Received: 22 November 2022 | Revised: 5 March 2023 | Accepted: 11 March 2023

DOI: 10.1111/wvn.12649

ORIGINAL ARTICLE

WORLDVIEWS ON EVIDENCE-BASED NURSING

Incidence of postoperative delirium in older adults undergoing surgical procedures: A systematic literature review and meta-analysis

Ezinne Oyidia Igwe PhD[1,2] | Jessica Nealon PhD[2,3] | Pauline O'Shaughnessy PhD[4] | Alera Bowden MEd, GCertNurse, BNurse[1,2,5] | Hui-Chen (Rita) Chang PhD[1,2,6] | Mu-Hsing Ho PhD, RN[7] | Jed Montayre PhD, RN[8] | Amy Montgomery NP, RN[1,2] | Kaye Rolls DN, MACN, RN[1] | Kuei-Ru Chou PhD[9,10,11,12] | Kee-Hsin Chen PhD[13,14,15,16] | Victoria Traynor PhD[1,2] | Peter Smerdely PhD, MBiostat, MPH, FRACP[17,18]

[1]School of Nursing, Faculty of Science, Medicine and Health, University of Wollongong, Wollongong, New South Wales, Australia

[2]Illawarra Health and Medical Research Institute (IHMRI), Wollongong, New South Wales, Australia

[3]School of Medicine, Faculty of Science, Medicine and Health, University of Wollongong, Wollongong, New South Wales, Australia

[4]School of Mathematics and Applied Statistics, Faculty of Engineering and Information Sciences, University of Wollongong, Wollongong, New South Wales, Australia

[5]Illawarra Shoalhaven Local Health District, Wollongong, New South Wales, Australia

[6]School of Nursing and Midwifery, Western Sydney University, Penrith, New South Wales, Australia

[7]School of Nursing, LKS Faculty of Medicine, The University of Hong Kong, Pok Fu Lam, Hong Kong

[8]School of Nursing, Hong Kong Polytechnic University, Hung Hom, Hong Kong SAR

[9]School of Nursing, College of Nursing, Taipei Medical University, Taipei, Taiwan

[10]Center for Nursing and Healthcare Research in Clinical Practice Application, Wan Fang Hospital, Taipei Medical University, Taipei, Taiwan

[11]Department of Nursing, Taipei Medical University-Shuang Ho Hospital, New Taipei, Taiwan

[12]Psychiatric Research Center, Taipei Medical University Hospital, Taipei, Taiwan

[13]Post-Baccalaureate Program in Nursing, College of Nursing, Taipei Medical University, Taipei, Taiwan

[14]Cochrane Taiwan, Taipei Medical University, Taipei, Taiwan

[15]Center for Nursing and Healthcare Research in Clinical Practice Application, Wan Fang Hospital, Taipei Medical University, Taipei, Taiwan

[16]Evidence-based Knowledge Translation Center, Wan Fang Hospital, Taipei Medical University, Taipei, Taiwan

[17]School of Population Health, UNSW Medicine, Sydney, New South Wales, Australia

[18]St George Hospital, Kogarah, New South Wales, Australia

Correspondence
Ezinne Oyidia Igwe, School of Nursing, Faculty of Science, Medicine and Health, University of Wollongong, Wollongong, NSW, Australia.
Email: ekorie@uow.edu.au

Abstract

Background: With the increase in life expectancy around the globe, the incidence of postoperative delirium (POD) among older people (≥65 years) is growing. Previous studies showed a wide variation in the incidence of POD, from 4% to 53%, with a lack of specific evidence about the incidence of POD by specific surgery type among older people. The aim of this systematic review and meta-analysis was to determine the incidence of POD by surgery type within populations 65 years and over.

Methods: Databases including PubMed, Cochrane library, Embase, and CINAHL were searched until October 2020. Due to the relatively higher number of meta-analyses undertaken in this area of research, a streamlined systematic meta-analysis was proposed.

Results: A total of 28 meta-analyses (comprising 284 individual studies) were reviewed. Data from relevant individual studies ($n=90$) were extracted and included in the current study. Studies were grouped into eight surgery types and the incidence of POD for orthopedic, vascular, spinal, cardiac, colorectal, abdominal, urologic, and mixed surgeries was 20%, 14%, 13%, 32%, 14%, 30%, 10%, and 26%, respectively. POD detection instruments were different across the studies, with Confusion Assessment Method (CAM & CAM-ICU) being the most frequently adopted.

Linking Evidence to Action: This study showed that POD incidence in older people undergoing surgery varied widely across surgery type. The more complex surgeries like cardiac and abdominal surgeries were associated with a higher risk of POD. This highlights the need to include the level of surgery complexity as a risk factor in preoperative assessments.

KEYWORDS
incidence, meta-analysis, older people, postoperative delirium, systematic review

INTRODUCTION

With life expectancy increasing around the globe, the incidence of postoperative delirium (POD) among older people (≥65 years) is growing. Overall, it is estimated that more than a third of older people undergoing a surgical procedure develop POD (Zhang et al., 2013). In clinical settings, 30% of older people admitted to hospital are deemed at risk of developing delirium (NSW Agency for Clinical Innovation, 2017) with an incidence rate of 56% in high-risk populations, including those in postoperative recovery and palliative-care settings. The risk factors of delirium are well documented (Vasilevskis et al., 2012; Zaal et al., 2015). There are specific risk factors associated with POD, including being 65 years and over, having a serious illness, or having a pre-existing cognitive impairment, especially dementia which is present in up to two-thirds of all delirium cases (e Silva et al., 2021; Fong et al., 2009; Young et al., 2010). Despite this knowledge being commonplace and policies being in place in many countries, POD often remains undetected and untreated (Aldecoa et al., 2017; Hughes et al., 2020).

Previous meta-analyses reported pooled incidences of delirium in non-cardiac surgery (e.g., orthopedic, general surgery, urology, gynecological, vascular surgery) as 21.5%–23.8% (Hamilton et al., 2017; Ho et al., 2021; Silva et al., 2021) and 19% for tumor surgeries (Ho et al., 2021). The incidence of POD varies greatly across surgery type (Jin et al., 2020), meaning that a pooled incidence value for POD that does not differentiate by surgery type is limited in its usefulness for planning improvements in clinical practice and healthcare services.

Some of the limitations to the existing literature that need to be addressed include not all meta-analyses restricted their age criteria to adults 65 years and over (Abawi et al., 2016; Bruce et al., 2007; Dyer et al., 1995; Gosselt et al., 2015; Lee & Park, 2010; Oh et al., 2015), which according to the UK National Institute of Clinical Excellent delirium guidelines is a significant risk factor for POD (Young et al., 2010). Furthermore, some meta-analyses included studies that did not report a validated tool to detect or screen for delirium (Abawi et al., 2016; Crocker et al., 2016; Dyer et al., 1995; Koster et al., 2011; Wu et al., 2019), which introduced another source of variability in the incidence rates reported. Accurate incidence estimations of POD are important clinically for adequate allocation of resources to effectively plan for delirium care, and for research studies to calculate the minimum sample size required for an intervention trial (Abawi et al., 2016).

This study provided new evidence by conducting a comprehensive meta-analysis on the incidence of POD in older people (≥65 years) on an extensive list of surgery types, including orthopedic, vascular, spinal, cardiac, colorectal, abdominal, urologic, and mixed surgeries. This review on delirium incidence was categorized by the level of urgency across different surgical procedures determined by the morbidity and mortality associated with elective and emergency surgeries.

METHODS

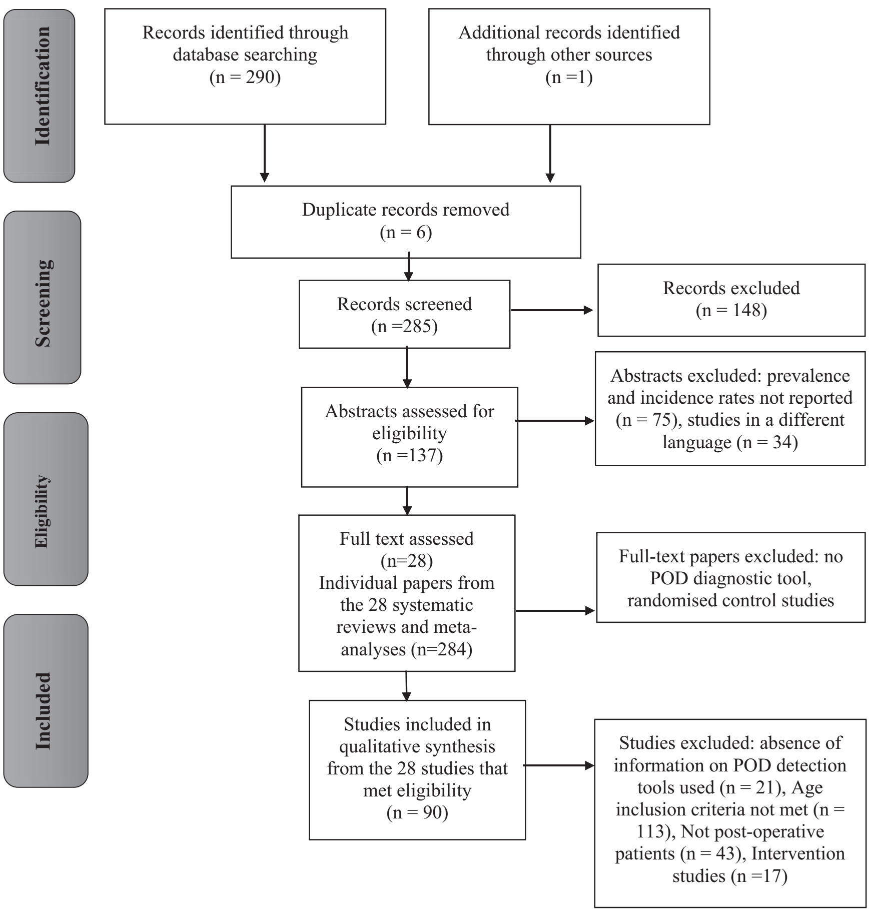
The current review followed the preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Figure 1; Moher et al., 2009). With regard to the objective, the following Population, Intervention, Outcome, Timing, and Setting (PICOTS) table was developed (Appendix S1; Debray et al., 2017). Scientific databases were searched up to October 2020: PubMed, Cochrane library, and CINAHL. A combination of search terms with truncations was used: Prevalence, incidence, "postoperative delirium," "postoperative cognitive dysfunction," review, epidemiology (Appendix S1). The review was registered on PROSPERO (International prospective register of systematic reviews) as CRD42020199399 (Centre for Reviews and Dissemination, 2015).

Definition of POD

For the current study, POD was defined according to the acceptable and validated definitions of POD. The key characteristics in these definitions were: reduced awareness of the environment and a disturbance in attention accompanied by other perceptual symptoms such as hallucinations and/or cognitive symptoms including disorientation or temporary memory dysfunction (Deiner & Silverstein, 2009). POD occurs from 10 min after the administration of an anesthesia up to 7 days postoperatively or until discharge (Janjua et al., 2020). Thus, time of POD diagnosis was screened for in the included studies. The common definitions and methods of detecting POD are derived from the Diagnostic and Statistical Manual (DSM) criteria (III, IV, V; American Psychiatric Association, 2013); Confusion Assessment Method (CAM) and CAM-ICU; the 4 'A's Test (4AT; Bellelli, Mazzola, et al., 2014; Bellelli, Morandi, et al., 2014; Tieges et al., 2021) chart abstraction method (Inouye et al., 2005); and Neelon-Champagne confusion scale (Van Rompaey et al., 2008).

Inclusion criteria

A central issue in this research question is the abundance of research undertaken on POD incidence and the associated risk factors. It was important to develop a specific search approach with an overall inclusion criterion to include Systematic literature reviews (SLRs) and meta-analyses on the incidence of POD to undertake a streamlined meta-analysis. A second-order meta-analysis could not be conducted because the studies that made up the first-order meta-analyses were not statistically independent (Schmidt & Oh, 2013). In other words, the current study did not meet the requirement for a first-order meta-analysis, as there were study duplicates across different first-order meta-analyses. For this study, only individual studies selected from first-order meta-analyses were extracted and included for a more robust meta-analysis.



Note. POD = post operative delirium.

FIGURE 1 PRISMA flowchart for study selection. POD, postoperative delirium.

Six criteria items were used for study inclusion:

1. cohort study design;
2. incidence of POD a focus of the study;
3. patient characteristics described, including age type of surgery and surgery urgency;
4. sample included adults 65 years and over;
5. method of POD detection described; and
6. English or Chinese languages publications; there were authors who are Chinese speaking.

Exclusion criteria

Three criteria items were used for study exclusion:

1. medical ward setting without any surgical intervention;
2. intervention studies; and
3. sample included individuals who had delirium on admission or incidence rates did not distinguish pre- and post-surgery delirium.

Following identification of relevant papers, duplicate records were removed, and the remaining were screened using the titles. Relevant abstracts were screened for eligibility. After the inclusion and exclusion criteria were applied, the relevant citations and abstracts were exported to the reference management software ENDNOTE X7. A tabular summary was developed for this review which included the population, sample size (*n*), POD incidence, POD diagnostic tool to detect and screen for delirium, and study quality.

Selection of studies and quality appraisal

Full-text papers were screened for their relevance (EI). Quality of included studies was appraised using the standardized Joanna Briggs Institute (JBI) Critical Appraisal Checklist (JBI, 2014; Table 1). The JBI Checklist is a standardized appraisal tool for evaluating the methodological quality of individual studies. The mean quality score of included studies was calculated to determine the overall quality of all included studies. The JBI checklist comprises 11 questions relating to methodological quality with options—"yes," "no," "unclear," and "not applicable." This checklist addresses the possibility of bias in study design, conduct, and analysis to facilitate rigorous appraisal and inform synthesis and interpretation of the result of the study. All authors participated in the quality appraisal of included studies. Every paper was allocated to two authors for the quality appraisal of the study. Any discrepancies in the quality appraisal were resolved through consensus between the two authors and when necessary, with an allocated third author. A flow diagram was prepared based on the number of studies identified and excluded at every stage according to PRISMA recommendations (Figure 1).

Data synthesis and analysis

The primary aim was to determine the incidence of POD according to surgery type. Individual studies were grouped according to surgery type. Incidence of POD according to surgery type was pooled using a random effect model to account for heterogeneity between studies. Risk factors that were common in these studies were extracted and discussed accordingly.

Meta-analysis of included studies was undertaken using the *metafor* package in RStudio and Microsoft excel software. The step-by-step process of using Microsoft excel software for meta-analysis of descriptive statistics described by Neyeloff et al. (2012) was adopted.

RESULTS

Study selection

The step-by-step process of studies included in this study is detailed in the PRISMA flowchart for study selection (Figure 1). After deletion of duplicates, 285 records were retrieved from the databases. Following screening for eligibility, a total of 28 papers (SLR or meta-analysis) were selected. The selected papers were made up of 284 individual papers: 20 papers were excluded due to the absence of information on the methods used to assess POD in the studies and 113 papers did not meet the age inclusion criterion and were excluded. A total of 91 studies were extracted for full-text review in a streamlined meta-analysis, we included all 91 individual studies and grouped them according to surgery type and urgency of surgery (emergency or elective).

Overview

The surgery type in the 91 individual studies included in this systematic review were: orthopedic ($n=36$ studies), vascular ($n=15$ studies), spinal ($n=9$ studies), colorectal ($n=10$ studies), cardiac ($n=4$ studies), abdominal (n=4 studies), urological ($n=5$ studies), and mixed surgeries ($n=13$ studies). Mixed surgeries were made up of studies with numbers that were too low for a subgroup analysis, that is, general, gastrointestinal, gynecological, and other studies where POD incidence was not specified according to surgery type, but overall incidence for all surgery types included. One of the included studies was in Chinese. Subgroup analysis by surgery type was undertaken according to the urgency of surgery where applicable. Table 1 describes the characteristics of studies included according to surgery type. POD incidence rates were reported for all study populations, including POD in people with cognitive impairment to generalize study results. Figures 2 and 4 show the meta-analysis undertaken according to surgery types and urgency. The calculated mean of overall quality of included studies in Table 1 ($n=91$) was 8.5 ± 1.25 (range: 6–11).

TABLE 1 Characteristics of included studies by surgery type: Orthopedic surgery (*n*=35), Vascular surgery (*n*=15), Spinal surgery (*n*=9), Colorectal surgery (*n*=10), Cardiac surgery (*n*=4), Abdominal surgery (*n*=4), Urological surgery (*n*=5), and Mixed surgery (*n*=14).

Reference	Population	Sample size (N)	Postoperative delirium incidence (%)	Delirium diagnostic tool	Study quality (JBI)
Orthopedic surgery					
Agrawal et al. (2020) USA	Hip fracture patients Age: ≥65 years	7391	23	Chart audits	11
Andersson et al. (2001) Sweden	Emergent or elective hip surgery Age: 65–96 years	457	11	DSM-IV criteria, Organic Brain Syndrome (OBS) Scale	10
Bellelli, Mazzola, et al. (2014) Italy	Hip fracture patients Age: ≥65 years	199	28.6	CAM, DSM-IV_TR	11
Bitsch et al. (2006) Denmark	Hip fracture patients Age: 75–95 years	100	31	MMSE	9
Bowman (1997) Canada	Elective hip surgery Age: 73 years	26	26.9	DSM-III	10
Bowman (1997) Canada	Emergent hip surgery patients Mean age: 80 years	17	47.1	DSM-III	10
Chen et al. (2014) China	Hip fracture patients Age: ≥65 years	186	38	CAM	10
Dai et al. (2000) China	Elective orthopedic surgery Age: ≥65 years	469	6.8	DSM-IV criteria	10
Dubljanin-Raspopović et al. (2012) Serbia	Hip fracture patients Age: ≥65 years	344	12.5	CAM, Patients' chart	10
Duppils and Wikblad (2000) Sweden	Elective hip surgery patients Age: ≥65 years	225	20.0	DSM-IV criteria	7
Edelstein et al. (2004) USA	Hip fracture surgery patients Age: ≥65 years	921	5.1	DSM and hospital chart	9
Flink et al. (2012) USA	Hip fracture surgical patients Age: ≥65 years	106	25	CAM and DSM-IV criteria	11
Formiga et al. (2003) Spain	Hip fracture patients Age: ≥65 years	89	28.1	CAM	9
Freter, Dunbar, et al. (2005) Canada	Elective arthroplasty patients Age: ≥65 years	132	13.6	CAM	11
Freter, George, et al. (2005) Canada	Hip fracture surgical patients Age: ≥65 years	100	24	CAM	9
Goldenberg et al. (2006) USA	Hip fracture surgical patients Age: ≥65 years	77	48	CAM	10
Gottschalk et al. (2015) USA	Hip fracture surgical patients Age: ≥65 years	459	32.9	CAM	10
Gustafson et al. (1988) Sweden	Femoral neck fracture patients Age: ≥65 years	111	28	OBS and DSM-III criteria	10
Hshieh et al. (2017) USA	Elective orthopedic surgery patients Age: ≥70 years	460	23	CAM, standardized chart review method	10
Jankowski et al. (2011) USA	Elective hip and knee surgery patients Age: ≥65 years	418	10	CAM	11
Juliebø et al. (2009) Norway	Hip fracture surgical patients Age: ≥65 years	187	36	CAM	10
Krogseth et al. (2011) Norway	Hip fracture surgical patients Age: ≥65 years	98	21.4	CAM	11
Kosar et al. (2014) USA	Elective orthopedic surgical patients Age: ≥70 years	459	23	CAM and chart	10

TABLE 1 (Continued)

Reference	Population	Sample size (N)	Postoperative delirium incidence (%)	Delirium diagnostic tool	Study quality (JBI)
Kudoh et al. (2004) Japan	Elective orthopedic surgery Age: 65–80 years	328	15	CAM	10
Lee et al. (2011) USA	Acute hip fracture patients Age: ≥65 years	425	35	CAM	10
Luger et al. (2014) Austria	Hip fracture surgical patients Age: ≥80 years	329	5	DSM-IV	9
Lundström et al. (2003) Sweden	Femoral neck fracture surgical patients Age: ≥65 years	67	28.4	DSM-IV	11
Mazzola et al. (2017) Italy	Hip fracture surgical patients Age: ≥70 years	415	29.9	CAM; DSM-IV-TR	10
Mézière et al. (2013) France	Hip fracture surgical patients Age: ≥70 years	52	13	CAM	10
Neufeld et al. (2013) USA	Orthopedic surgery patients Age: ≥70 years	31	48.4	DSM-IV	11
Rade et al. (2011) USA	Total hip and knee arthroplasty (THA & TKA) Age: ≥70 years	40	5	CAM	9
Schuurmans et al. (2003) The Netherlands	Hip fracture patients Age: ≥70 years	92	20	Delirium Observation Screening scale (DOS)	9
Shen et al. (2013) China	Hip fracture surgical patients Age: ≥65 years	458	15	CAM	8
Wang et al. (2015) USA	Hip fracture surgical patients Age: ≥65 years	103	22	CAM	10
Zakriya et al. (2002) USA	Emergent hip fracture patients Mean age: 78 years	168	28	CAM	10
Vascular surgery					
Abawi et al. (2016) The Netherlands	Transcatheter aortic valve replacement surgery patients Age: ≥70 years	268	13.4	DOS	10
Assmann et al. (2016) The Netherlands	Transcatheter aortic valve replacement surgery patients Age: ≥75 years	89	28	DOS	10
Bagienski et al. (2017) Poland	Transcatheter aortic valve replacement surgery patients Age: ≥75 years	141	20.6	Chart-based delirium identification instrument (CHARTDEL)	10
Eide et al. (2015) Norway	Transcatheter aortic valve replacement surgery patients Age: ≥80 years	65	44.6	CAM	11
van Eijsden et al. (2015) The Netherlands	Critical limb ischemia surgery patients Age: ≥65 years	75	16	DOS, DSM-IV	11
Erdoes et al. (2012) Switzerland	Transcatheter aortic valve replacement surgery patients Age: ≥70 years	44	0	CAM	9
Fanning et al. (2016) Australia	Transcatheter aortic valve replacement surgery patients Mean age: 82 years	40	2.5	CAM and MoCA	11
Fanning et al. (2017) Australia	Transcatheter aortic valve replacement surgery patients Mean age: 82 years	31	3.2	CAM	11

(Continues)

TABLE 1 (Continued)

Reference	Population	Sample size (N)	Postoperative delirium incidence (%)	Delirium diagnostic tool	Study quality (JBI)
Giuseffi et al. (2017) USA	Transcatheter aortic valve replacement surgery patients Mean age: 80 years	105	19	CAM-ICU	10
Hshieh et al. (2017) USA	Elective vascular surgery patients Age: ≥70 years	35	31.4	CAM, standardized chart review method	10
Huded et al. (2017) USA	Transcatheter aortic valve replacement surgery patients Mean age: 84 years	294	20.7	CAM, CAM-ICU and clinician diagnosis	11
Koebrugge et al. (2010) The Netherlands	Open and endovascular aortoiliac surgery patients Age: ≥65 years	107	23	DOS and DSM-V criteria	10
Maniar et al. (2016) USA	Transcatheter aortic valve replacement surgery patients Age: ≥65 years	168	29.2	CAM-ICU	10
Schoenenberger et al. (2016) Switzerland	Transcatheter aortic valve replacement surgery patients Age: ≥70 years	229	0.9	Medical record review	7
Tse et al. (2014) Canada	Transcatheter aortic valve replacement surgery patients Mean age: 81 years	117	27	DSM-IV-TR	11
Spinal surgery					
Adogwa et al. (2018) USA	Thoracolumbar deformity surgery patients Age: ≥65 years	82	18	CAM	10
Brown IV et al. (2016) USA	Cervical, lumbar spinal surgery patients Age: 72–78 years	195	18.5	CAM; CAM-ICU; DRS-98-R	11
Elsamadicy et al. (2017) USA	Spinal surgery patients Age: ≥65 years	453	3.8	DSM-V	10
Kim et al. (2018) South Korea	Elective spinal surgery patients Age: ≥65 years	104	14.4	CAM	10
Lee and Park (2010) South Korea	Lumbar spinal surgery patients Age: 70–85 years	87	13.6	CAM; DSM-IV	9
Oichi et al. (2019) Japan	Lumbosacral surgery patients Age: ≥65 years	88,370	5.1	Patients prescribed anti-psychotics postoperatively	9
Pan et al. (2019) Korea	Lumbar spinal surgery patients Age: ≥65 years	83	14.5	CAM	10
Radcliff et al. (2017) USA	Cervical spinal surgery patients Age: ≥65 years	2792	5.6	ICD-9	10
Susano et al. (2019) USA	Cervical, lumbar spinal surgery patients Age: ≥65 years	715	17.8	Comprehensive chart review and ICD-10	10
Colorectal surgery					
Indrakusuma et al. (2015) The Netherlands	Colorectal surgery patients Age: ≥70 years	443	11.1	DOS	7
Mokutani et al. (2016) Japan	Colorectal surgery patients Age: ≥75 years	156	21.8	CAM	7
Monacelli et al. (2018) Italy	Colorectal surgery patients Age: >70 years	97	12.4	4AT; DSM-V	10
Mosk et al. (2018) The Netherlands	Colorectal surgery patients Age: ≥70 years	251	13	DOSS; DSM-IV	9

TABLE 1 (Continued)

Reference	Population	Sample size (*N*)	Postoperative delirium incidence (%)	Delirium diagnostic tool	Study quality (JBI)
Patti et al. (2011) Italy	Colorectal surgery patients Age: >65 years	100	18	CAM	10
Raats et al. (2015) The Netherlands	Colorectal surgery patients Age: 65–89 years	83	18.1	DOS	9
Souwer et al. (2019) The Netherlands	Colorectal surgery patients Mean age: 70 years	550	6.2	DOSS; Medical records; Prescription of haloperidol	9
Tei et al. (2010) Japan	Colorectal surgery patients Mean age: 70 years	128	10.9	CAM; medical records	10
Tei et al. (2016) Japan	Colorectal surgery patients Age: ≥75 years	311	14.1	CAM; medical records	10
Xiang et al. (2017) China	Colon cancer surgery patients Age: ≥65 years	160	24.4	CAM-ICU	10
Cardiac surgery					
Bakker et al. (2012) The Netherlands	Elective Cardiac surgery patients Age: ≥70 years	201	31.3	CAM-ICU	Bakker et al. (2012) The Netherlands
Min et al. (2015) USA	Elective Cardiac surgery patients Age: 65–90 years	62	14.5	New symptoms of confusion, agitation, and/or altered mental status, or new need for antipsychotic medications	Min et al. (2015) USA
Rolfson et al. (1999) Canada	Elective Cardiac surgery patients Age: ≥65 years	75	32	CAM	Rolfson et al. (1999) Canada
Smulter et al. (2013) Sweden	Routine cardiac surgery patients Age: ≥70 years	178	54.9	MMSE; OBS; DSM-IV-TR	Smulter et al. (2013) Sweden
Abdominal surgery					
Brouquet et al. (2010) France	Abdominal surgery patients Age: 75–98 years	118	23.7	CAM	Brouquet et al. (2010) France
Koebrugge et al. (2009) The Netherlands	Abdominal surgery patients Age: ≥65 years	71	23.9	DOS and DSM-IV criteria	Koebrugge et al. (2009) The Netherlands
Morimoto et al. (2009) Japan	Abdominal surgery patients Age: ≥65 years	20	25	DRS ≥12 and DSM-IV criteria	Morimoto et al. (2009) Japan
Olin et al. (2005) Sweden	Abdominal surgery patients Age: ≥65 years	51	51	CAM and Medical records	Olin et al. (2005) Sweden
Urological surgery					
Dai et al. (2000) China	Urological surgery patients Age: ≥65 years	232	1.7	DSM-IV criteria	Dai et al. (2000) China
Gani et al. (2013) Albania	Urological surgery patients Age: ≥65 years	640	25.9	CAM	Gani et al. (2013) Albania
Large et al. (2013) USA	Urological surgery patients Age: ≥65 years	49	28.6	CAM	Large et al. (2013) USA
Tognoni et al. (2011) Italy	Urological surgery patients Age: 66–93 years	90	8.9	CAM	Tognoni et al. (2011) Italy
Xue et al. (2016) China	Urological surgery patients Age: ≥65 years	358	7.8	CAM	Xue et al. (2016) China

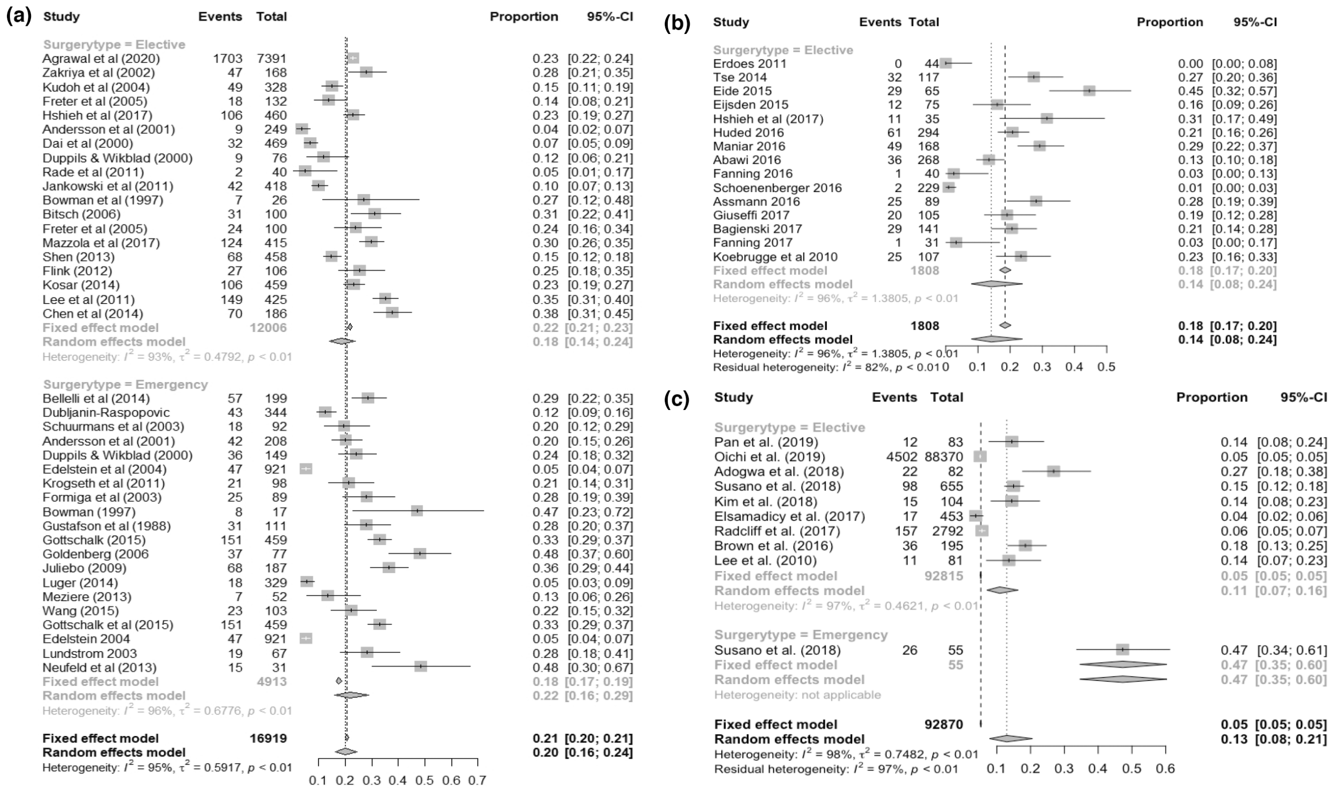
(Continues)

TABLE 1 (Continued)

Reference	Population	Sample size (N)	Postoperative delirium incidence (%)	Delirium diagnostic tool	Study quality (JBI)
Mixed surgeries					
Ansaloni et al. (2010) Italy	Elective and emergency general surgery Age: ≥ 65 years	351	13.4	CAM	Ansaloni et al. (2010) Italy
Dasgupta et al. (2009) Canada	Orthopedic, vascular, abdominal and neurosurgical patients Age: 70–92 years	125	12	Chart abstraction method	Dasgupta et al. (2009) Canada
Gleason et al. (2015) USA	Elective major orthopedic, vascular or abdominal surgery Age: ≥70 years	566	23.9	CAM, validated medical record review method	Gleason et al. (2015) USA
Hattori et al. (2009) Japan	Gastrointestinal, orthopedic, and vascular surgery patients Age: ≥75 years	160	54.7	NEECHAM score < 20	Hattori et al. (2009) Japan
Hshieh et al. (2017) USA	General surgery patients Age: ≥65 years	71	25.4	CAM, standardized chart review method	Hshieh et al. (2017) USA
Kim et al. (2013) Korea	General, urological, gynecological, thoracic, breast, ophthalmologic, ENT surgery patients Age: ≥80 years	141	9.9	DSM-IV criteria	Kim et al. (2013) Korea
Leung et al. (2013) USA	Orthopedic, urological, gynecological, vascular, thoracic, ENT, plastic, general surgery patients Age: 65–96 years	581	40.3	CAM	Leung et al. (2013) USA
Leung et al. (2005) USA	Orthopedic, urologic, general and vascular surgery. Patients. Age: ≥65 years	219	46	CAM	Leung et al. (2005) USA
Neufeld et al. (2013) USA	Gastrointestinal and other surgery patients Age: ≥70 years	35	51.4	DSM-IV	Neufeld et al. (2013) USA
Neufeld et al. (2013) USA	Urinary and gynecologic surgery patients Age: ≥70 years	25	32	DSM-IV	Neufeld et al. (2013) USA
Robinson et al. (2012) USA	Abdominal, cardiac, non-cardiac thoracic, and vascular surgery patients Age: ≥65 years	186	54.8	CAM-ICU	Robinson et al. (2012) USA
Shim et al. (2015) USA	Non-cardiac surgery patients Age: >65 years	631	31	CAM	Shim et al. (2015) USA
Suh et al. (2014) Korea	Gynecological, general surgery patients Age: 70–85 years	60	6.7	>2/5 criteria: disorientation, inappropriate behavior, and words, delusion/hallucination, delayed psychomotor activity	Suh et al. (2014) Korea

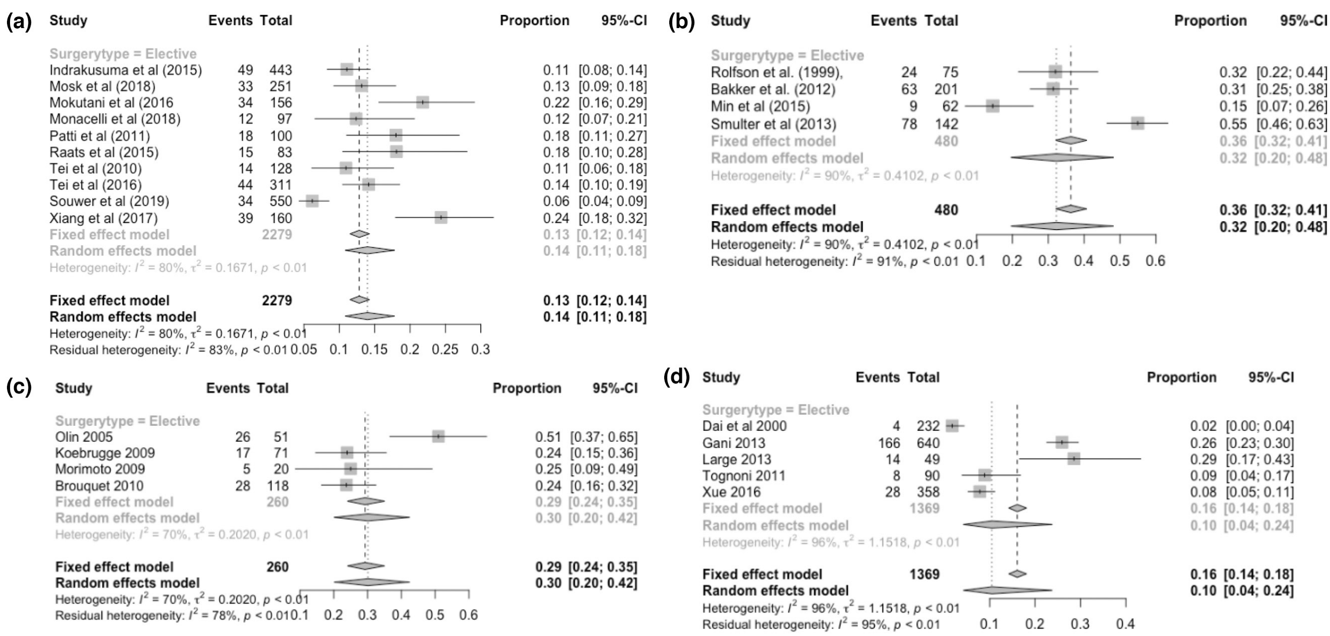
Abbreviations: CAM, Confusion Assessment Method; DOS, Delirium Observation Scale; DRS-98-R, Delirium Rating Scale revised 98; ICDSC, Intensive Care Delirium Screening Checklist; ICU, Intensive Care Unit; MoCA, Montreal Cognitive Assessment; NA, Not Available.

Incidence of POD was detected using different diagnostic tools and some studies utilized more than one method. CAM and CAM-ICU were the most commonly adopted delirium diagnostic tools ($n=55$) followed by the DSM-IV ($n=20$), DSM-III criteria ($n=7$), and the 4AT ($n=1$). The follow-up period varied across studies, ranging from postoperative day 1 until discharge from hospital.



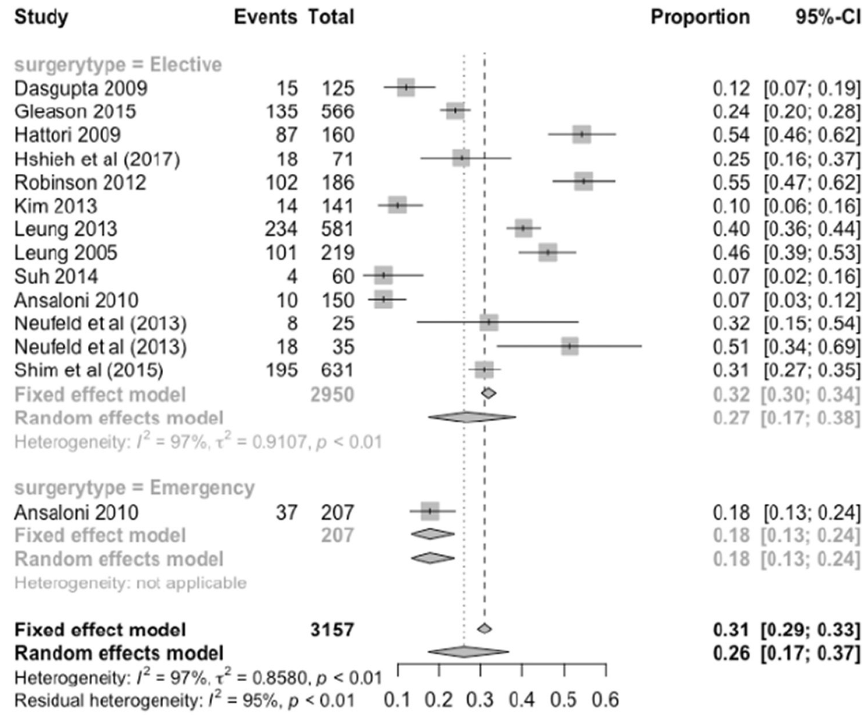
Note. POD = post operative delirium.

FIGURE 2 Pooled POD Incidence of (a) Elective and Emergency Orthopedic Surgery (n = 36), (b) Vascular Surgery (n = 15), and (c) Spinal Surgery (n = 9). POD, postoperative delirium.



Note. POD = poster operative delirium.

FIGURE 3 Pooled POD incidence of (a) Colorectal surgery (n = 10), (b) cardiac surgery (n = 4) (c), abdominal surgery (n = 4), and (d) urological surgery (n = 5). POD, postoperative delirium.



Note. POD = post operative delirium.

FIGURE 4 Pooled POD incidence of mixed surgery types (n = 13). POD, postoperative delirium.

Results of individual studies

For most studies, the primary outcome was the incidence of POD (n = 85). Some studies reported incidence separately for elective and emergency surgeries (Andersson et al., 2001; Bowman, 1997; Duppils & Wikblad, 2000; Susano et al., 2019). These data were entered as separate incidence rates in the current meta-analysis. Studies included in this meta-analysis detailed common risk factors of POD in the study populations including adults 65 years and over, cognitive impairment, previous history of delirium, polypharmacy, anti-cholinergic medicines, benzodiazepines, history of major depressive disorder or depressive symptoms, and other comorbidities such as diabetes (Smulter et al., 2013). Surgical risk factors that were identified included an increase in the duration of surgery (Abawi et al., 2016; Neufeld et al., 2013; Shim et al., 2015; Xiang et al., 2017).

The surgery types were reported according to the volume of evidence in each surgery group (Table 1). In Figure 2a, meta-analysis according to surgery type and urgency showed an incidence of 22% (95% CI [17, 29]) for emergency orthopedic surgery (n = 12,006) and 18% (95% CI–14, 24) for elective orthopedic surgery (n = 5291) and an overall POD incidence in orthopedic surgery of 20% (95% CI [17, 24]; n = 17,297). For vascular surgery, all procedures in the studies included were elective and POD incidence was 14% (95% CI [8, 24]; n = 1808; Figure 2b). In the spinal surgery group, there was one emergency surgery with a POD incidence of 47% (95% CI [34, 61]; n = 55), while POD incidence for the elective spinal surgeries was 11% (95% CI [7, 16]; n = 92,815) and the overall POD incidence in spinal surgery was 13% (95% CI [8, 21]; n = 92,870; Figure 2c). The POD incidence in elective colorectal surgery was 14% (95% CI [11, 18]; n = 2279; Figure 3a). A higher POD incidence was observed for cardiac (32%; 95% CI [20, 48]; n = 480) and abdominal surgery types (30%; 95% CI [20, 42]; n = 260; Figure 3b, c). Urological surgery had a POD incidence of 10% (95% CI [4, 24]; n = 1369; Figure 3d). Finally, in the mixed surgeries type, all but one study were elective surgeries (n = 207), and the overall POD incidence was 27% (95% CI [17, 38]; n = 3157; Figure 4). There was also an observed high heterogeneity (I^2) across surgery types (70%–98%) in the random effects models (Figures 2–4). In some of the mixed surgeries studies where incidence rates were reported for specific surgery types, the data were entered separately under the relevant surgery type (n = 6).

DISCUSSION

Results highlights

This study provides new evidence by conducting a comprehensive meta-analysis to determine the incidence of POD in people 65 years and over from published papers according to an extensive range of surgery types. The incidence of POD varied according to surgery type (10%–47%). Orthopedic surgery is commonly performed in older people (Gjorgjievski & Ristevski, 2020) and as such, a large proportion of studies on POD incidence were undertaken among older people undergoing orthopedic surgery. As expected, the incidence of POD was higher in emergency surgery compared to elective surgery. Our paper reported a POD incidence of 18% for elective and 22% for emergency orthopedic surgery. However, our study agrees with previous reports (Jin et al., 2020) that suggested POD incidence is highest in more complex surgeries, such as cardiac and abdominal surgeries, with incidences of 32% (95% CI [20, 48;] n=480) and 30% (95% CI [20, 42]; n=260) respectively, compared to 20% (95% CI [17, 24]; n=17,297) for orthopedic surgery. The high incidence of pain prior to orthopedic surgeries could explain a high incidence of POD (Arefayne et al., 2020), whereas factors contributing to POD in cardiac and abdominal surgeries are likely to be the mechanical ventilation and advanced age of patients undergoing these surgeries (Arenson et al., 2013). This indicates that although research studies currently focus on POD care in orthopedic surgery, this study shows that there is a need for more focus on POD care in other complex surgeries because the incidence rates of delirium in these surgery types are higher than in orthopedic surgery.

For the majority of the included 91 studies, incidence of POD was a primary aim; however, five studies had POD incidence as a secondary aim (Assmann et al., 2016; Erdoes et al., 2012; Fanning et al., 2016; Koebrugge et al., 2010; Souwer et al., 2019). In studies where POD incidence was a secondary aim, there was either an absence or low incidence of POD. There is a possibility that, as a secondary aim, there was less focus on delirium as an outcome. In addition, it might be that cases were undetected due to retrospective data collection from medical records (n=10 studies). Four out of the five studies where POD incidence was a secondary aim were conducted in vascular surgery and had no or low POD incidence rates (Assmann et al., 2016; Erdoes et al., 2012; Fanning et al., 2016; Koebrugge et al., 2010). These results from the four studies might explain the lower POD incidence observed in vascular surgery in the current meta-analysis. When these studies were excluded from the meta-analysis, the POD incidence in vascular surgery from a random effects model was 24% (19%–28%; 95% CI) compared to 14% (8%–24% CI) when they were included. Consideration of the study design is crucial to accurately report the incidence of delirium to inform the development of strategies that improve detection, management, and prevention of POD in older people.

Risk factors

In understanding the incidence of POD, it is important to highlight some of the common risk factors, including age 65 years and over, cognitive impairment, polypharmacy, other present physical comorbidities, and history of major depressive disorders or depressive symptoms (Berggren et al., 1987; Hudek, 2009; Inouye et al., 2015) in this review. There is already established evidence about risk factors of delirium. For the current study, we present a summary of the current evidence that appear in the reviewed papers.

Well-known risk factors like age were described; however, there is still some uncertainty and contradictory findings about procedural features, including anesthesia type, perioperative medications, and length of surgery. Type of anesthesia has been suggested as a possible risk factor for POD onset (Strøm et al., 2014) with general anesthesia mainly linked to POD development (Wang et al., 2015). Some studies have demonstrated an increased incidence of POD with general anesthesia administration compared with regional anesthesia (Papaioannou et al., 2005; Strøm et al., 2014), but meta-analyses and observational studies showed no difference in the emergence of POD with anesthetic type (Ellard et al., 2014; Guay et al., 2016; Ilango et al., 2016; Mason et al., 2010). One meta-analysis found that, compared to other anesthesia types, general anesthesia may heighten the risk of postoperative cognitive dysfunction (POCD) but not POD (Mason et al., 2010). As such, the role of anesthesia in the development of POD remains inconclusive (Strøm et al., 2014). In addition, some studies reported an association between select perioperative medications such as anti-cholinergic medicines and benzodiazepines and the onset of POD; however, there is no consensus in the wider body of literature on the presence of an association between POD and these medication classes. One paper found that patients who had a long-term history of taking benzodiazepines had a higher incidence of POD compared to those who were not (Kudoh et al., 2004). Conversely, a different paper did not observe any association between POD incidence and preoperative use of benzodiazepines (Shim et al., 2015). One paper found that general anesthesia and length of surgery were common in patients who developed POD following transcatheter aortic valve replacement (Abawi et al., 2016). Identifying these risk factors and increasing awareness of those surgery types with a higher incidence of POD will allow clinicians to implement earlier identification and management plans for patients who are at a higher risk of developing POD.

Although our study focused on POD, the prevalence of delirium and cognitive impairment in older people prior to undergoing surgery is an important risk factor to consider, as pre-existing cognitive impairment before surgery is likely to be related to undesirable outcomes following a surgical procedure with anesthesia. A paper by Lee et al. (2016) investigated the prevalence of cognitive impairment in a cohort of patients scheduled for surgery and found that the existence of cognitive impairment (38%) was associated with higher rates of POD and prolonged hospital stays, which affected clinical outcomes. It is imperative that the prevalence of preoperative delirium in older people scheduled for surgery is studied because research in this area could provide important understanding about risk factors related to delirium among older people scheduled to undergo surgery. The impact of POD incidence on future risk is another critical aspect. Evidence showed that the incidence of delirium predicts a future cognitive decline with an increased risk of dementia (Bickel et al., 2008).

Timeframe of POD detection

Available evidence shows that POD occurs between 10 min after administration of anesthesia up to 7 days postoperatively (Janjua et al., 2020). Studies included in the current meta-analysis detected POD in a similar manner with 'days of detection' within the acceptable range. However, three studies (Bitsch et al., 2006; Lee et al., 2011; Wang et al., 2015) conducted in hip fracture surgery excluded the first 8 h to 1 day for detecting POD, citing the possible lingering effects of anesthetic medications that might interfere with an accurate detection of POD. This method of POD detection was criticized as evidence shows that more than 60% of patients develop POD on postoperative day 1 (Iamaroon et al., 2020). As such, there is a possibility of under-detection of POD cases by excluding the first 24 h post-surgery. The incidence of POD in the studies that excluded the first 8 h to 1 day post-surgery ranged between 25% and 35%. These results did not significantly affect the overall incidence rate observed (18% in emergency surgery and 22% in elective surgery). There is no consistent approach to when POD starts and ends. For practitioners to benchmark the incidence of POD in clinical settings in research studies, there needs to be agreement on the likelihood of when POD begins and ends. Only then can genuine comparisons be made on the incidence of POD across surgery types. In a similar vein, the follow-up period across different studies varied and majority of the studies followed up participants until they were discharged from hospital (between 5 and 30 days) and one paper (Adogwa et al., 2018) followed up participants for up to 2 years. Standards need to be included within international guidelines and policy documents to ensure hospitals can begin benchmarking POD detection rates and follow-up timeframes for POD. Making these additions would enable hospitals to improve their protocols and procedures and enable them to determine whether their standards of their delirium care are satisfactory.

Strengths and limitations

A strength of this study is in the comprehensive evidence generated on POD incidence in older people (≥65 years) in an extensive list of surgery types and urgency level. There was general consistency with the diagnostic tools used for POD detection. This enabled a robust comparison across studies to generate evidence about delirium incidence across many surgery types. In studies that described the method of POD detection, the CAM and CAM-ICU were the most commonly used diagnostic tools. Since these POD detection methods are efficient and acceptable, this was a strength of the studies included in this meta-analysis (Green et al., 2019). It is worthy of note that there are various POD detection methods employed in clinical settings (Inouye et al., 2014). One paper (Bitsch et al., 2006) used the MMSE and the presence of antipsychotics prescription in patients' files to diagnose POD to explore a broad concept of delirium as a cognitive impairment. The authors noted that as the MMSE displays high sensitivity to moderate to severe cognitive impairment, there is a possibility that it was this choice of diagnostic tool that resulted in more mild cases of POD, with a predominantly nocturnal aspect, being missed in that study. The data from the paper that utilized the MMSE did not affect the overall incidence of delirium in the current study as the incidence rate reported from the MMSE paper was comparable to the rest of the included studies. It is imperative that clinicians and researchers exercise some uniformity in POD to enable comparisons between studies.

A limitation of this study could lay in the high heterogeneity observed across all meta-analyses for surgery types. The high heterogeneity could be attributed to the wide range in sample sizes as well as incidences of delirium, and the study design (retrospective vs prospective; Wu et al., 2019). Factors such as study design, incidence rates according to surgery type, and standardized methods of detecting POD are important considerations in future studies to control for increased heterogeneity across studies.

Linking evidence to action

- The incidence of POD in older people undergoing surgery varies widely across surgery type.
- More complex surgeries like cardiac (32%) and abdominal (30%) surgeries showed higher POD incidence.
- There is a highlighted need to include the level of surgery complexity as a risk factor in preoperative assessments.
- Across clinical settings, there needs to be some consensus on the gold standard for the different aspects of detecting POD including time of detection, uniformity across available tools, and the variability in the presentation of POD definition across different settings.

Another area of POD research with paucity of data is POD incidence in culturally and linguistically diverse (CALD) communities and rural communities. Individuals from these populations are included in the populations in published studies; however, it would be useful to determine whether there are any differences in POD incidence across these communities, especially in people from CALD backgrounds who might experience difficulties in being clearly understood when their first language is not the same as the staff. The 4AT has been validated for use within CALD communities but we have seen from this study that is not yet commonplace in research studies. Older people living in rural communities might not have access to specialized gerontological staff with an understanding about delirium care and thus these regions could be targeted for education programs. Conversely, if the older people undergoing surgery are already known in their small communities by local practitioners, this could have a protective factor against developing POD. First, we need data about POD incidence rates in rural communities to determine whether there needs to be targeted education to improve delirium care or whether there are lessons that can be learnt from these communities about effective delirium care.

CONCLUSION

The importance of increasing understanding about POD in older people cannot be overemphasized because of the established financial burden and the long-term effects of POD. This study reports detailed POD incidence in older people undergoing surgery according to surgery types. Depending on the surgery type and complexity, the incidence of POD ranged from 10% to 47%. Different factors contributed to the incidence of POD in each surgery type; however, it is important to understand the POD risk associated with different surgical procedures. There is still a need for some consensus on the gold standard for the different aspects of detecting POD including time of detection, uniformity across available tools, and the variability in the presentation of POD definition across different settings. This could assist practitioners and service providers in understanding the significance of POD as well as ascertain how to compare current practice across country-specific studies that report on the incidence of POD. Finally, future studies need to explore the impact of POD on the recurrence of delirium as well as the incidence in Indigenous and CALD communities.

Developing clinical guidelines that would provide a clear and concise approach to the management of new onset delirium prior to surgery is a crucial clinical investment as delirium can be treated in 24–48 h. This could reduce unfavorable outcomes related to surgery in patients with delirium preoperatively.

ACKNOWLEDGMENT

Open access publishing facilitated by University of Wollongong, as part of the Wiley - University of Wollongong agreement via the Council of Australian University Librarians.

CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest to declare.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

ORCID

Ezinne Oyidia Igwe https://orcid.org/0000-0002-3271-7829
Pauline O'Shaughnessy https://orcid.org/0000-0002-4741-3326
Alera Bowden https://orcid.org/0000-0001-6863-3136
Hui-Chen (Rita) Chang https://orcid.org/0000-0002-8305-0585

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SUPPORTING INFORMATION

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

How to cite this article: Igwe, E. O., Nealon, J., O'Shaughnessy, P., Bowden, A., Chang, H.-C., Ho, M.-H., Montayre, J., Montgomery, A., Rolls, K., Chou, K.-R., Chen, K.-H., Traynor, V., & Smerdely, P. (2023). Incidence of postoperative delirium in older adults undergoing surgical procedures: A systematic literature review and meta-analysis. *Worldviews on Evidence-Based Nursing*, *20*, 220–237. https://doi.org/10.1111/wvn.12649