracic, trauma, dental, neurosurgery, reconstructive surgery, paediatric surgery, maxillofacial surgery, paediatric otolaryngology and primary care.

Forty-six records (48%) reported a total of 5,684,198 surgeries performed by nurse-surgeons (see Table 3). This figure did not include the number of surgeries performed by nurse-surgeons in Zhang et al. (2018) and Abdullah et al., 2011 studies. Zhang et al. (2018) provided the total number of surgeries performed by Advanced Practice Professionals, the collective title that the study used for nurse practitioners and physician assistants. It was unclear how many of the 2.69 million surgeries in 2012 and 4.54 million surgeries in 2015 were performed by nurse-surgeons. (Abdullah et al., 2011) reported two different figures whereby the hospital administrator reported 4896 nurse-performed surgeries while only 2335 nurse-performed surgeries were documented on the surgical logbooks.

The surgeries that were mentioned at least thrice in the included records were biopsy, flexible sigmoidoscopy, colonoscopy, diagnostic or therapeutic excision, endoscopy, flexible cystoscopy, hernia repair, vein stripping, curettage, polypectomy, circumcision, incision and drainage of abscess, debridement, caesarean section, skin

TABLE 2 Published record descriptions.

Author	Title	Year	Country	Design
Abdullah et al.	Assessment of surgical and obstetrical care at 10 district hospitals in Ghana using on-site interviews	2010	Ghana	Quantitative descriptive
Abraham	Changing faces within the perioperative workforce: New, advanced and extended roles	2019	United Kingdom	Review
Abraham et al.	Development and implementation of non-medical practitioners in acute care	2016	United Kingdom	Review
Adamson et al.	Geographic Distribution of Nonphysician Clinicians Who Independently Billed Medicare for Common Dermatologic Services in 2014.	2018	United States	Retrospective review
Basnyat et al.	Nurse-led direct access endoscopy clinics: the future?	2001	United Kingdom	Quantitative descriptive
Beck	Nurse endoscopist skills training programme within a national health workforce innovation and reform project.	2013	Australia	Report
Brotherstone et al.	Uptake of population-based flexible sigmoidoscopy screening for colorectal cancer: a nurse-led feasibility study	2007	United Kingdom	Quantitative descriptive
Bull et al.	Upper gastrointestinal endoscopy training: a retrospective audit of the first 210 examinations performed by an Advanced Practice Nurse (APN) at a metropolitan hospital in South Australia	2006	Australia	Quantitative descriptive
Butler, Schultz & Drennan	Substitution of nurses for physicians in the hospital setting for patient, process of care, and economic outcomes	2020	Ireland	Review
Cera et al.	Defining the Role of the Urogynecology Nurse Practitioner: A Call to Contemporary Distinction through Subspecialty Certification.	2021	United States	Quantitative descriptive
Coldiron & Ratnarathorn	Scope of physician procedures independently billed by mid-level providers in the office setting.	2014	United States	Quantitative descriptive
Comola	A Nurse Practitioner's Experience in a Post-Graduate Nurse Practitioner Urology Fellowship.	2014	United States	Government / organizational report
Cooper	Introducing an ANP-led temporal artery biopsy service for patients with suspected giant cell arteritis.	2021	United Kingdom	Text and opinion
Cusack et al.	Evaluating nurse endoscopist advanced practice roles in a South Australia metropolitan health service	2018	Australia	Mixed methods
Davis et al.	The Role of Nurses and Midwives in Expanding and Sustaining Voluntary Medical Male Circumcision Services for HIV Prevention: A Systematic and Policy Review	2021	Kenya, Uganda, Rwanda, Mozambique, Zambia, Zimbabwe, Malawi	Review
Day et al.	Non-physician performance of lower and upper endoscopy: a systematic review and meta-analysis	2014	United States, United Kingdom, Canada, Netherlands, Hong Kong	Review
De Bruijn-Geraets et al.	National mixed methods evaluation of the effects of removing legal barriers to full practice authority of Dutch nurse practitioners and physician assistants	2018	Netherlands, Belgium	Mixed methods
Dimond	When the nurse wields the scalpel	1995	United Kingdom	Editorial
Dryer	Interventional radiology: new roles for nurse practitioners	2006	United States	Editorial
Duffield et al.	Nurse-Performed Endoscopy: Implications for the Nursing Profession in Australia	2017	Australia	Discussion paper
Duncan et al.	Introduction of the Nurse Endoscopist Role in One Australian Health Service	2017	Australia	Quantitative descriptive

TABLE 2 (Continued)

Author	Title	Year	Country	Design
Duthie et al.	A UK training programme for nurse practitioner flexible sigmoidoscopy and a prospective evaluation of the practice of the first UK nurse flexible sigmoidoscopist	1998	United Kingdom	Quantitative descriptive
Eddy & Duffy	A study of the skills, education, and qualifications of nurses performing dermatological surgery in the United Kingdom	2019	United Kingdom	Quantitative descriptive
Fitzgerald	Rural nurse specialists: clinical practice and the politics of care	2008	New Zealand	Text and opinion
Fox, Schira & Wadlund	The pioneer spirit in perioperative advanced practice--two practice examples	2000	United States	Text and opinion
Ge et al.	Advanced Practice Providers Utilization Trends in Otolaryngology From 2012 to 2017 in the Medicare Population	2021	United States	Quantitative descriptive
Gifford & Stone	Quality, access, and clinical issues in a nurse practitioner colposcopy outreach programme	1993	United States	Quantitative descriptive
Gilani et al.	The safety and feasibility of large volume paracentesis performed by an experienced nurse practitioner	2009	United States	Quantitative descriptive
Giramonti & Kogan	Paediatric penile surgery by a nurse practitioner in the operating room	2018	United States	Quantitative descriptive
Godsell	Dermatology. The development of a nurse biopsy role.	2005	United Kingdom	Discussion paper
Goodfellow, Fretwell & Simms	Nurse endoscopy in a district general hospital	2003	United Kingdom	Quantitative descriptive
Grota et al.	Current methods of nurse-surgeon training and education: Systematic review	2021	Australia	Review
Hallquist	Developments in the RN first assistant role during the Korean War	2005	Korea	Discussion paper
Hickey & Cooper	Varicose vein surgery performed by a surgical care practitioner	2009	United Kingdom	Text and opinion
Hillier	The advanced practice nurse in gastroenterology. Identifying and comparing care interactions of nurse practitioners and clinical nurse specialists	2001	United States	Quantitative descriptive
Hilton	Apps: Urology's new normal.	2018	United States	Text and opinion
Hlozek & Zacharias	The RN first assistant's role during inferior epigastric artery harvesting	1997	United States	Text and opinion
Hlozek, Zacharias & Mizener	RN first assistants expand their perioperative role	1998	United States	Text and opinion
Hough	Advanced role in colorectal screening.	2012	Ireland	Text and opinion
Hui et al.	Comparison of colonoscopic performance between medical and nurse endoscopists: a non-inferiority randomized controlled study in Asia	2015	Hong Kong	Quantitative RCT
Jalloh et al.	Credentialing and Privileging of Acute Care Nurse Practitioners to Do Invasive Procedures: A state-wide Survey	2016	United States	Quantitative descriptive
Johal & Dodd	Physician extenders on surgical services: A systematic review	2017	Canada	Review
Johnston	The National Nurse Endoscopist Project.	2008	United Kingdom	Report
Judd	Identifying ways to improve the health pathway of a child with a musculoskeletal problem: A comparison of practice of midlevel providers in the United States of America (USA) and the United Kingdom (UK)	2013	United Kingdom & United States	Review
Kanchanasinith et al.	Postpartum Sterilization by Nurse-Midwives in Thailand	1990	Thailand	Quantitative descriptive
Kingsnorth	General Surgery	2005	United Kingdom	Quantitative descriptive

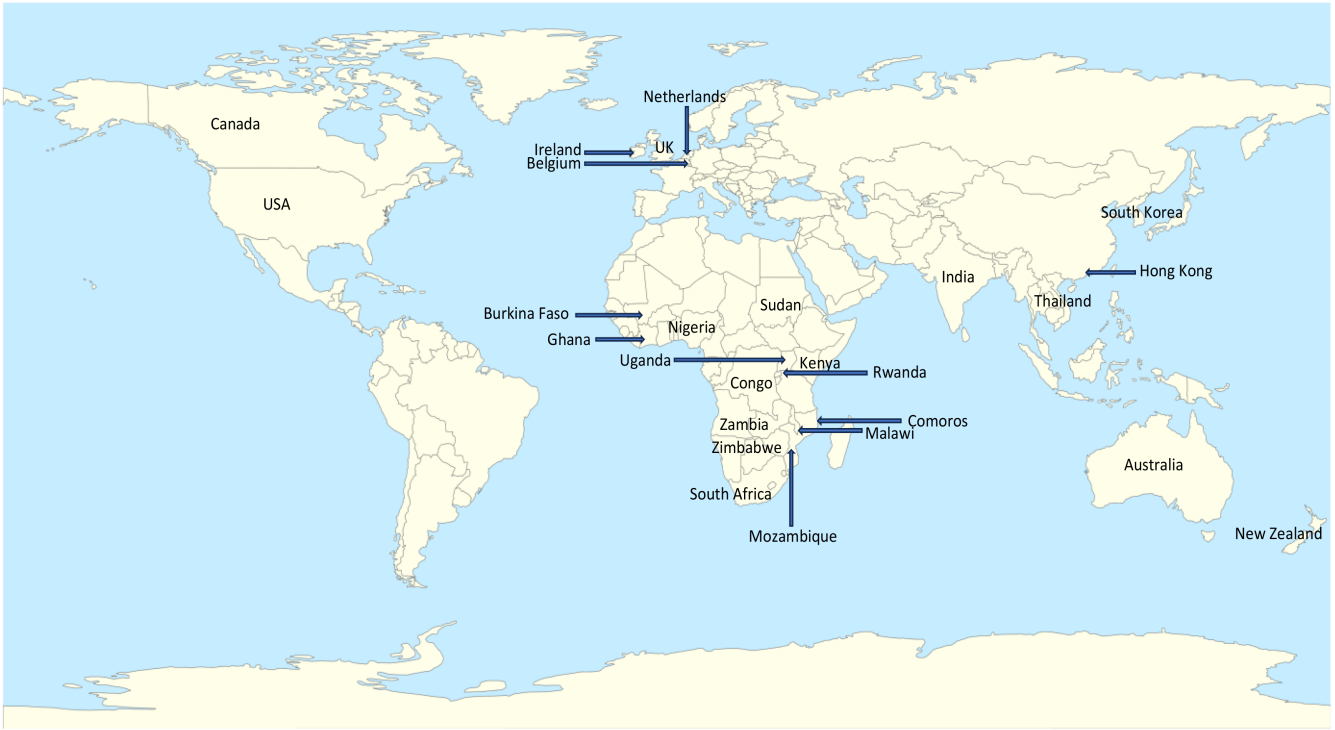
(Continues)

TABLE 2 (Continued)

Author	Title	Year	Country	Design
Koetsawang et al.	Postpartum sterilization by operating-room nurses in Thailand	1981	Thailand	Quantitative descriptive
Kowalewski & Jahn	Health professionals for maternity serrvices: experiences on covering the population with quality maternity care	2001	Burkina Faso, Congo	Review
Laing	Minor surgery: an extended role for ophthalmic nurses in the United Kingdom	1999	United Kingdom	Discussion paper
Lane & Minns	Empowering advanced practitioners to set up nurse led clinics for improved outpatient care	2010	United Kingdom	Text and opinion
Limoges-Gonzalez	Opening doors for nonphysician colonoscopists	2012	United Kingdom, United States	Text and opinion
Lucas	The learning curve of a surgical care practitioner performing local anaesthetic transperineal prostate biopsies: Cancer rate detection and complications	2020	United Kingdom	Quantitative descriptive
Marsh	Nurse-surgeons: New arrivals on the healthcare platform face a welcome - and controversy	2005	United Kingdom	Text and opinion
Maruthachalam et al.	Nurse led flexible sigmoidoscopy in primary care--the first 1000 patients	2006	United Kingdom	Quantitative descriptive
Massl et al.	Comparing quality, safety, and costs of colonoscopies performed by nurse versus physician trainees	2014	Netherlands	Quantitative descriptive
Mcconkey & Hahessy	Developing the advanced nursing practice role in non‚Äêmuscle invasive bladder cancer surveillance in Ireland.	2018	Ireland	Text and opinion
Mcconkey et al.	Development of an advanced nurse practitioner led bladder cancer surveillance service in Ireland: Preliminary audit results	2019	Ireland	Conference abstract
Meenan et al.	Training in radial EUS: what is the best approach and is there a role for the nurse endoscopist?	2003	United Kingdom	Quantitative descriptive
Melleney & Willoughby	Audit of a nurse endoscopist based one stop dyspepsia clinic	2002	United Kingdom	Quantitative descriptive
Meo et al.	Rural surgery in southern Sudan	2006	Sudan	Text and opinion
Mickute	Surgical training: what has changed?	2009	United Kingdom	Text and opinion
Moshakis, Ruban & Wood	Role of the nurse endoscopist in colorectal practice	1996	United Kingdom	Quantitative descriptive
O'Rourke	The orthopaedic nurse practitioner: Breaking tradition to fill gaps in care delivery through varied scopes of practice	2022	Australia	Review
Oliver	Meet the nurse who will soon perform surgery on patients alone	2017	United Kingdom	News article
Patel & Nguyen	Characterization of Biopsies by Dermatologists and Nonphysician Providers in the Medicare Population: A Rapidly Changing Landscape	2021	United States	Quantitative descriptive
Pearce	Operation in hand	2013	United Kingdom	Editorial
Pervaiz et al.	Office hysteroscopic morcellation service: Evaluation of women experience and factors affecting satisfaction	2021	United Kingdom	Quantitative descriptive
Puzey	A look at the life of an upper gastrointestinal nurse endoscopist	2013	United Kingdom	Text and opinion
Quick	The role of the surgical care practitioner within the surgical team	2013	United Kingdom	Qualitative
Quick	From novice to expert: a surgical care practitioner's reflection on their role development	2016	United Kingdom	Discussion paper
Ranjan et al.	Primary treatment of female urethral stricture by nurses leads to improved outcomes.	2016	India	Review

TABLE 2 (Continued)

Author	Title	Year	Country	Design
Rich et al.	Defining the role of advanced care practitioners in paediatric surgery practice	2021	United States	Quantitative descriptive
Salibian et al.	The National Ambulatory Medical Care Survey: pas and nps in outpatient surgery	2016	United States	Quantitative descriptive
Sapre et al.	Nurse-led flexible cystoscopy in Australia: initial experience and early results	2012	Australia	Quantitative descriptive
Satyapan et al.	Postpartum Tubal Ligation by Nurse-Midwives in Thailand: A Field Trial	1983	Thailand	Quantitative non-RCT
Schoenfeld et al.	Accuracy of polyp detection by gastroenterologists and nurse endoscopists during flexible sigmoidoscopy: a randomized trial	1999	United States	Quantitative RCT
Schultz	Practical and Legal Implications of Nurse Practitioners and Physician Assistants in Cystoscopy.	2011	United States	Text and opinion
Schwegel et al.	Meeting the evolving demands of neurointervention: Implementation and utilization of nurse practitioner	2019	United States	Narrative review
Shegafi et al.	Two decades on - cardiothoracic surgical care practitioners in the UK: a narrative review	2020	United Kingdom	Review
Shum et al.	A comprehensive training programme for nurse endoscopist performing flexible sigmoidoscopy in Hong Kong	2010	Hong Kong	Quantitative descriptive
Simcock et al.	A safety audit of the first 10,000 intravitreal ranibizumab injections performed by nurse practitioners	2014	United Kingdom	Quantitative descriptive
Sprout	Nurse endoscopist training: the next step	2000	United States	Text and opinion
Taylor et al.	The role of the nurse practitioner in interventional radiology	2012	United States	Review
Thommasen et al.	Cervical cancer screening performed by a nurse. Evaluation in family practice	1996	Canada	Quantitative descriptive
Tingle et al.	Performance and learning curve of a surgical care practitioner in completing hip aspirations	2016	United Kingdom	Quantitative non-RCT
Turner & Aslet	Nurse practitioner-led prostate biopsy in the United Kingdom	2011	United Kingdom	Review
Turner & Pati	Nurse practitioner led prostate biopsy: an audit to determine effectiveness and safety for patients.	2010	United Kingdom	Quantitative descriptive
Van Putten et al.	Nurse endoscopists perform colonoscopies according to the international standard and with high patient satisfaction	2012	Netherlands	Quantitative descriptive
Weinstein & Demers	Rural nurse practitioner clinic: the public's response	1974	United States	Quantitative non-RCT
Weiss et al.	Complications of circumcision in male neonates, infants and children: a systematic review	2010	Nigeria, United Kingdom, Comoros Islands, South Africa	Review
White, Thorpe & Maine	Emergency obstetric surgery performed by nurses in Zaire	1987	Congo (formerly Zaire)	Quantitative descriptive
Wildi et al.	Accuracy of esophagoscopy performed by a non-physician endoscopist with a 4-mm diameter battery-powered endoscope	2003	United States	Quantitative non-RCT
Williams et al.	Experience with implementation of a nurse practitioner-led newborn circumcision clinic	2020	United States	Mixed methods
Wise	The BMJ Awards 2021: Dermatology team of the year	2021	United Kingdom	Text and opinion
Wright	A description of the gastroenterology nurse endoscopist role in the United States	2000	United States	Quantitative descriptive
Zhang et al.	Trends and Scope of Dermatology Procedures Billed by Advanced Practice Professionals From 2012 Through 2015.	2018	United States	Quantitative descriptive



High-income countries*	Upper-middle-income countries*	Low- and lower-middle income countries*
Australia	South Africa	Burkina Faso
Belgium	Thailand	Comoros
Canada		Congo
Hong Kong		Ghana
Ireland		India
Netherlands		Kenya
New Zealand		Malawi
South Korea		Mozambique
UK		Nigeria
USA		Rwanda
		Sudan
		Uganda
		Zambia
		Zimbabwe

* Based on World Bank (2022) data

FIGURE 2 Countries where nurse-surgeons practice.

grafting, tubal ligation, minor, intermediate and complex repair, avulsion, dilation, aspiration, wound closure, carpal tunnel surgery, ureteric stent removal, saphenofemoral disconnection, sclerotherapy, episiotomy, fracture manipulation, esophagogastroduodenoscopy, paracentesis, pap smear, interventional radiology, neurostimulation, and destruction of benign, premalignant and malignant lesions. A multitude of varied surgeries were identified in one or two records such as laparotomy, hysterectomy, vasectomy, harvesting of artery, harvesting of skin grafts, organ resection, appendicectomy, flap reconstruction, local flap, reverse circumcision and tooth extraction (see Table 3 for the full list).

4.4 | Patient safety and complication rates

Patient safety was reported in 12 (13%) records (Davis et al., 2021; Day et al., 2014; Hickey & Cooper, 2009; Goodfellow et al., 2003; (Hough et al., 2012); Koetsawang et al., 1981; Maruthachalam

TABLE 3 Nurse-surgeon titles, types of surgeries, numbers and specialty areas.

Author	Nurse-surgeon title	Surgeries performed by nurse-surgeon	Number of surgeries performed by nurse-surgeons	Surgical specialty	Findings
Abdullah et al.	Midwives; nurse anaesthetists; theatre nurses	Suturing (including episiotomies), Diagnostic or therapeutic excisions (e.g. lipoma removal, ganglion excision), Other minor procedures (e.g. removal of foreign body), Incision and drainage of abscess, Wound debridement/management, Other minor gynaecological procedures (manual placenta removal, Norplant removal), Cervical cerclage, casting of fractures	4896 according to the hospital administrator, 2335 based on the surgical logbooks	Plastics, general, gynaecology, orthopaedics	Surgical and obstetrical care providers consisted of Medical Officers (8.5%), nurse anaesthetists (6%), theatre nurses (33%), mid-wives (50.7%) and others (4.5%). Major surgical cases represented 37% of overall case volumes with caesarean section as the most common type of major surgical procedure performed. The most common minor surgical procedures performed were suturing of lacerations or episiotomies
Abraham	Surgical care practitioner	Surgical care practitioners undertake some surgical operative procedures autonomously	Not stated	Not listed	Brief overview of new, advanced and extended practitioner roles in the perioperative environment.
Abraham et al.	Surgical care practitioner; surgical first assistant	Surgical interventions, investigations including radiology, catheterization	Not listed	Not listed	Not a primary research study
Adamson et al.	Nurse Practitioners	Destruction premalignant lesion, biopsy, repair, flaps, grafts, destruction of benign lesion, destruction of malignant lesion, malignant excision, benign excision	956, 944	Dermatology	The 938,147 unique clinicians billed Medicare in 2014. Of that number, 10,957 (1.2%) were dermatologists, 68,420 (7.3%) were Nurse Practitioners and 49,270 (5.3%) were Physician Assistants.
Basnyat et al.	Nurse-endoscopist	Proctoscopy, flexible sigmoidoscopy, biopsy	706	Gastroenterology	Ninety-nine percent of the 249 patients were satisfied with the nurse-practitioner performing the surgery. Of the 706 patients undergoing full sigmoidoscopic and proctoscopic examination by the nurse-endoscopist, a cause for bleeding was identified in more than 90% of the cases. The nurse-led service cost was $81 per patient whereas a consultant-led new outpatient department referral cost $112 and a further $59 for follow-up visits – a saving of $90 per patient.
Beck	Nurse-endoscopist	Colonoscopy	Not stated	Gastroenterology	Not applicable
Brotherstone et al.	Experienced nurse	Flexible sigmoidoscopy	280	Gastroenterology	Of the 510 people invited to attend, 280 (55%) underwent FS. Among non-attenders, 91 (18%) were ineligible for screening or did not receive the invitation, 19 (4%) accepted the offer of screening but were unable to attend during the study period, 52 (10%) declined the offer, 41 (8%) did not respond to the invitation, and 27 (5%) accepted the offer of screening but did not attend. Attendance among those eligible to be screened, who had received the invitation, was 67%. People from more socioeconomically deprived neighbourhoods were less likely to attend (OR: 0.90; CI: 0.84–0.96. Women were more likely to attend than men (OR: 1.44; CI: 1.01–2.05).
Bull et al.	Advanced Practice Nurse Endoscopist Trainee	Upper gastrointestinal endoscopy, biopsy	210	Gastroenterology	The overall procedural success rate was 96.2%. The completion rate increased with experience. There were no deaths or procedural complications as a result of the endoscopic examinations performed or from percutaneous gastrostomy placement. No adverse events related to medications administered or unrelated diseases occurred.
Butler, Schultz & Drennan	Nurse	Colonoscopy, open carpal tunnel reduction, pleural procedures for pleural effusions	Not stated	Gastroenterology, plastics, pulmonology	Not a primary research study

(Continues)

TABLE 2 (Continued)

Author	Nurse-surgeon title	Surgeries performed by nurse-surgeon	Number of surgeries performed by nurse-surgeons	Surgical specialty	Findings
Cera et al.	Nurse Practitioner	Cystoscopy, Botox injection via cystoscopy, vulvar biopsy, endometrial biopsy	Not stated	Urogynecology	Fifty-five Nurse Practitioners completed the survey, representing a range of states and practice experience, as well as experienced and recent graduate Nurse Practitioners. The majority of participants (79.9%) support subspecialized certification, and the importance of a national certification examination was deemed as moderately, very, or extremely important by 70% of respondents. Most respondents work collaboratively with physician colleagues. Results also detail an initial overview of general women's health and role-specific urogynecology responsibilities and procedures needed to provide competent, comprehensive care.
Coldiron & Ratnarathorn	Nurse practitioner	Destruction of benign, premalignant and malignant lesions, arthrocentesis, injection, drainage, aspiration, biopsy, urogenital procedures, debridement, excision, removal of impacted cerumen, posterior tibial neurostimulation, incision and drainage, intermediate and complex repair (forehead, cheek, chin, mouth, neck, axillae, genitalia, hands, feet)	1,789,020	Dermatology, orthopaedics, plastics, ENT, urology	Nurse practitioners undertake many dermatological procedures independently. Concern regarding whether Nurse Practitioners are educated to diagnose and manage these conditions. No reporting of complications. Recommend a data collection for adverse outcomes.
Comola	Nurse Practitioner	Cystoscopy, stent removal, suprapubic catheter exchange, urethral dilation, vasectomy.	Not stated	Urology	Not a primary research study
Cooper	Advanced Nurse Practitioner	Temporal artery biopsy, harvesting skin grafts, harvesting dermis fat grafts, excision of lesions, diathermy and wound closure.	137	Oculoplastics, ophthalmology	Standard 1: timely undertaking of the biopsy procedure (within 14 days). No one individual patient breached the 14-day limit, a 100% success rate, compared to audits in 2012 (81%) and 2014/2015 (87%). Standard 2: the appropriate length of specimen was obtained (over 15 mm). The average length of specimen over the duration of the audit period was 13 mm, which is above the minimum national requirement of 10 mm, but falls short of the 15 mm expected from the standard set from the previous audit. Standard 3: complications associated with surgery. No significant complications in the 137 cases undertaken during this audit period were reported.
Cusack et al.	Advanced Practice Nurse Endoscopist	Colonoscopy, snare polypectomy	409	Gastroenterology	Full implementation of the project was achieved. The required number of colonoscopies for each APNE ($n = 200$) was met within the established timeframe of 12 months. Out of the original three Advanced Practice Nurse Endoscopists who commenced, two completed. Of the 409 procedures that were completed, the caecal intubation rate was 97.3%. The recommended target was a caecal intubation rate of 90% or greater. The mean colonoscopy withdrawal time was 15.8 min for all procedures. The Advanced Practice Nurse Endoscopist withdrawal time decreased by 6 min from 16.4 min in August 2017 to 10.4 min in June 2018. Data was not collected on the number of polyps retrieved per procedure. There were seven complications (1.7%), none of which were directly related to the Advanced Practice Nurse Endoscopists' actions. There was a 53% response rate to the consumer feedback survey ($n = 53$), with the majority of responses indicative a positive experience for patients and high levels of satisfaction. There were 35 responses to a staff survey. The staff survey indicated overall support for the introduction of this role. Cost Consequences: The main costs considered were for the training of each nurse and comprised three components: initial training, financial contribution to support the training development component at the hospital site, and interstate project support. For nurses who complete the training and continue in the Advanced Practice Nurse Endoscopist role, an additional 10,672 procedures could be performed over a 5-year period with an average training cost per additional procedure of $49 and would take 2.2 years to redeem all training costs.

TABLE 2 (Continued)

Author	Nurse-surgeon title	Surgeries performed by nurse-surgeon	Number of surgeries performed by nurse-surgeons	Surgical specialty	Findings
Davis et al.	Nurse, nonphysician	Male circumcision	Unable to determine	Urology	The preponderance of evidence on male circumcision performed by nonphysicians is that it is safe, both by the standards of the often-cited 2% moderate/severe AE rate threshold and compared with physicians. The noted exceptions to the overall safety equivalence between physician and nonphysician cadres support cautions around ensuring adequate mentorship for new providers as they develop experience. Voluntary medical male circumcision performed by nurses is safe, yet many countries have not yet aligned national nursing and midwifery regulations with national policies to provide clear authorization to perform male circumcision.
Day et al.	Nurse, nurse practitioner, non-physician, mid-level provider	Flexible sigmoidoscopy, upper endoscopy, colonoscopy,	Unable to determine	Gastroenterology	Non-physicians can safely perform endoscopic procedures with similar quality, especially with respect to screening flexible sigmoidoscopy. Far fewer data was reported for non-physicians performing colonoscopy and upper endoscopy, but among this data non-physicians perform both procedures within accepted national benchmarks for quality measures used in endoscopy.
De Bruijn-Geraets et al.	Nurse Practitioner	Endoscopy, injection, puncture, small surgical procedure	Not stated	Not stated	Quantitative data included 1251 Nurse Practitioners, 798 Physician Assistants and 504 physicians. The proportion of Nurse Practitioners and Physician Assistants performing reserved procedures increased from 77% to 85% and from 86% to 93%, respectively. The proportion of procedures performed on own authority increased from 63% to 76% for Nurse Practitioners and from 67% to 71% for Physician Assistants. The mean number of monthly contacts between Nurse Practitioner/Physician Assistant group and Physician group about procedures decreased (from 81 to 49 and from 107 to 54, respectively), as did the mean duration in minutes (from 9.9 to 8.6 and from 8.8 to 7.4, respectively). Utilization of Full Practice Authority was dependent on the setting, as scepticism of physicians and medical boards hampered full implementation. Legal cross-compliance requirements were mostly fulfilled.
Dimond	Nurse	Appendicectomy, vein stripping	Not stated	General	Not a primary research study
Dryer	Nurse Practitioner	Fistulogram, vascular access, venography, image-guided diagnostic vascular and interventional procedures, image-guided diagnostic procedures for treating disease	Not stated	Interventional radiology	Not a primary research study
Duffield et al.	Nurse endoscopist	Endoscopy, polyp removal, flexible sigmoidoscopy	1458	Gastroenterology	Not a primary research study
Duncan et al.	Nurse Endoscopist Trainee	Colonoscopy	255	Gastroenterology	The Nurse Endoscopist trainee completed 212 unassisted colonoscopies achieving an 83% success rate. Polyps were removed from 100 patients, and no complications were reported. 80% of patients reported no pain or discomfort during the procedure, 95% of patients reported the personal manner of the Nurse Endoscopist trainee as very good or excellent, 80% of patients rated the explanation and information given by the Nurse Endoscopist trainee at the start as very good or excellent, 68% of patients rated the Nurse Endoscopist 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.

(Continues)

TABLE 2 (Continued)

Author	Nurse-surgeon title	Surgeries performed by nurse-surgeon	Number of surgeries performed by nurse-surgeons	Surgical specialty	Findings
Duthie et al.	Nurse Practitioner / Nurse Endoscopist	Flexible sigmoidoscopy	215	Gastroenterology	Two hundred fifteen patients have been examined independently by the nurse practitioner. 93% of the examinations were judged successful and pathology was identified in 51%. The nurse endoscopist successfully identified all significant pathology whereas barium enema failed to identify pathology in 12.5%. There were no complications.
Eddy & Duffy	Nurse surgeon, nurse consultant, skin care nurse specialist, surgical nurse practitioner, dermatology nurse specialist, dermatology staff nurse, practice nurse, clinical nurse specialist	Excision (head and neck, trunk and limb), incisional biopsy, shave excision, shave biopsy, curettage and cautery, punch biopsy	Not stated	Dermatology	Great disparity in training access, roles, pay and titles.
Fitzgerald	Rural nurse specialists	Invasive procedures by the nurse, such as suturing, x-rays, cervical smears	Not stated	Not stated	Not a primary research study
Fox, Schira & Wadlund	Acute care nurse practitioner	Endotracheal Intubation, inserting/removing chest tubes, inserting central/arterial intravenous lines, suturing, bronchoscopy, diagnostic peritoneal lavage, minor procedures, wound closure, excision of skin lesions, repair of minor lacerations, incision and drainage of simple abscesses	Not stated	General	The acute care nurse practitioner provides another pathway for perioperative nurses in advanced nurse practice.
Ge et al.	Advanced practice provider (note: the article combined Physician Assistants and Nurse Practitioners as one group)	Balloon sinus dilation, flexible laryngoscopy, diagnostic nasal endoscopy, epistis control, canalith repositioning, fine needle aspiration, pressure equalization tube placement, mastoid bowl debridement, ear microscopy, sinus debridement, stroboscopy, skin biopsy, cerumen removal.	Not stated	Otolaryngology	Increasing number of Nurse Practitioners and Physician Assistants working in the area assisting with supply and demand issues.
Gifford & Stone	Nurse practitioner	Colposcopy, Pap smears, Ectocervical biopsies, Endocervical curettages	593	Gynaecology	Only 18 of the 73 (3%) discrepancies required re-examination by the consulting gynaecologist before a treatment plan could be set. Taking the service to the patient's hometowns raised show-rates to the 90–100% level.
Gilani et al.	Nurse practitioner	Large Volume Paracentesis	245	General	No difference in complications between two group
Giramonti & Kogan	Nurse practitioner/advanced practice practitioner	Circumcision, revision circumcision, minor endoscopic procedures (e.g. intravesical Botox injection)	100	Urology	Excellent success with a well-trained Nurse Practitioner performing minor penile procedures on children in the operating room was demonstrated. The operating room times for the circumcision for the Nurse Practitioner as compared to the surgeon with a resident were reviewed and found the times similar, 25 versus 27 min (with the caveat that the attending cases were slightly more complex).

TABLE 2 (Continued)

Author	Nurse-surgeon title	Surgeries performed by nurse-surgeon	Number of surgeries performed by nurse-surgeons	Surgical specialty	Findings
Godsell	Skin cancer nurse specialist	Skin biopsy	1500	Dermatology	Nurse biopsy role decreased waiting times. Structured framework developed for training.
Goodfellow, Fretwell & Simms	Colorectal nurse practitioner	Endoscopy, flexible sigmoidoscopy	282	Gastroenterology	Nurse endoscopy is safe and efficient
Grota et al.	Nurse-surgeon	Flexible sigmoidoscopy, colonoscopy, polypectomy, oesophageal banding, sclerotherapy, intravitreal therapy, saphenofemoral disconnection, long saphenous vein stripping, avulsions, wound closure, caesarean section, supracervical hysterectomy for ruptured uterus, dilatation and curettage, symphysiotomy, suction extraction and episiotomy, laparotomy, hernia repair	5450	Gastroenterology, ophthalmology, vascular, obstetric, gynaecological, and general surgery	A total of 18 studies was included in this review. Current methods of nurse-surgeon training were identified as surgical speciality specific ($n=18$). Most training courses were at least 1 year in length ($n=4$) with a theoretical component ($n=15$). All studies included a practical requirement ($n=18$), which was generally supervised by a physician ($n=16$). A competency assessment was required by 15 programmes, with 9 (9) using a formative assessment approach.
Hallquist	Nurse	Organ resection	Not stated	General	Not a primary research study
Hickey & Cooper	Surgical Care Practitioner	Saphenofemoral disconnection and long saphenous vein stripping, varicose veins avulsions, groin dissections	434	Vascular	No difference in outcomes between consultant performed procedures and through by the SCP.
Hillier	Nurse Practitioner / Clinical Nurse Specialist	Flexible sigmoidoscopy, paracentesis	16	Gastroenterology, general	Procedures performed by the Advanced Practice Nurses are predominantly those associated with enteral feeding tubes (19%) and flexible sigmoidoscopy (30%). 80% of Clinical Nurse Specialists and 40% of Nurse Practitioners felt studies looking at outcomes of Advanced Practice Nurse care (e.g. length of stay, number of emergency room and hospital visits, level of patient satisfaction, client compliance and number of repeat visits, and telephone management) were the best measures of cost-effectiveness of Advanced Practice Nurses.
Hilton	Advanced practice provider, nurse practitioner	Bladder instillations, intracavernosal injections for erectile dysfunction, percutaneous tibial nerve stimulation, cystoscopy for stent removal, neuromodulation with InterStim programming, priapism injection treatment, urodynamics	Not stated	Urology	Not a primary research study
Hlozek & Zacharias	Registered nurse first assistant	Harvesting of inferior epigastric arteries	Not stated	Cardiothoracic	Registered Nurses s can take on increased responsibilities.
Hlozek, Zacharias & Mizener	Registered nurse first assistant	Harvesting of radial artery for coronary artery bypass surgery	297	Cardiothoracic	Registered Nurse First Assistant use saves money for the health service.
Hough	Advanced nurse practitioner	Sigmoidoscopy, Colonoscopy, upper endoscopy	3870	Gastroenterology	Advanced Nurse Practitioner can undertake procedures safely and is cost effective. There is a need for a national education programme.

(Continues)

TABLE 2 (Continued)

Author	Nurse-surgeon title	Surgeries performed by nurse-surgeon	Number of surgeries performed by nurse-surgeons	Surgical specialty	Findings
Hui et al.	Nurse endoscopist	Colonoscopy	364	Gastroenterology	Nurse Endoscopists had a higher adenoma detection rate per procedure, but the rate becomes significantly lower than that of medical endoscopists after adjusting for the longer withdrawal time. The complication rates of the nurse endoscopists were comparable with those of the medical endoscopists (9.3% vs. 9.0%). The relatively high complication rate in this study is due to the stringent reporting of even minor adverse events such as transient desaturation or hypotension after conscious sedation. The nurse endoscopists performed well in terms of patients' pain and satisfaction scores as over 98% of patients were willing to have a repeat colonoscopy by the same endoscopist. The nurse endoscopists had a high level of patient acceptance.
Jalloh et al.	Acute care nurse practitioners	Paracentesis, thoracentesis, bone marrow biopsy, thoracostomy, bronchoscopy	Not stated	General	Acute Care Nurse Practitioner privileging varies among institutions. The only commonality is that the medical staff offices oversee the credentialing and privileging process. Although an attending physician provided supervision and proctoring in most hospitals, the number of proctored procedures before they could practice independently was not standardized and varied by institution and the procedure performed.
Johal & Dodd	Nurse practitioners/ physician's assistant	Thoracostomy, percutaneous endoscopic gastrostomy, tracheotomy	Unable to determine	Trauma, general	With the addition of Nurse Practitioners and Physician Assistants, patient length of stay decreased, and morbidity and mortality were unchanged. In addition, resident workload decreased, sleep time increased, and operating time improved. Patient and healthcare worker satisfaction rates were high. Several studies reported cost savings after the addition of Nurse Practitioners and Physician Assistants. The addition of NPs and PAs to surgical/trauma services appears to be a safe, cost-effective method to manage some of the challenges arising because of resident duty hour restrictions. More high-quality research is needed to confirm these findings and to further assess their economic impact.
Johnston	Nurse endoscopist	Endoscopy	Not stated	Gastroenterology	Not a primary research study
Judd	Advanced nurse practitioner	Minor surgery, for example, toenail ablation, fracture manipulation	Not stated	Plastics	Not a primary research study
Kanchanasinith et al.	Nurse-midwife	Postpartum Sterilization	541	Gynaecology	A comparison of 541 procedures done by nurse- midwives and 279 performed by physicians show that the two provider groups do not differ significantly with respect to the rate of surgical difficulties (2.2% among physicians and 3.1%among nurse-midwives) or the rate of complications 1 year after the operation (3.9% among physicians and 4.4% among nurse-midwives). However, there were significant differences regarding counselling about the operation ($p < .05$), with nurse-midwives providing more complete information about the surgery than the physicians. The results of the study support the training of nurse-midwives to perform postpartum sterilization.
Kingsnorth	Nurse surgeon	Hernia surgery	Not stated	General	A clinical scoring system is useful in guiding trainees through hernia surgery.
Koetsawang et al.	Operating room nurse	Postpartum tubal sterilization	1074	Gynaecology	Equivalence of outcomes between nurses and surgeons
Kowalewski & Jahn	Registered nurse and midwife (paramedic staff)	Minor surgery, caesarean section, strangulated hernia	Not stated	Obstetrics, general surgery	Poor midwifery coverage in rural areas
Laing	Ophthalmic nurse	Incision and curetting of cysts of Moll, Removal of sebaceous cysts or cysts of Zeiss, Incision and curetting chalazions (meibomian or tarsal cysts), Excision of small skin tags or papilloma	Not stated	Ophthalmology	Waiting time for an assessment appointment after referral by a general practitioner has been reduced from approximately 6 months in 1992, to 8 weeks in 1998 allowing time for health promotion, health education and a holistic care approach.

TABLE 2 (Continued)

Author	Nurse-surgeon title	Surgeries performed by nurse-surgeon	Number of surgeries performed by nurse-surgeons	Surgical specialty	Findings
Lane & Minns	Advanced nurse practitioner	Prostate biopsy	Not stated	Urology	Advanced Nurse Practitioner outcomes equal to medical colleagues. There is a need for professional development opportunities for nurses.
Limoges-Gonzalez	Nurse Practitioner, nurse endoscopist	Sigmoidoscopy, colonoscopy,	Not stated	Gastroenterology	With training, nurse endoscopists are equivalent to physicians. There is large variation in American states as to if nurse practitioners are allowed to undertake colonoscopies within their scope of practice.
Lucas	Nurse, Surgical Care Practitioner	Trans-perineal prostate biopsies	55	Urology	This work has demonstrated that transperineal prostate biopsy under local anaesthesia can be safely adopted by allied healthcare professionals with no detriment to oncological outcomes or patient experience and with zero complications.
Marsh	Nurse-surgeon	Vein stripping from the leg for Coronary artery bypass grafting, minor surgeries	Not stated	Vascular, orthopaedics, ophthalmology, gynaecology	Reduced the average time for bilateral varicose vein surgery by 30 min in one hospital and in the other enabled a 2-week target for bladder cancer treatment to be met.
Maruthachalam et al.	Nurse endoscopist	Flexible sigmoidoscopy	1002	Gastroenterology	Our study reinforces the fact that flexible sigmoidoscopy can be safely performed in primary care. It is the first study from the UK to demonstrate that flexible sigmoidoscopy can be safely performed by a nurse endoscopist for lower gastrointestinal tract symptoms in primary care with adequate support and training. Investigating patients at the community flexible sigmoidoscopy clinic resulted in reduction of the waiting time to flexible sigmoidoscopy and the time to histological diagnosis of colorectal cancer. In addition the clinic was able to generate additional capacity for endoscopy in secondary care by routing the flexible sigmoidoscopy service to primary care.
Massl et al.	Nurse endoscopist	Colonoscopy, polypectomy	866	Gastroenterology	Comparable outcomes between nurses and physician assistants. Nurses less costly to employ.
McConkey & Hahessy	Advanced nurse practitioner, nurse cystoscopist	Flexible cystoscopy, bladder biopsy, diathermy, removal of ureteric stents	Not stated	Urology	Not a primary research study
McConkey et al.	Nurse cystoscopist, Candidate Advanced Nurse Practitioner (abbreviated as cANP)	Flexible cystoscopy	Unclear	Urology	Twenty consecutive records of patients attending the candidate Advanced Nurse Practitioner for surveillance of high-grade non-muscle invasive bladder cancer demonstrated a 90% compliance rate (two patients unable to void anappropriate sample). 100% of patients who received a prophylactic antibiotic had a documented valid reason for administration. The Candidate Advanced Nurse Practitioner completed (supervised) 57% of all cystoscopies without a perceivable increase in the average time to complete an entire episode of care (26:27 vs. 26:12 min, s).
Meenan et al.	Nurse Endoscopist	Radial endosonography	5	Gastroenterology	The role of the nurse endoscopist could be expanded to encompass diagnostic endoscopic ultrasound and so meet the increasing demand for it. In view of the lengthy and demanding nature of EUS training, such an approach might also prove to be an attractive option in the long term, as gastroenterology fellows are more likely to move on to other institutions, with a net loss of skills.

(Continues)

TABLE 2 (Continued)

Author	Nurse-surgeon title	Surgeries performed by nurse-surgeon	Number of surgeries performed by nurse-surgeons	Surgical specialty	Findings
Melleney & Willoughby	Nurse endoscopist	Upper gastrointestinal endoscopy	84	Gastroenterology	The provision of a nurse endoscopist has facilitated the creation of the one stop service and will be important in its evolution and refinement in the future. Although the one stop dyspepsia clinic in our hospital has not, to date, achieved its original intention in terms of the rapid detection of important pathology, it has allowed the development of an integrated diagnostic service involving specialist physicians and a skilled nurse endoscopist. The system is popular with patients and provides the basis for a fast-track system to assess patients at a single hospital visit.
Meo et al.	Nurse	Caesarean section, hernia repair (inguinal, Busoga, congenital, lumbar, femoral, epigastric, umbilical, Spigelian), proctologic surgery, gynaecologic surgery, Management of and fluid therapy for shock, Incision and drainage of abscesses and pyomyositis, Management of wounds, burns, surgical infections, snakebites, Excision of lipomas, sebaceous cysts, small skin tumours, onchocercal nodules, encysted guinea worms, Uterine curettage, Manual removal of the placenta, Suprapubic puncture of the bladder with a trocar for urinary retention, Immobilization of fractured limbs, Skin grafting, Tooth extraction	Not stated	General, obstetrics, gynaecology, plastics, dental	A total of 1642 patients (71% males, 30% under the age of 16) have undergone anoperation. Altogether, 1264 elective procedures (77%) and 378 emergency procedures (23%) were performed. Hernia surgery comprised the main workload, followed by proctologic and gynecologic operations. Most operations were performed under spinal anaesthesia. Other cases required ketamine, and a small number of patients had local anaesthesia. There were 14 fatal complications, most of them related to the delay in obtaining medical attention. Based on the training results, the Sudanese personnel of two of the five health centres involved in the programme are already fully autonomous. Two doctors and two nurses are proficient in essential surgery; two not qualified nurses are proficient in primary anaesthesia, and others are proficient in scrubbing and surgical nursing.
Mickute	Nurse surgeon, Nurse Practitioner	Gastroscopy, colonoscopy	Not stated	Gastroenterology	Not a primary research study
Moshakis, Ruban & Wood	Nurse endoscopist	Flexible sigmoidoscopy, clinical coloproctology, haemorrhoids injection	150	Gastroenterology	Nurse training was stricter than those of physician. Comparable results.
O'Rourke	Orthopaedic nurse practitioner	Reduce dislocations and fractures, administer fascia iliaca compartment blocks, wound closures, sutures, carpal tunnel decompression procedures, harvest anterior cruciate ligament grafts,	Not stated	Orthopaedics	Nurse Practitioners can be effectively implemented in the perioperative setting to provide holistic care for all patients requiring surgical management of musculoskeletal injuries and/or conditions.
Oliver	Surgical care practitioner	Facial skin cancer excisions, skin grafts and flap reconstructions	Not stated	Plastics	Not a primary research study

TABLE 2 (Continued)

Author	Nurse-surgeon title	Surgeries performed by nurse-surgeon	Number of surgeries performed by nurse-surgeons	Surgical specialty	Findings
Patel & Nguyen	Nurse Practitioner	Skin cancer biopsy	Unclear	Dermatology	All 50 states had increases in the number of biopsies claims per 100,000 Medicare beneficiaries by nonphysician providers between 2012 and 2018, with dermatologists having an average decline over the same period. From 2012 to 2018, national biopsy rates per 100,000 Medicare beneficiaries for dermatologists decreased by 6%, whereas those for Nurse Practitioners and Physician Assistants increased by 97% and 82%, respectively. Each state showed variation in both the proportion of biopsies by provider type and the net change in biopsies rates over time. All states saw increases in the number of biopsies per 100,000 Medicare beneficiaries by nonphysician providers.
Pearce	Nurse, Surgical assistant prior to training for this surgery	Carpal Tunnel Surgery	Not stated	Plastics	When the nurse first suggested that she could do carpal tunnel surgery, the consultants at Stepping Hill were entirely supportive. Most of the resistance to change came from nurses. After extensive training, the nurse is now able to offer a seamless service to patients, from assessment through to surgery and discharge.
Pervaiz et al.	Nurse Hysteroscopist	Hysteroscopic morcellation	287	Gynaecology	The trainee and the nurse specialist were more likely to use local anaesthesia (OR = 4.8, 95% CI = 1.1–21.5). There was no significant difference between operators as regards to the use of gas and air (OR = 1.6, 95% CI = 0.3–8.2) or combined anaesthesia (OR = 1.15, 95% CI = 0.2–6.5). The majority confirmed receiving adequate preoperative information by doctors and nurses (97.3%). Consultants were significantly less likely to use local anaesthesia when compared to the trainees and nurse specialist probably due to the higher experience and confidence. However, this has not affected women satisfaction which remained high irrespective of the operator. Results suggest that the subjective estimation of the polyp size by consultants and nurses specialized in hysteroscopy may be an accurate and simple method of measurement.
Puzey	Nurse endoscopist	Oesophageal manometry, flexible sigmoidoscopy, endoscopy	Not stated	Endoscopy	Nurse endoscopist was training to perform oesophageal manometry and flexible sigmoidoscopy at time of interview
Quick	Surgical Care Practitioner	Saphenofemoral junction ligation and disconnection, long saphenous vein strip and harvest, avulsion, multiple stab avulsions, ablation therapy, sclerotherapy, open inguinal hernia	Not stated	Urology, trauma, orthopaedics, cardiothoracic, plastics and reconstructive surgery, neurosurgery, paediatrics, general surgery, vascular, maxillofacial, otorhinolaryngology, gynaecology	*"As a novice SCP, I drew upon the national SCP curriculum to guide me in acquiring the core knowledge and clinical skills required to perform the role safely and effectively. Learning the specialist knowledge required of a vascular and general SCP allowed me to move into the advanced beginner stage as I started to develop my own portfolio of cases I could assist for and perform. Successfully completing a national SCP training programme supported my competence at this level".*

(Continues)

TABLE 2 (Continued)

Author	Nurse-surgeon title	Surgeries performed by nurse-surgeon	Number of surgeries performed by nurse-surgeons	Surgical specialty	Findings
Quick	Nurse, Surgical Care Practitioner	Inguinal hernia repair	Not stated	General surgery	The findings from this study identified that as a permanent member of the surgical team, the nurse made a difference to the experience of the surgical patient. As a knowledgeable team member, the addition of a Surgical Care Practitioner to the surgical team was seen by the surgeons to directly improve patient care by ensuring patient understanding and compliance. Additional finding suggested that including a nurse in the surgical team encouraged a cohesive approach that improved the patient experience. In particular, the findings from this study suggest that the addition of a nurse to a surgical team enhances patient care, maintains surgical services and supports the training of junior doctors. Additional findings suggest that nurses who undertake innovative roles adhere to the professional, ethical and legal obligations of advanced perioperative practice. Interprofessional collaboration was improved, as was service provision.
Ranjan et al.	Nurse specialist	Cystoscopy, urethral dilation, urethroscopy	Not stated	Urogynaecology	One hundred ninety patients have been treated at the cystoscopy and dilation clinic and are at various stages of follow up. We find that the primary treatment performed by nurses at the institute leads to improved outcomes.
Rich et al.	Advanced Care Practitioner (collective term for Nurse Practitioners and Physician Assistants)	Removal of ear/nasal foreign body, tongue tie lysis, nasopharyngoscopy, flexible laryngoscopy	Not reported	Paediatric otolaryngology	The current study demonstrated that most Advanced Care Practitioners are involved in procedures (93%) with 83% at the bedside, 77% in the clinic (both 62% without supervision), and 34% in the operating room. A large proportion of respondents feel that the presence of Advanced Care Practitioners has a positive effect on surgical trainees, both fellows and residents. Their use in paediatric surgery is widespread. While staffing models vary, Advanced Care Practitioners perform a wide variety of tasks, cover many shifts, and bill for services. Overall, paediatric surgeons are satisfied with their respective Advanced Care Practitioner coverage model but endorse potential benefits of increased shifts and responsibilities. It is largely felt they enhance the paediatric surgery trainee experience.
Salibian et al.	Nurse practitioner	Local excision or destruction of lesion or tissue, aspiration curettage of uterus, circumcision, vasectomy, irrigation of ear	2,894,406	General surgery, obstetrics, gynaecology, orthopaedics, urology, ophthalmology, otolaryngology	Physician Assistants or Nurse Practitioners were involved in 5.9% of visits, though the percentage of patients seen by them alone (1.1%) was significantly lower ($p < .0001$). Physician Assistants and Nurse Practitioners were more likely to be involved in pre- or postop visits, and often saw the same diagnoses alone as physicians only.
Sapre et al.	Nurse	Flexible cystoscopy	720	Urology	The introduction of nurse-led flexible cystoscopy has reduced the waiting list from an average of 68 patients per month in the 3-month period preceding the introduction of this service to between 10–30 patients per month, currently.

TABLE 2 (Continued)

Author	Nurse-surgeon title	Surgeries performed by nurse-surgeon	Number of surgeries performed by nurse-surgeons	Surgical specialty	Findings
Satyapan et al.	Nurse-midwife	Tubal ligation	3549	Gynaecology	In only 18 cases (0.5%), assistance was needed from the supervising doctors because of difficulties resulting from one or more of the following conditions: thick abdominal fat, tubal adhesions, inadequate sedation and/or analgesia. The average operating times decreased as the nurse-midwives gained experience. The postoperative complication rates were not substantially different from the rates observed in the pilot study On discharge from the hospitals, 3457 subjects (97.4%t) reported full satisfaction with the service and said that they would recommend tubal ligation to friends. The results of the field trial of the nurse-training programme are similar to those of the pilot study, and further demonstrate that nurse-midwives with operating-room experience can safely perform post- partum tubal ligation under local anaesthesia in provincial settings.
Schoenfeld et al.	Nurse endoscopist	Flexible sigmoidoscopy	162	Gastroenterology	Gastroenterologists and nurse endoscopists had equivalent miss rates for adenomatous polyps (20% vs. 21%, respectively). No complications occurred in any patient. Polyp location in the descending colon (95% CI: 1.7–10.3) was highly associated with missed polyps.
Schultz	Nurse practitioners, nurse cystoscopist	Cystoscopy, sigmoidoscopy and colposcopy with biopsy		Urology	Nurse cytoscopists should be trained.
Schwegel et al.	Nurse Practitioner	Angiography	Not stated	Interventional radiology	The lack of both state and federal regulations for Nurse Practitioner work and standardization of clinical training has resulted in confusion regarding scope of practice. The title practitioner caused further misunderstandings because it included the term nurse. However, a view that Nurse Practitioners are encroaching on their training is additionally a major obstacle in specialty practice. This drives the fear that Nurse Practitioners overstep professional boundaries as they become autonomous. If duties and responsibilities can be appropriately apportioned, non-physician providers can relieve some of the excess clinical duties for both attending and trainee radiologists.
Shegafi et al.	Surgical care practitioner	Removal of sebaceous cysts, skin tags, basal cell papilloma and lipomas, varicose vein surgery, hip aspiration	Not stated	Dermatology, vascular, orthopaedics	Based on the available evidence, the role of Surgical Care Practitioners in cardiac surgery has been found to be effective in acting as first assistants or in teaching basic surgical skills to junior doctors. Even within other surgical settings, the presence of the Surgical Care Practitioner has been found to be of benefit in terms of their clinical outcomes, impact on the workforce and colleagues' opinions. However, this conclusion is weakened by several limitations that affect its external validity. Thus, this review advocates for prospective clinical research to examine the impact of Surgical Care Practitioners in cardiac surgery and other surgical settings.
Shum et al.	Trained nurse endoscopist	Flexible sigmoidoscopy	119	Gastroenterology	The examinations performed by the nurse endoscopist resulted in no procedure-related complications. If screening sigmoidoscopy is performed by the nurse endoscopist, the cost, manpower and resources will be better used. The sample size used in this paper was relatively small for clinical application or generalization. This study determined that flexible sigmoidoscopy is feasible for nurses to perform provided they are suitably motivated and technically skilled.

(Continues)

TABLE 2 (Continued)

Author	Nurse-surgeon title	Surgeries performed by nurse-surgeon	Number of surgeries performed by nurse-surgeons	Surgical specialty	Findings
Simcock et al.	Nurse Practitioner	Intravitreal therapy, minor lid surgery	10,006	Ophthalmology	The Nurse Practitioners administered 10,006 injections in the first 5.5 years of the service (1 May 2008 to 8 October 2013). This represented 84.1% of the total injections performed during this period. Four patients developed presumed infectious endophthalmitis (one was culture positive and three were culture negative). The incidence of post-injection endophthalmitis was 0.04%. There was no evidence of lens touch, retinal detachment, or systemic thrombo-embolic events. Carefully selected and well-trained Nurse Practitioners are capable of delivering a safe and effective wet age-related macular degeneration injection treatment service.
Sprout	Licensed vocational nurse, registered nurse, clinical nurse specialist, nurse practitioner	Colonoscopy, esophagogastroduodenoscopy, dilations, sclerotherapy, variceal banding, flexible sigmoidoscopy	Not stated	Gastroenterology	Discuss different training for nurse cystoscopists. Need for standardized training criteria.
Taylor et al.	Nurse practitioner	Skin and endometrial biopsy, minimally invasive image-guided interventional radiology	Not stated	Interventional radiology	These challenges of clinical practice have prompted interventional radiologists to partner with allied health professionals to meet the needs of growing and increasingly complex practices. These professionals include, but are not limited to, nurse practitioners, physician assistants, and radiology practitioner assistants. Each professional has different training and education, potential scope of practice, and ability to bill for service.
Thommasen et al.	Nurse practitioner	Papanicolaou smear	55	Gynaecology	Nurse practitioner in the study collected Pap smears that were of comparable quality to those collected by physicians in our clinic. Having the nurse practitioner take Pap smears has also been positive for the clinic and the community. Women no longer have to be concerned about whether a female healthcare provider is available to do a Pap smear if they prefer a woman. Having the nurse do routine Pap smears has allowed physicians (particularly our female physicians) more time for diagnosis and treatment of disease.
Tingle et al.	Surgical care practitioner	Hip aspiration	360	Orthopaedics	The hip aspiration failure rate for the Surgical Care Practitioner was significantly lower than for the surgeons, probably as a result of the learning curve, which this study demonstrated. Other trusts should consider delegating routine hip aspiration work to a Surgical Care Practitioner to lower failure rates.
Turner & Aslet	Nurse practitioner	Transultrasound-guided prostate biopsy, flexible cystoscopy	Not stated	Urology	Accreditation for advanced practice roles has yet to be implemented in the United Kingdom. Therefore, it is up to individual practitioners to develop themselves and their employing organization to authorize advanced practice.
Turner & Pati	Nurse practitioner	Transrectal ultrasound and prostate biopsy	116	Urology	Patient outcomes of nurse led clinic comparable to doctor led clinic outcomes.

TABLE 2 (Continued)

Author	Nurse-surgeon title	Surgeries performed by nurse-surgeon	Number of surgeries performed by nurse-surgeons	Surgical specialty	Findings
van Putten et al.	Nurse endoscopists	Colonoscopy, polypectomy	2013	Gastroenterology	Nurse endoscopists perform according to required standards. High patient satisfaction scores following colonoscopy.
Weinstein & Demers	Nurse practitioner	Minor surgery	35	Primary care	Of 275 patient visits for inoculations, injections, and laboratory tests, 189 (68.7%) were made. Visits for minor surgery rank low in all categories. Total visits number only 35, ranking tenth of 12. 37.1% of the 35 visits for minor surgery were recorded.
Weiss et al.	Nurse	Male circumcision	Not clear	Urology	Circumcision was common with few complications.
White, Thorpe & Maine	Nurse-surgeon	Caesarean sections, hernia repair, repair of ruptured uterus, hysterectomy, laparotomy for ruptured ectopic pregnancy, dilatation and curettage, symphysiotomy, suction extraction, episiotomy, tubal ligation	326	General, obstetrics, gynaecology	Two hundred seventy-eight of 321 caesarean sections were done by nurse-surgeons in 18 months, with two deaths. All 32 caesarean sections in 13 months were done by the nurse-surgeons, with one death. Of the 37 laparotomies done in both centres, 16 were by nurse-surgeons, and there were two deaths. Four of the five deaths were attributable to protracted labour with septicaemia, postoperative infection, and protracted labour with no blood pressure on admission.
Wildi et al.	Non-physician endoscopist	Oesophagoscopy	43	Gastroenterology	Esophagoscopy by a non-physician endoscopist is feasible and accurate in detecting oesophageal pathologies. The non-physician endoscopist missed six lesions. The identification of rings in the distal oesophagus is sometimes dependent on adequate air insufflation with maximal unfolding of the lumen.
Williams et al.	Nurse practitioner	Circumcision	239	Urology	High patient satisfaction rate with Nurse Practitioner circumcision for low-risk patients. Substantial cost savings.
Wise	Nurse surgeon	Skin surgery	5000	Dermatology	Not a primary research study
Wright	Nurse endoscopist	Flexible sigmoidoscopy, biopsy, polypectomy, hot biopsy, percutaneous endoscopic gastrostomy, esophagogastroduodenoscopy, colonoscopy	Not stated	Gastroenterology	Ten subjects reported they started as nurse endoscopists to provide colorectal cancer screening. Another subject was initially trained to do follow-up endoscopic gastroduodenoscopy and colonoscopy. Training generally consisted of a review of gastroenterology anatomy and physiology ($n=4$), reading related literature ($n=4$), observation of endoscopic procedures ($n=6$), and hands-on practice ($n=11$). Most subjects ($n=12$) were taught endoscopy by a physician, though several were trained by a nurse or nurse/physician team ($n=3$). Two subjects did not identify who taught them endoscopy. The number of supervised endoscopies required before independent practice as an endoscopist ranged from 10 to 104 (mode = 25). Twelve of 15 subjects supported the need for a standardized nurse endoscopist curriculum for standardized training. Reasons for supporting a standardized curriculum included the need to establish competency ($n=3$), gain public trust ($n=2$), instill confidence ($n=4$), and identify a minimal standard of practice ($n=4$).
Zhang et al.	Advanced Practice Professional (collective term for Certified Registered Nurse Practitioner and Physician Assistant)	Biopsy, shave, removal of benign lesion, removal of malignant lesion, destruction of benign lesion, destruction of malignant lesion, simple repair, intermediate repair, complex repair, local flap, full thickness graft,	2.69 million in 2012 4.54 million in 2015 Both figures shared by Advanced Practice Professional	Plastics, dermatology	Increasing number of dermatological procedures by nurse practitioners. Question need for credentialing of APPs and studies into patient outcomes.

et al., 2006; Ranjan et al., 2016; Rich et al., 2021; Sapre et al., 2012; Satyapan et al., 1983; Thommasen et al., 1996). All of these 12 records stated that nurse-surgeons can perform surgeries on patients safely with five records (Davis et al., 2021; Day et al., 2014; Hickey & Cooper, 2009; Koetsawang et al., 1981; Thommasen et al., 1996;) specifying that nurse-surgeons performed safe surgeries that were comparable with physicians. Davis et al. (2021) further noted that nurse-surgeon and physician performed surgeries were safe by the 2% moderate to severe adverse event rate. Satyapan et al. (1983) believed that nurse-surgeons with theatre nursing experience can safely undertake surgeries in rural areas.

Complication rates from nurse-surgeon performed surgeries were reported in 16 (17%) records. No complications were reported by Lucas (2020), Cusack et al. (2018), Duncan et al. (2017), Shum et al., 2010, Bull et al. (2006), Schoenfeld et al. (1999), Duthie et al. (1998), and Moshakis et al. (1996). Comparisons of complication rates between nurse-surgeons and physicians were studied in five records and all reported comparable outcomes (Gilani et al., 2009; Hui et al., 2015; Kanchanasinith et al., 1990; Lane & Minns, 2010; Turner & Pati, 2010). One record compared nurse-surgeons with physician assistants and the outcomes were also comparable (Massl et al., 2014). Two records (Simcock et al., 2014; Weiss et al., 2010) reported few complications with Simcock et al. (2014) specifying a 0.04% incidence rate of postsurgical complications.

4.5 | Surgical care efficiency

Efficiency of surgical care as an outcome of nurse-surgeon performed surgeries were reported in 19 (20%) records (Cooper, 2021; Cusack et al., 2018; Ge et al., 2021; Gifford & Stone, 1993; Giramonti & Kogan, 2018; Godsell, 2005; Goodfellow et al., 2003; Johal & Dodd, 2017; Kanchanasinith et al., 1990; Laing, 1999; Marsh, 2005; McConkey et al., 2019; Meo et al., 2006; Quick, 2013; Thommasen et al., 1996). All specified the positive impact of nurse-surgeons in the efficient delivery of surgical services in terms of patient access to surgery (Cooper, 2021; Cusack et al., 2018; Ge et al., 2021; Meo et al., 2006), waiting times (Godsell, 2005; Laing, 1999; Marsh, 2005; Sapre et al., 2012), surgery times (Giramonti & Kogan, 2018; Johal & Dodd, 2017; McConkey et al., 2019), patient show rates or the rate of patients showing up to their surgical appointment (Gifford & Stone, 1993), patient education (Kanchanasinith et al., 1990), physician workload and rest times (Johal & Dodd, 2017; Thommasen et al., 1996), and junior physicians' training (Quick, 2013; Rich et al., 2021). Cooper (2021) noted the 100% achievement of the ideal referral-to-treatment time upon the addition of nurse-surgeons in the service as compared to the prior to the implementation of nurse-surgeons with a referral to treatment time of 81% in 2012 and 85% in 2015. Marsh (2005) reported the achievement of a hospital's 2-week target for bladder cancer surgical treatment when nurse-surgeons were implemented.

As reported in 3 (3%) records, nurse-surgeons did not deviate from the usual amount of time a surgeon spends to complete a surgery and instead decreased the theatre flow time (the time patients spend from entering to leaving of the operating theatres) from 59 to 40 min, thereby improving surgical times (Cusack et al., 2018; Johal & Dodd, 2017; McConkey et al., 2019). Ge et al. (2021) and Meo et al. (2006) indicated that nurse-surgeons assisted with supply and demand in the context of perioperative service delivery. According to Gifford and Stone (1993), the introduction of nurse-surgeons in rural areas increased patient show rates (the rate of patients showing up to their surgical appointment) to the 90%–100% level. On average, Giramonti and Kogan (2018) found that nurse-surgeons completed paediatric penile surgeries in 25 versus 27 min by physicians. Nurse-surgeons decreased waiting times by 30 min (Marsh, 2005), from 6 months to 8 weeks (Laing, 1999), and from 68 per 3 months to 10–30 per month (Sapre et al., 2012). Nurse-surgeons decreased the junior physicians' workload which increased their sleep time (Johal & Dodd, 2017), assisted them in managing the restrictions in their work hours (Johal & Dodd, 2017), enhanced their surgical training experience (Quick, 2013; Rich et al., 2021), and allowed them more time to diagnose and treat other diseases (Thommasen et al., 1996). Finally, Kanchanasinith et al. (1990) found the statistically significant ($p < .05$) difference in the provision of more complete preoperative patient education by nurse-surgeons versus physicians.

4.6 | Patient satisfaction

Patient satisfaction was reported in 7 (7%) records (Basnyat et al., 2001; Cusack et al., 2018; Hui et al., 2015; Johal & Dodd, 2017; Satyapan et al., 1983; van Putten et al., 2012; Williams et al., 2020). All studies reported positive patient satisfaction. Using a patient questionnaire, 99% of the first 249 patients in Basnyat et al. (2001) study was satisfied with their surgery being performed by nurse-surgeons with 238 patients experiencing minimal discomfort and nine experiencing moderate discomfort. Cusack et al. (2018) evaluated the patients' overall satisfaction via a consumer feedback form with majority of responses indicating "high" (exact numerical figure was not explicitly provided) levels of satisfaction. Following full recovery validated by the ability to answer a 100-7 subtraction test three times, the patients in Hui et al. (2015) study were asked to rate on a scale of 1 (poor) to 5 (excellent) their satisfaction in terms of the nurse-surgeons' bedside manner, technique, level of explanation and overall experience. Overall, the patients in the nurse-surgeon arm rated their overall experience as excellent (standard deviation of 4.5). Of the 364 patients in the nurse-surgeon arm, 360 (98.9%) reported willingness to have their surgery performed by a nurse-surgeon again. Johal and Dodd's (2017) systematic review of 29 articles found six studies reporting improved or high patient satisfaction with the addition of nurse-surgeons and other non-physician surgical providers. In Satyapan et al. (1983) study, patients were interviewed by the nurse-surgeons' physician supervisor to determine their satisfaction with their procedure and 3, 457 (97.4%) reported full satisfaction with the surgical service they received and would recommend tubal ligation to friends. Van Putten et al. (2012) measured patient

satisfaction through a questionnaire that was filled in by patients at the time of their discharge from the post anaesthesia care unit. Of the 734 patients that completed the questionnaire, 694 (95%) were satisfied with the service. Finally, Williams et al. (2020), surveyed 239 patient families 6 weeks after their newborns' circumcision. Of the 49 (20.5%) patient families that responded, 89.5% rated the overall quality of care they received as excellent or very good and 87.5% were either extremely satisfied or satisfied with the appearance of their newborns' penis postoperatively.

4.7 | Economic outcomes

The implementation of nurse-surgeons was identified as cost-effective in 5 (5%) records (Basnyat et al., 2001; Hough et al., 2012; Johal & Dodd, 2017; Massl et al., 2014; Williams et al., 2020). These savings were substantial translating into a net saving of at least $90 per patient (Basnyat et al., 2001; Williams et al., 2020). Nurse-surgeons were less costly to employ as compared to surgeons and appeared to be a cost-effective method in managing the difficulties emerging from junior physicians' work hour restrictions (Johal & Dodd, 2017; Massl et al., 2014). Cost-effective ratios reported via net cost savings are provided in Appendix S3.

4.8 | Credentialing, professional development and standardization of nurse-surgeons

The standardization of nurse-surgeon practice in terms of nationwide regulation in titles, scope of practice, salary, training, credentialing and professional development was recommended by 13 (14%) records (Eddy & Duffy, 2019; Fox et al., 2000; Grota et al., 2021; Hough et al., 2012; Jalloh et al., 2016; Lane & Minns, 2010; Moshakis et al., 1996; Quick, 2013; Quick, 2016; Schultz, 2011; Schwegel et al., 2019; Sprout, 2000; Zhang et al., 2018). The lack of regulations to standardize nurse-surgeon scope of practice caused confusions due to the ambiguity of the titles used (Schwegel et al., 2019) and demonstrated the great disparity in nurse-surgeons' titles, roles, pay and training access (Eddy & Duffy, 2019). According to Quick (2013), the standardization of nurse-surgeon practice would assist in the adherence to professional, ethical and legal obligations of advanced perioperative practice. Most nurse-surgeon training programmes were at least 1 year which combined practical and theoretical components along with clinical supervision and competency assessment prior to independent practice (Grota et al., 2021) and the credentialing of nurse-surgeon was seen to provide an additional pathway for perioperative nurses in advanced nursing practice (Fox et al., 2000). Professional development opportunities for nurse-surgeons were also necessary (Lane & Minns, 2010).

5 | DISCUSSION

The findings from this scoping review identified various roles that nurse-surgeons play in global surgical care with data being predominantly published in the United Kingdom and United States. This reflects the scope and use of nurse-surgeons in high-income, upper-middle-income and low- and lower-middle-income countries. It is worth noting however the differences in the included records in these countries particularly in how nurse-surgeons emerged, and the types of surgeries nurse-surgeons performed. In low- and lower-income countries, nurse-surgeons emerged mainly from a chronic demand in specialized surgeons requiring nurses to perform complicated surgeries such as caesarean section, laparotomy and trauma surgery (White et al., 1987). Whereas, in high-income countries, nurse-surgeons mainly emerged as an answer to the ballooning waiting lists for diagnostic surgeries allowing them to perform targeted minor surgeries such as endoscopy, hysteroscopy, cystoscopy or biopsy which will then translate to faster specialist referrals should anomalies arise from such diagnostic surgeries (Bull et al., 2006; Marsh, 2005; Sapre et al., 2012). In both scenarios, access to surgery is paramount in truly achieving universal healthcare. Figure 2 displays the income classification of the countries in the included records.

Our findings suggest a gradual increase in published literature about nurse-surgeon roles has occurred from five records in the previous three to five decades to 53 in the most recent decade. Our scoping review found more than 5 million nurse-performed surgeries in multiple specialties. Due to the inclusion of grey literature and unpublished data, this scoping review found a more diverse set of nurse-surgeon performed surgeries and surgical specialties than identified in earlier reviews (Grota et al., 2021; Grota et al., 2022).

This scoping review also highlights the benefits and research gaps on nurse-surgeon roles. The identified benefits include high patient satisfaction, improved surgical care efficiency, comparable complication rates with physicians, high patient safety and improved cost-effectiveness. The research gaps, on the other hand, include the need for standardization and credentialing of nurse-surgeon practice and the ambiguity in nurse-surgeon titles.

A consistently high satisfaction of patients from surgical services provided by nurse-surgeons preoperatively, intraoperatively and postoperatively was found in the studies. Nurse-surgeons provide more time to educate patients preoperatively as compared with physicians (Kanchanasinith et al., 1990; Wright, 2000). Patients who were also satisfied with their nurse-surgeon during surgery and postoperatively, would recommend their nurse-surgeon to friends or opt to have a surgery provided by a nurse-surgeon again (Satyapan et al., 1983). These findings are consistent with Grota et al. (2022) and Grota et al. (2021) findings where both systematic reviews concluded the high patient satisfaction from nurse-surgeons.

This review also identified the positive contribution of nurse-surgeons in the efficient delivery of global surgical care in the context of timely patient access to surgery, waiting times, surgery times, patient show rates, preoperative patient education, physician workload and rest times, and junior physicians' training (Cooper, 2021; Cusack et al., 2018; Ge et al., 2021; Gifford & Stone, 1993; Giramonti & Kogan, 2018; Godsell, 2005; Johal & Dodd, 2017; Kanchanasinith et al., 1990; Laing, 1999; Marsh, 2005; McConkey et al., 2019; Meo et al., 2006; Quick, 2013; Rich et al., 2021; Sapre et al., 2012;

Thommasen et al., 1996). While Grota et al. (2021, 2022) also reported the contribution of nurse-surgeons in surgical access, waiting times and patient show rates, this scoping review further added the benefits of nurse-surgeons in improving patient show rates in rural settings and provision of a more comprehensive patient education prior to surgery. In lieu of the restrictions to junior physicians' work hours, this scoping review also found that nurse-surgeons contributed to the enhancement of junior physicians' training experience which offered them more time to rest and mitigate their clinical workload (Johal & Dodd, 2017; Quick, 2013; Rich et al., 2021; Thommasen et al., 1996).

Additionally, our findings suggest that nurse-surgeons perform safe surgeries. This was further proven by the low to no complication rates in nurse-surgeon performed surgeries as reported in the included records that were comparable with the physicians' complication rates. This indicates that nurse-surgeons can perform surgeries safely, effectively and efficiently. Finally, our findings suggest that nurse-surgeons are cost effective. To the authors' best knowledge, there is currently no known review to date that explored the cost-effectiveness of nurse-surgeons as one group of advanced practice nurses.

Our scoping review found at least two gaps in nurse-surgeon research. These were significant ambiguity in nurse-surgeon titles and the need to standardize and regulate nurse-surgeon practice on a national level. This scoping review found 41 unique titles that nurse-surgeons use worldwide. The systematic review conducted by Grota et al. (2021) also highlighted nurse-surgeon title inconsistencies which affected the clarity and generalizability of the studies included in the review. The use of various ambiguous titles seems to be a common practice in nursing. A study by Leary et al. (2017) found 595 titles used by the 17, 960 nurses who participated in the study. Duffield et al. (2011) studied the nurses in Australia and argued that the uncoordinated and unregulated use of nursing titles may cause blurring, confusion and proliferation of titles which results in boundaries and scopes of practice becoming unclear, and patients along with their service providers having trouble understanding the scope of such titles.

Moorthy et al. (2006) also identified this problem where the use of multiple titles such as laparoscopic nurse, surgical nurse practitioner, arthroplasty practitioner or specialist nurse can be confusing to both the health professionals and patients. Grota et al. (2021) recommended the use of "nurse-surgeon" to encompass the group of nurses who perform surgeries independently effectively matching the term "surgeon" which encompasses physicians who perform surgeries independently. The use of more consistent language around nurse-surgeon practice will prevent research fragmentation and isolation of data.

Another gap that this scoping review found is the need for national regulation and standardization of nurse-surgeons (Eddy & Duffy, 2019; Fox et al., 2000; Grota et al., 2021; Hough et al., 2012; Jalloh et al., 2016; Lane & Minns, 2010; Moshakis et al., 1996; Quick, 2013; Quick, 2016; Schultz, 2011; Schwegel et al., 2019; Sprout, 2000; Zhang et al., 2018). There is currently no known or widely accepted national credentialing regulations around nurse-surgeon practice internationally. This is due to the implementation of nurse-surgeons being highly dependent on the need of a surgical specialty within a local healthcare system or organization to innovate their service delivery to resolve an imminent surgical crisis resulting in localized pseudo-credentialing processes that may or may not be consistent with existing national standards of care (Eddy & Duffy, 2019; Schwegel et al., 2019). Additionally, our findings indicate the different specialties, countries and contexts of nurse-surgeon practice. However, there are similarities in the way nurse-surgeons worldwide are viewed as fully trained and therefore competent for independent practice. These are practical training, educational preparation, relevant clinical experience, clinical supervision by an experienced surgeon or nurse-surgeon, and competency assessment (Grota et al., 2021). These similarities may assist national health systems and policymakers in formulating a standardized credentialing process for nurse-surgeons. Considering the global impact of nurse-surgeons in improving the provision of surgical care, it is imperative to conduct further research on how to regulate nurse-surgeon training, professional development and practice on a national level.

5.1 | Implications

This scoping review mapped the roles of nurse-surgeons in global surgical care. In doing so, the large contribution of nurse-surgeons to global healthcare has been identified. Considering the global surgical burden and the need to improve access to surgical care, the main opportunity of nurse-surgeons here is in providing timely patient access to surgery while maintaining patient safety, maintaining clinical quality and improving cost-efficiency. Future high-quality quantitative and qualitative research is necessary to study and fully understand the roles, training, practice and experiences of nurse-surgeons in local and national health systems. International collaborative research may also aid in further strengthening the standardization and credentialing pathway of nurse-surgeons worldwide.

5.2 | Limitations

This scoping review included records that were written in the English language only as English is the primary language of three of four authors. Research on nurse-surgeon roles that was written in non-English language may have contributed to a more comprehensive scoping of the roles nurse-surgeons play in global surgical care. The nurse-surgeon titles that emerged from this scoping review was based on the search strategy developed by the authors based on what is known in extant literature and anecdotally. Therefore, there might be other nurse-surgeon roles that were not captured by this scoping review and would have made this review more robust.

As scoping reviews are designed to include all records that answer a broad review question, regardless of the data source being a primary research study, an opinion paper, or a news article, another limitation of this scoping review is the lack of high-quality primary research

studies which could have increased its methodological rigour resulting in a more detailed analysis of the findings. The limitations of the 48 included primary research study are outlined in Appendix S4.

6 | CONCLUSION

Nurse-surgeons perform millions of surgeries worldwide including major surgeries such as laparotomies, caesarean sections and organ resections to minor surgeries such as biopsies, endoscopies, dental extractions and repairs. This work assists in easing the global surgical burden. Although nurse-surgeons in contemporary literature have been practising since the 1950s, there is still limited research evidence supporting their clinical practice. The great disparity of titles nurse-surgeons use proved to be a major hurdle in mapping this group of advanced practice nurses. This scoping review found the multiple roles and benefits nurse-surgeons play in global surgical care which include patient safety, timely patient access to surgery, high patient satisfaction, surgical care efficiency and cost-effectiveness. This scoping review also discovered gaps on nurse-surgeon research prompting the need to standardize their career and training pathway and the usage of a more consistent nurse-surgeon title.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in OSF at 10.17605/OSF.IO/SJ2WU.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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