Detection of Postoperative Cognitive Dysfunction by Telemedicine Among Octogenarian Patients Who Underwent Minor Elective Surgery; Prospective Cohort Study

Hathaichanok Suesat, M.D.*, Varalak Srinonprasert, M.D., ***, Panita Limpawattana, M.D.****, Salinee Nakyos, M.D.*****, Jiraporn Poontananggul, M.D.*, Chalita Jiraphorncharas, B.S.***, Wiraphon Manatarinat, M.D.******, Thanachai Noomprom, B.S.******, Arunotai Siriussawakul, M.D.*, ***

Department of Anesthesiology, **Division of Geriatric Medicine, Department of Medicine, ***Siriraj Integrated Perioperative Geriatric Excellent Research Center, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand, ****Division of Geriatric Medicine, Department of Internal Medicine, Faculty of Medicine, Khon Kaen University, Khon Kaen 40002, Thailand, *****Division of Anesthesiology, Buddhachinaraj Hospital, Phitsanulok 65000, Thailand,****Siriraj Center of Telemedicine (SiTEL), Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand*

ABSTRACT

Objective: Postoperative cognitive dysfunction (POCD) is associated with permanent disability, increased mortality, and diminished quality of life. The incidence of acute POCD among geriatric patients who have undergone minor surgery is uncertain because they are typically discharged before acute POCD is detected. Owing to the efficient postoperative care that can be provided, telemedicine is an attractive tool to investigate POCD. The primary objective of our research was to explore the incidence of acute POCD, while its secondary objective was to describe the consequences of POCD on functional recovery and quality of life.

Materials and Methods: This prospective cohort study enrolled patients aged ≥ 80 years and scheduled for minor elective surgery. During pre-anesthetic visits, we installed a telecommunications program on the patients' smartphones. Assessments of cognitive and other functions were performed preoperatively and 1 week postoperatively via telemedicine.

Results: Forty octogenarian patients undergoing minor surgery were included in the final analysis. The acute-POCD incidence was 10% (95% CI 4.79-18.39). Recall memory was the main cognitive domain impaired after the procedures. Nevertheless, there were no significant differences in the functional recovery and quality of life of the POCD and non-POCD patients.

Conclusion: The acute-POCD patients demonstrated minor symptoms that were unrelated to delayed postoperative functional recovery or decreased quality of life.

Keywords: Anesthesia; geriatrics; postoperative cognitive dysfunction; RUDAS-Thai; telemedicine. (Siriraj Med J 2022; 74: 126-133)

Corresponding author: Arunotai Siriussawakul
E-mail: arunotai.sir@mahidol.ac.th
Received 12 December 2021 Revised 9 January 2022 Accepted 13 January 2022
ORCID ID: https://orcid.org/0000-0003-0848-6546
http://dx.doi.org/10.33192/Smj.2022.16

INTRODUCTION

Multiple comorbid conditions are typical in the elderly, resulting in an increased possibility of surgical intervention and anesthesia.[1] Postoperative cognitive dysfunction (POCD), defined as an impairment of cognitive function arising after surgery, frequently occurs among elderly patients.[2] The systemic stress response arising during surgical procedures includes changes in the brain function and is involved in a decline in cognitive function.[3] Factors that elevate the risk of POCD include increasing age, pre-existing cerebrovascular and cardiovascular disorders, a history of alcohol abuse, and a low educational level.[4] Perioperative hypoxemia and hypotension, postoperative infection, and respiratory complications are some of the recognized risk factors for POCD.[5] POCD is associated with poorer recovery, an increased risk of permanent disability, and the need to utilize social financial assistance.[4,6]

POCD can be divided into acute, intermediate, and long-term changes. "Acute POCD" is used to describe cognitive declines detected within 1 week of surgery, "intermediate POCD" for changes occurring within 3 months, and "long-term POCD" for declines persisting up to 1-2 years following surgery. However, the exact significance of detecting POCD at these various time points is unclear.[7] POCD was found to be present in 25.8% of patients 1 week after non-cardiac surgery and in 9.9% after 3 months.[5] Other research on patients aged ≥ 60 years who had undergone minor surgery established that their POCD incidence was 6.8% at 1 week and 6.6% at 3 months.[8]

The symptoms of acute POCD may be subtle and might be difficult to detect among geriatric patients who have undergone minor surgery. Patients are often discharged before any symptoms occur. Neuropsychological testing is required to detect POCD by comparing preoperative and postoperative scores.[4] The Rowland Universal Dementia Assessment Scale (RUDAS) is a short, cognitive-screening instrument designed to minimize the effects of cultural learning and language diversity on the assessment of baseline cognitive performance. The Thai version of RUDAS can be utilized for assessments conducted via telemedicine. Telemedicine facilitates the post-discharge monitoring of remotely delivered health care in a cost- and time-saving manner.[9,10] The primary objective of this study was to establish the incidence of acute POCD detected via telemedicine among octogenarian patients who had undergone minor surgery. The secondary objective was to describe the consequences of POCD on their functional recovery and quality of life.

MATERIALS AND METHODS

Study design and participants

The study was approved by the Siriraj Institutional Review Board, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand (protocol approval number Si. 168/2018) and was registered in the Thai Clinical Trials Registry (TCTR) under study number TCTR20201216001 date registered on December 16, 2020. Retrospectively registered. Written informed consent was obtained from all study participants. A prospective study was conducted at a large university-based national tertiary referral center during the July 2018 to April 2019 study period. The inclusion criteria were patients aged ≥ 80 years who were scheduled for minor elective surgery. Such surgery had an expected blood loss of < 500 ml, no significant fluid shift, and no need for complex post-operative care typically done on an ambulatory basis (breast surgery without reconstruction; laparoscopic cholecystectomy; hernia repair; most cutaneous, superficial, soft tissue excision; and endoscopic procedures such as ERCP, bladder, and ureteric surgery).[11] Patients or their caregivers needed to use smartphone support provided by way of the "Polycom RealPresence Mobile" application. Patients were excluded if they had factors that might affect the execution of remote cognitive assessments, such as an inability to understand the Thai language, a severe visual or auditory dysfunction, an unstable mental status, or being bedridden. Patients reluctant to complete the preoperative and postoperative RUDAS-Thai test were also excluded. The study protocol followed the guidelines of the Declaration of Helsinki and all of its later amendments.

The day before surgery, a staff member installed the RealPresence Mobile application on the smartphones of the patients or their primary caregivers, who were then trained in its usage. The caregivers helped the patients to establish the connection. However, they did not have any active role during the interview or examination. The mobile application enabled high-quality audio and video communications to be had during preoperative and postoperative assessments. Audio-visual data were shared and transferred via a real-time video stream over a 3G or 4G mobile phone network, with the intermediary Internet Service Provider providing the software interface between the applications held by the hospital-based physicians and the patients. Fig 1 illustrates the broad process of collecting data for telemedicine purposes using a technological network. The tests for each patient were performed in about 30 minutes. They were conducted by a psychologist who was trained to communicate with patients by oral and visual questioning based on a questionnaire.

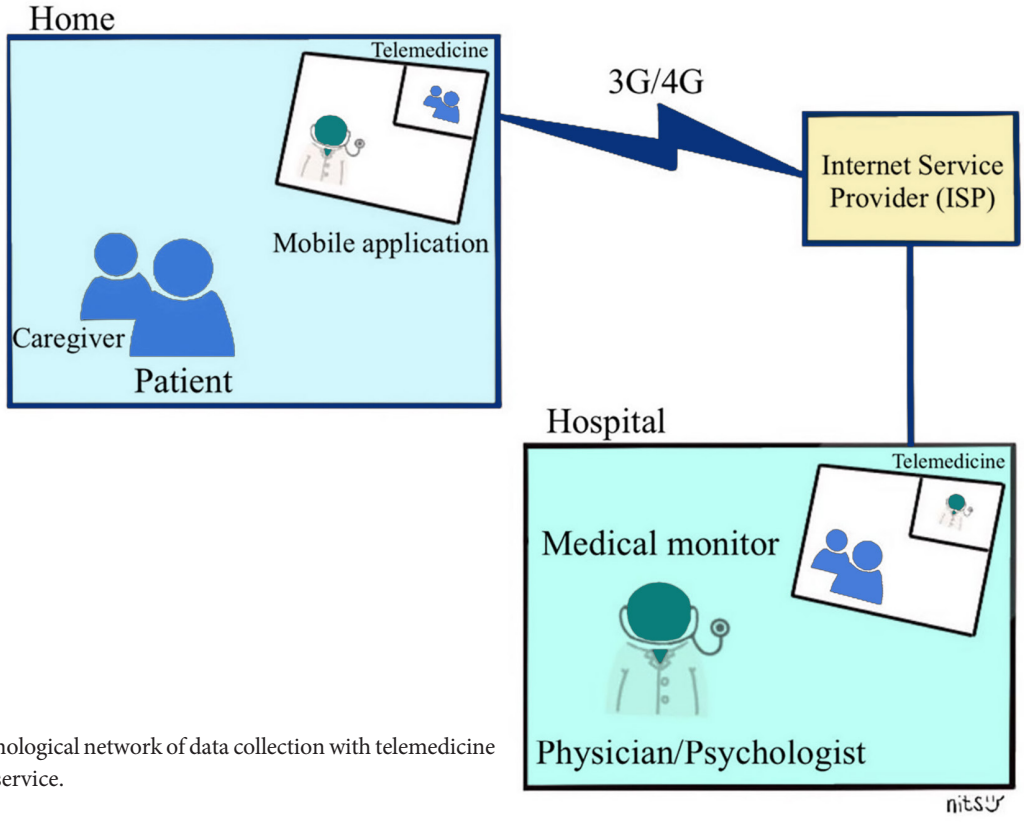

Fig 1. The technological network of data collection with telemedicine in health care service.

Assessments

The RUDAS-Thai version was applied to assess cognitive functions preoperatively. The 6 cognitive domains that RUDAS assesses are memory, praxis, language, judgment, drawing, and body orientation.[12] The maximum total score is 30. In elderly patients with a pre-elementary education level, preoperative cognitive impairment was suspected if the total score was ≤ 23 (AUC = 0.79; sensitivity and specificity of 71.43% and 76.92, respectively), while in the case of elderly patients with a post-elementary education, a score of ≤ 24 (AUC = 0.8, sensitivity and specificity of 77% and 70%, respectively) was considered the threshold. The RUDAS-Thai can be an effective alternative test and can be utilized instead of the Mini-Mental State Examination (MMSE) for dementia screening.[13] The present study therefore used the RUDAS-Thai to detect POCD. Acute POCD, detected within 1 week post-operatively, was diagnosed if a score had decreased by ≥ 3 compared with its pre-operative level.[14,15]

Several other tests were carried out to comprehensively assess potentially affected aspects. The Barthel Activities of Daily Living index was used to measure activity limitations in the domains of personal care and mobility.[16] The 5-level EQ-5D questionnaire was administered to assess quality of life.[17] Montgomery–Asberg Depression Rating Scale testing was conducted to establish the severity of depressive symptoms.[18] Finally, a numeric rating scale was utilized to evaluate postoperative pain levels, while a verbal rating scale was employed to identify the degrees of postoperative nausea and vomiting.

Statistical analysis

The sample size calculation was based on a study by Canet et al., which found a POCD incidence of 6.8%.[8] Therefore, 43 patients were needed for the rare-event analysis in this study. (nQuery Advisor version 7.0; Statistical Solutions Ltd., Cork, Ireland).[19] Once an estimated 10% loss to follow-up was added, the number of participants required was determined to be 48.

The demographic data and clinical variables were summarized using descriptive statistics. The continuous data were reported as means and standard deviations, or as medians with minima and maxima, as appropriate. The categorical data were reported as frequencies and percentages. The statistical analyses were calculated using SPSS Statistics for Windows (version 18; SPSS Inc., Chicago, Ill., USA). A p-value of < 0.05 was considered statistically significant.

RESULTS

Fifty-six octogenarian patients were recruited for the study (Fig 2). Of those, sixteen (28%) were subsequently withdrawn due to surgery postponement, loss to follow-up,

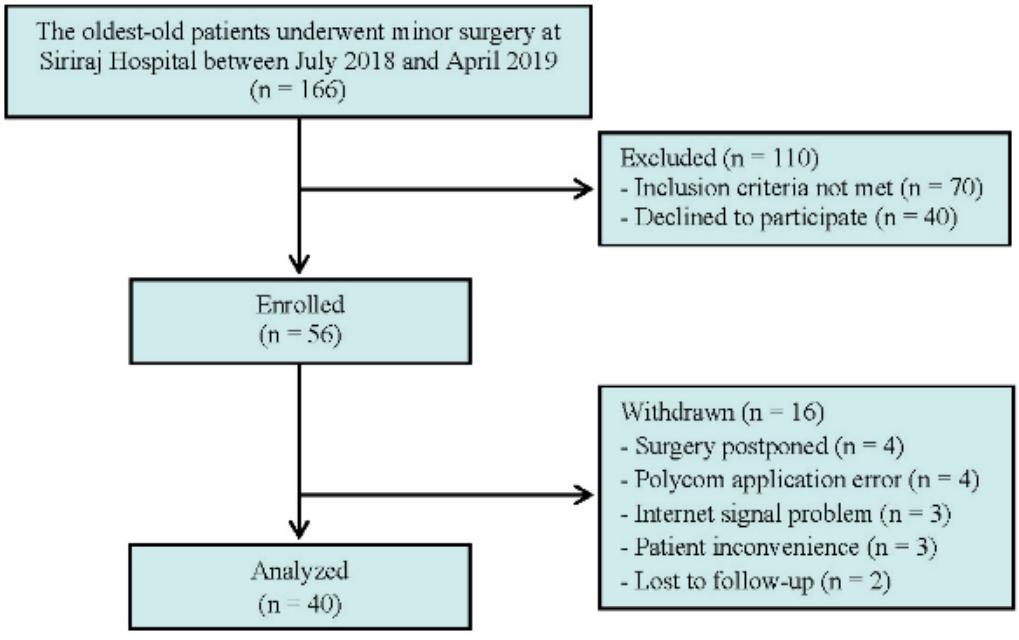

Fig 2. Flowchart of study design.

or incomplete postoperative data collection resulting from patient inconvenience or technical issues (application errors and internet-signal problems). The data relating to 40 patients were therefore included in the final analysis. The number of patients needed for the study was re-calculated, based on the actual probability of event (π) with a 95% confidence interval (CI), to confirm that a sample size of 30 cases was adequate for the achievement of the primary objective.

The characteristics of the octogenarian patients who underwent minor elective surgery and anesthetic management are detailed in Table 1. The mean preoperative RUDAS score, Barthel Index score, EQ-5D-5L score, and MARDS score were 23.40, 17.38, 0.860, and 2.45, respectively. Four octogenarian patients were diagnosed with acute POCD during postoperative Days 5-9, giving an incidence of acute POCD of 10% (95% CI 4.8-18.4). The characteristics of those patients are summarized in Table 2. All four had graduated from primary school, and hypertension was one of their coexisting diseases. Impairment in recall memory was found with each POCD patient. One patient received benzodiazepine to achieve adequate sedation before surgery. Two patients experienced intraoperative adverse events (bradycardia or hypotension) requiring fluid resuscitation and a vasopressor.

There were no differences in the functional declines, decreases in the quality of life, or levels of depression of the POCD and non-POCD patients (Table 3). About 3 days after surgery, the incidence of POCD patients who had experienced mild-to-moderate pain was 7.5% (95% CI 3.45-15.76). The median (range) pain score for the numeric rating scale was 0 (0, 6). Only one of the 40 octogenarian patients had a mild severity of nausea and vomiting, occurring on the first day after anesthesia; consequently, the overall incidence of postoperative nausea and vomiting was 2.5% (95% CI 0.61-8.76).

DISCUSSION

The incidence of acute POCD in this study was 10%. This was higher than the figure reported by a previous study, which revealed that the POCD incidence among patients aged ≥ 60 years and undergoing minor surgery was 6.8% (95% CI 4.3–10.1).[8] Increasing age significantly elevates the incidence of POCD because, relative to younger age groups, individuals with advanced age more frequently have physical and mental frailty as well as a decreased ability to cope with stresses, such as anesthesia and surgery.[2] Yon et al, reported that anesthesia-induced apoptotic neuro-degeneration might also be a potential pathway mediating the development of POCD in the older brain.[20] Glumac et al. showed that preoperative dexamethasone administration may ameliorate the incidence of early POCD after cardiac surgery. This may be because the inflammatory response to surgical procedure is a key factor in the development of POCD.[21]

All 4 POCD patients had impaired recall memory performance. A deterioration of the memory functions is one of the most consistently reported complaints by the elderly.[22] Work by Philp et al. demonstrated that the associations between thalamic structure, integrity, and higher-order cognitive processes-including the

TABLE 1. Patient characteristics, type of surgical procedures, and anesthetic management.

Variables	n = 40
Age (years)	84.20 ± 3.6
Gender	
Female	20
Male	20
Education levels	
Pre-elementary	29 (72.5)
Post-elementary	11 (27.5)
Monthly income (Thai baht)	
≤ 20,000	12 (30.0)
> 20,000	28 (70.0)
Marital Status	
Married	17 (42.5)
Widowed	23 (57.5)
Type of surgery	
Urological endoscopic surgery	20 (50)
Laparoscopic surgery	7 (17.5)
Breast surgery	4 (10.0)
Endoscopic retrograde cholangiopancreatography	4 (10.0)
Wound debridement	3 (7.5)
Anesthetic technique	
General anesthesia	23 (57.5)
Spinal anesthesia	11 (27.5)
Deep sedation	6 (15.0)
Preoperative Scores	
The Rowland Universal Dementia Assessment Scale	23.40 ± 5.00
The Barthel Activities of Daily Living index	17.38 ± 3.41
The 5-level EQ-5D	0.860 ± 0.188
The Montgomery–Asberg Depression Rating Scale	2.45 ± 3.60
Intraoperative benzodiazepine administration	4 (10.0)
Intraoperative adverse events	
Hypotension	19 (47.5)
Bradycardia	2 (5.0)
Hypertension	2 (5.0)

Values expressed as the mean ± SD or n (%).

TABLE 2. Characteristics of the POCD patients.

Case no.	Age	Gender	Education	Coexisting diseases	BDZ	Operation	Anesthetic technique	Intraoperative adverse events	Cognitive domain impairments		
									Recall memory	Drawing	Language
1.	80	Male	Primary school	HT, DLP, DM	No	Urological endoscopy	SA	Bradycardia	√	√	√
2.	82	Male	Primary school	HT, DLP, CVA	No	Urological endoscopy	GA	No	√	√	
3.	83	Female	Primary school	HT, DM	No	Debridement	GA	Hypotension	√		√
4.	85	Female	Primary school	HT, IHD, DLP, CVA	Yes	ERCP	Deep sedation	No	√	√	

Abbreviations: BDZ: Benzodiazepine, CVA: cerebrovascular accident, DLP: dyslipidemia, DM: diabetic mellitus, ERCP: endoscopic retrograde cholangiopancreatography, GA: general anesthesia, HT: hypertension, IHD: ischemic heart disease, SA: spinal anesthesia

TABLE 3. Comparison of the postoperative functional recovery, depression, and quality of life of the POCD and non-POCD patients.

Variables	POCD (n = 4)	Non-POCD (n = 36)	p-value
Functional decline	2 (16.7)	10 (83.3)	0.35
Depression	1 (6.7)	14 (93.3)	0.58
Decreased quality of life	2 (13.3)	13 (86.7)	0.58

Values expressed as the n (%).

component processes of memory and the executive functions of attention and information processing-typically decline with age.[23] Therefore, reductions in the functional connectivity to the thalamus may contribute to age-related cognitive decline.[24] This may explain why most of the cognitive-domain effects in our study were related to recall memory.

POCD is associated with functional dependence and a poor quality of life.[21,25] Previous research has demonstrated that even the early stages of cognitive impairment adversely affect the quality of life.[26] In contrast, our research found that there was no significant development of functional dependence or lowering of the quality of life of the acute-POCD patients. This suggests that minor elective surgery, ambulatory surgery, and anesthesia are quite suitable for octogenarian patients. Depression is also one of the most common illnesses in the elderly population.[27] Steinmetz et al. found that the occurrence of depression was not associated with the incidence of POCD at 1 week.[28] Likewise, we found that there was no significant development of depression among the POCD patients.

Improvements to the population's health literacy has the potential to allow individuals to access health services, to understand basic health-related information,

to communicate their health statuses well enough, and to make appropriate health decisions.[29] In other words, adequate health literacy is key to patients' abilities to maintain their health, achieve behavioral change, and effectively utilize medical services.[30] eHealth requires the use of everyday technology, such as telephones, computers, and services available through the Internet; unfortunately, this can prove to be very challenging for elderly patients.[31] Our study found that many of the octogenarian patients had limited experience with new technological devices, and their eHealth literacy skills were low. The assistance of their caregivers was therefore vital in allowing them to communicate effectively via the application. It follows that the provision of basic training in communications technology and the use of a less complex eHealth application are needed to significantly improve the eHealth literacy of the older population.

There were several limitations of our study. Firstly, the anesthetic techniques and surgical procedures employed were varied. Although all of the procedures were categorized as minor surgery, further research should be considered to assess the impact of technique variations on POCD, such as the use of moderate sedation, deep sedation, and general anesthesia. Secondly, data collection was interrupted on occasion by technological hindrances, such as internet-signal loss and the application not being sufficiently user-friendly for the elderly. Sixteen participants were therefore terminated from our study due to their inability to complete the postoperative cognitive tests. Lastly, the sample size was too small to identify the risk factors for acute POCD in the elderly Thai population. Future studies are recommended to establish those risk factors and to discover means of preventing POCD onset.

In summary, the incidence of early POCD after minor surgery in octogenarian Thai patients was higher than the figure reported by previous research, most probably due to the present study focusing on a much older population. The acute POCD revealed by the current work was not related to a delayed postoperative functional recovery or a poor quality of life. Hence, it can be concluded that minor elective surgery and anesthesia are quite suitable for octogenarian patients.

ACKNOWLEDGEMENTS

This study was supported by a grant from the Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand (IO R016131035). The funding bodies had no role in the design of the study; the collection, analysis, and interpretation of data; or the writing of the manuscript. The authors acknowledge Mrs. Nipaporn Sangarunakul, BNS, Ms. Sunit Jarungjitaree, and Ms. Chayanan Thanakiattiwibun MSc, the Siriraj Integrated Perioperative Geriatric Excellent Research Center, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand, to provide support for research.

Potential conflicts of interest

The authors declare that there are no conflicts of interest.

REFERENCES

1. Yang R, Wolfson M, Lewis MC. Unique Aspects of the Elderly Surgical Population: An Anesthesiologist's Perspective. Geriatr Orthop Surg Rehabil. 2011;2(2):56-64.
2. Wang W, Wang Y, Wu H, Lei L, Xu S, Shen X, et al. Postoperative cognitive dysfunction: current developments in mechanism and prevention. Med Sci Monit. 2014;20:1908-12.
3. Pappa M, Theodosiadis N, Tsounis A, Sarafis P. Pathogenesis and treatment of post-operative cognitive dysfunction. Electron Physician. 2017;9(2):3768-75.
4. Rundshagen I. Postoperative cognitive dysfunction. Dtsch Arztebl Int. 2014;111(8):119-25.
5. Moller JT, Cluitmans P, Rasmussen LS, Houx P, Rasmussen H, Canet J, et al. Long-term postoperative cognitive dysfunction in the elderly ISPOCD1 study. ISPOCD investigators. International Study of Post-Operative Cognitive Dysfunction. Lancet. 1998; 351(9106):857-61.
6. Steinmetz J, Christensen KB, Lund T, Lohse N, Rasmussen LS. Long-term consequences of postoperative cognitive dysfunction. Anesthesiology. 2009;110(3):548-55.
7. Tsai TL, Sands LP, Leung JM. An Update on Postoperative Cognitive Dysfunction. Adv Anesth. 2010;28(1):269-84.
8. Canet J, Raeder J, Rasmussen LS, Enlund M, Kuipers HM, Hanning CD, et al. Cognitive dysfunction after minor surgery in the elderly. Acta Anaesthesiol Scand. 2003;47(10):1204-10.
9. Gunter RL, Chouinard S, Fernandes-Taylor S, Wiseman JT, Clarkson S, Bennett K, et al. Current Use of Telemedicine for Post-Discharge Surgical Care: A Systematic Review. J Am Coll Surg. 2016;222(5):915-27.
10. Hwa K, Wren SM. Telehealth follow-up in lieu of postoperative clinic visit for ambulatory surgery: results of a pilot program. JAMA Surg. 2013;148(9):823-7.
11. Ian smith, Mark A. Skues, and Beverly et, al. Ambulatory (outpatient) anesthesia, chapter 72. Miller's Anesthesia, ninth edition, 2020.
12. Storey JE, Rowland JT, Basic D, Conforti DA, Dickson HG. The Rowland Universal Dementia Assessment Scale (RUDAS): a multicultural cognitive assessment scale. Int Psychogeriatr. 2004;16(1):13-31.
13. Limpawattana P, Tiamkao S, Sawanyawisuth K, Thinkhamrop B. Can Rowland Universal Dementia Assessment Scale (RUDAS) replace Mini-mental State Examination (MMSE) for dementia screening in a Thai geriatric outpatient setting? Am J Alzheimers Dis Other Demen. 2012;27(4):254-9.
14. Wong L, Martin-Khan M, Rowland J, Varghese P, Gray LC. The Rowland Universal Dementia Assessment Scale (RUDAS) as a reliable screening tool for dementia when administered via videoconferencing in elderly post-acute hospital patients. J Telemed Telecare. 2012;18(3):176-9.

15. Hensel A, Angermeyer MC, Riedel-Heller SG. Measuring cognitive change in older adults: reliable change indices for the Mini-Mental State Examination. J Neurol Neurosurg Psychiatry. 2007;78(12):1298-303.
16. Wade DT, Collin C. The Barthel ADL Index: a standard measure of physical disability? Int Disabil Stud. 1988;10(2):64-7.
17. Herdman M, Gudex C, Lloyd A, Janssen M, Kind P, Parkin D, et al. Development and preliminary testing of the new five-level version of EQ-5D (EQ-5D-5L). Qual Life Res. 2011;20(10):1727-36.
18. Montgomery SA, Asberg M. A new depression scale designed to be sensitive to change. Br J Psychiatry. 1979;134:382-9.
19. Elashoff JD. nQuery Advisor Version 7.0 User's Guide. Cork, Ireland, Statistical Solutions Ltd 2007.
20. Safavynia SA, Goldstein PA. The Role of Neuroinflammation in Postoperative Cognitive Dysfunction: Moving From Hypothesis to Treatment. Front Psychiatry. 2018;9:752.
21. Lima-Silva TB, Yassuda MS. The relationship between memory complaints and age in normal aging. Dement Neuropsychol. 2009; 3(2):94-100.
22. Philp DJ, Korgaonkar MS, Grieve SM. Thalamic volume and thalamo-cortical white matter tracts correlate with motor and verbal memory performance. Neuroimage. 2014;91:77-83.
23. Fama R, Sullivan EV. Thalamic structures and associated cognitive functions: Relations with age and aging. Neurosci Biobehav Rev. 2015;54:29-37.
24. Glumac S, Kardum G, Sodic L, Supe-Domic D, Karanovic N. Effects of dexamethasone on early cognitive decline after cardiac surgery: A randomised controlled trial. Eur J Anaesthesiol. 2017;34(11):776-84.
25. Phillips-Bute B, Mathew JP, Blumenthal JA, Grocott HP, Laskowitz DT, Jones RH, et al. Association of neurocognitive function and quality of life 1 year after coronary artery bypass graft (CABG) surgery. Psychosom Med. 2006;68(3):369-75.
26. Bárrios H, Narciso S, Guerreiro M, Maroco J, Logsdon R, de Mendonça A. Quality of life in patients with mild cognitive impairment. Aging Ment Health. 2013;17(3):287-92.
27. Pilania M, Yadav V, Bairwa M, Behera P, Gupta SD, Khurana H, et al. Prevalence of depression among the elderly (60 years and above) population in India, 1997-2016: a systematic review and meta-analysis. BMC Public Health. 2019;19(1):832.
28. Steinmetz J, Siersma V, Kessing LV, Rasmussen LS. Is postoperative cognitive dysfunction a risk factor for dementia? A cohort follow-up study. Br J Anaesth. 2013;110 Suppl 1:i92-7.
29. Rios G. eHealth Literacy and Older Adults: A Review of Literature. Topics in Geriatric Rehabilitation 2013;29:116–125.
30. Leung JM, Sands LP, Mullen EA, Wang Y, Vaurio L. Are preoperative depressive symptoms associated with postoperative delirium in geriatric surgical patients? J Gerontol A Biol Sci Med Sci. 2005;60(12):1563-8.
31. Jakobsson E, Nygård L, Kottorp A, Malinowsky C. Experiences from using eHealth in contact with health care among older adults with cognitive impairment. Scand J Caring Sci. 2019;33(2): 380-9.