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Common postoperative neurological complications after cardiac surgery

Abstract

Neurological complications, including postoperative delirium and postoperative cognitive dysfunction (POCD), occur frequently after cardiac surgery. The aim of this article is to enable nurses to consider their role in managing patients who have, or are at risk of developing, neurological complications after cardiac surgery. This article provides an overview of the most common postoperative neurological complications: delirium and POCD

Keywords – To be drawn from the Nursing Standard taxonomy

Aims and intended learning outcomes

The aim of this article is to enable nurses to consider their role in managing patients who have, or are at risk of developing, neurological complications after cardiac surgery. Neurological complications after surgery include stroke, encephalopathy, seizures, postoperative delirium, postoperative cognitive dysfunction (POCD), and peripheral nerve injury (Mulkey, 2020). This article provides an overview of the most common postoperative neurological complications: delirium and POCD. While these are discussed in the context of cardiac surgery, the principles are generally applicable to all postoperative patients. After reading this article and completing the timeout activities you should be able to:

- Identify the patient groups at risk of developing delirium and POCD.
- Determine the nurse's role in the recognition and management of the most common postoperative neurological complications.
- Explain the rationale for the revised terminology associated with cognitive change after surgery and general anaesthesia, and discuss the key differences in the associated diagnostic criteria.

Introduction

In the UK, over 35,000 adult cardiac surgeries are performed annually (SCTS, 2021). While operative mortality is low, ranging from 0.6% for elective isolated coronary artery bypass graft (CABG) surgery to 1.7% for isolated aortic valve replacement (SCTS, 2021), neurological complications are common. They are associated with poor postoperative outcomes including

prolonged length of hospital stay, increased morbidity and mortality, and reduced quality of life, resulting in a significant burden on the healthcare system (Cropsey et al., 2015).

Delirium

Delirium is an acute fluctuation in mental status with features of inattention and changes on level of consciousness. It is a common complication after surgery and can occur in patients of any age. The incidence of postoperative delirium (POD) ranges from 2%-3% in the general surgical population, increasing to 50%-70% in higher risk groups (Jin et al., 2020) and up to 87% in critically-ill patients (van den Boogaard et al., 2012). It is associated with poor patient outcomes including an increased hospital and intensive care unit (ICU) length of stay, functional decline and higher 1-year mortality (Zhou et al., 2021). Further, patients who develop delirium are more likely to have institutional care needs when discharged from hospital (Aitken et al., 2017). The economic burden of delirium is estimated to cost an additional £2000 to £8000 per case (Jin et al., 2020).

POD commonly occurs between postoperative days 2-5, however it can occur at any time after the operation (recovery room) until the effects of anaesthesia and surgery are expected to have resolved (30 days) (Evered et al., 2018, Jin et al., 2020). POD that occurs during early recovery, or during emergence from anaesthesia is referred to as 'emergence delirium' (Lee and Sung, 2020). While emergence delirium can occur in the adult population (Proekt, 2019), it is more common in children and therefore outside the scope of this paper.

Risk factors

There are several risk factors and conditions that can predispose patients to developing POD. These can be categorised as preoperative, intraoperative, and postoperative (Table 1). However, the development of delirium is a product of a combination of the predisposing factors (patient-specific factors such as age, cognitive decline, compromised functional status, sensory impairment, pre-existing medical conditions) and precipitating factors (those that trigger the onset of delirium such as certain drugs, primary neurological disease, surgery, admission to ICU, prolonged mechanical ventilation, physical restraint, and urinary catheterisation). The resulting risk factors for developing delirium are additive, which highlights the need for a comprehensive assessment of patients on admission (and frequently thereafter, as the patient's condition dictates). This will facilitate early recognition and treatment of POD.

Diagnosis

The gold standard for diagnosing delirium is by using the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (American Psychiatric Association, 2013) or the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) criteria (World Health Organization, 2004). However, the criteria require specific expertise to perform and can be time-consuming. Several validated screening tools have been developed based on the DSM-5 criteria for delirium, such as the Nursing Delirium Screening Scale (Nu-DESC) (Gaudreau et al., 2005) and the Confusion Assessment Method (CAM) (Inouye et al., 1990), which enable trained practitioners to identify delirium quickly and accurately. A modification of CAM is the Confusion Assessment Method-Intensive Care Unit (CAM-ICU) which relies more on non-verbal responses for critically ill or intubated patients (Ely et al., 2001). Regardless of the screening tool used, it is important that the team have a common understanding of delirium and are able to consistently communicate the results. If there is difficulty distinguishing between the diagnoses of delirium, dementia, or delirium superimposed on dementia, the National Institute for Heath and Care Excellence (NICE) (2010) guidelines recommend treating delirium first.

Signs and symptoms

Signs and symptoms of POD fluctuate and are usually temporary. There are three different types of delirium. These are based on symptoms and psychomotor manifestations (National Institute for Health and Care Excellence, 2010):

1. Hyperactive delirium occurs when a patient is restless, irritable, agitated, aggressive or combative. Symptoms include increased confusion, hallucinations or delusions, sleep disturbance, and being less cooperative.
2. Hypoactive delirium occurs when a patient is withdrawn, quiet or lethargic. Symptoms include poor concentration, being less aware, reduced mobility or movement, and reduced appetite.
3. Mixed delirium is characterised by presentation of the symptoms of both hyperactive and hypoactive delirium.

Nursing priorities and management

Delirium is preventable and is easily treatable. To help prevent development of POD, clinicians should try these non-pharmacological measures (Jin et al., 2020):

- Avoid moving patients within or between wards or rooms, unless absolutely necessary.

- Ensure effective communication and reorientation (e.g consider providing clock in a room, use of visual/hearing aids when communicating, providing appropriate lighting and clear signage).
- Ensure adequate fluid intake to prevent dehydration.
- Encourage early nutrition.
- Optimise oxygen saturation as clinically appropriate.
- Promote good sleep patterns. Facilitate noise reduction particularly during rest periods.
- Encourage patients to mobilise early soon after surgery.
- Avoid unnecessary contraptions and indwelling catheters.

In patients diagnosed with POD, it is important to identify and manage the underlying cause(s) as soon as possible to reduce the effects and duration of this complication. The European Society of Anaesthesiology have produced evidence- and consensus-based guidelines on the prevention and treatment of postoperative delirium (Aldecoa et al., 2017). These are summarised in Box 1. The 'I WATCH DEATH' acronym (Box 2) facilitates the assessment and modification of the underlying causes of delirium. It is recommended that non-pharmacological measures, as indicated above, should be initiated first. But if non-pharmacological measures fail, pharmacological treatment can also be used to maintain patient safety. [insert time out 1]

Time out 1

Access the latest European Society of Anaesthesiology guidelines (Aldecoa, et al., 2017) to increase your knowledge of evidence-based and consensus-based management of postoperative delirium.

Postoperative cognitive dysfunction (POCD)

The concept of cognitive impairment following general anaesthesia and surgery was first described in 1955, when Bedford (1955) reported 'adverse cerebral effects of anaesthesia on old people'. This phenomenon was later characterised as postoperative cognitive dysfunction (POCD) (Moller 1998). More recently, recommendations for the nomenclature of cognitive change associated with anaesthesia and surgery were published, whereby POCD has been divided into categories to reflect the timing of onset and magnitude, in order to better align it with similar cognitive disorders that already exist (Evered et al., 2018) (Box 3).

POCD is a decline in cognitive function measured objectively both before and after any type of surgery (Berger et al., 2018). The incidence of POCD varies greatly, however it is generally

higher after cardiac surgery than after general non-cardiac surgery, with reported rates ranging from 30%-80% in the weeks following surgery, decreasing to 10%-60% after 3 to 6 months (Kotekar, 2018). Variation in the reported incidence can be attributed to the methodological heterogeneity in the definitions of POCD used across studies, the variety of tests used to diagnose POCD, and the timing of testing (Patel et al., 2015). POCD is a common complication affecting a significant number of patients. Manifestations of POCD can be subtle and vary depending on the cognitive domains affected, however impairments in memory, language skills, and attention, as well as subjective complaints of difficulty thinking and concentrating, are commonly reported (Nelli, 2019, Nilsson et al., 2019).[insert time out 2]

Time out 2

Are you familiar with cognitive domains? The DSM-5 defines six domains of cognitive function, each with a number of subdomains (American Psychiatric Association, 2013): perceptual-motor function, language, learning and memory, social cognition, complex attention, and executive function. Review the cognitive domains and consider whether you have encountered any postoperative patients with impairment in any of these.

Causes

Despite extensive research, the underlying pathophysiology and causes of POCD are still poorly understood. It is believed that the mechanisms leading to POCD are multi-factorial and are usally separated into patient related, surgical related, and anaesthesia related factors (Berger et al., 2018). It was previously assumed that this impairment was related to microemboli caused by cardiopulmonary bypass (CPB), but evidence of cognitive impairment in ‘off-pump’ patients calls this belief into question (Shroyer et al., 2009). Other potentially causative factors that have been identified include age, post-operative delirium, haemodynamic instability, inflammatory responses, and rewarming after hypothermia (Patel et al., 2015), although inconsistencies exist in this body of evidence resulting in a lack of consensus on the cause of POCD after cardiac surgery.

Risk factors and predictors

Numerous risk factors have been implicated in the development of POCD (Table 1), however those most commonly identified include increasing age, lower education level, preoperative cognitive impairment, prior stroke, diabetes, poor functional status, duration of surgery, and depth of anaesthesia (Moller et al., 1998, Berger et al., 2018, Patel et al., 2015). In a recent

systematic review, advancing age and fewer years of education were found to be important predictors of POCD (Bowden et al., 2021). [insert time out 3]

Time out 3

The terms 'risk factor' and 'predictor' are often used interchangeably. Can you explain the difference between these concepts? Access Schooling and Jones (2018) and / or van Diepen et al. (2017) to explore these concepts in greater detail.

Assessment and diagnosis

Historically, the assessment and diagnosis of POCD has presented several challenges: POCD lacks a formal definition (in the DSM-5 or ICD-10), there is no universally accepted standard for assessment, and formal and appropriate testing rarely occurs outside of the research setting. Consequently POCD is often described as a research construct (Needham et al., 2017). A consensus statement on the assessment of neurobehavioral outcomes after cardiac surgery (1995), recommended a core battery of tests, to be performed both before and after surgery. However, adherence to the consensus statement recommendations is generally poor (Rudolph et al., 2010, van Sinderen et al., 2020).

The diagnosis of POCD is dependent on administering a number of objective neuropsychological tests that examine several cognitive domains. These are time-consuming and they are administered and interpreted by trained clinical neuropsychologists. As previously indicated, the diagnosis of POCD is also dependent on measuring cognitive function before and after surgery, however in the UK, it is not customary practice to measure cognitive function in surgical patients, making the diagnosis of POCD difficult (Harvey, 2019, Severn, 2018). Severn (2018) advocate using screening tools to trigger a more comprehensive neuropsychological assessment if deemed necessary. These are brief tests of global cognition that are widely used for screening for specific conditions, for example mild cognitive impairment. The following screening tools are used in many UK centres and have been suggested for use in the preoperative clinic environment: the Montreal Cognitive Assessment (MoCA), Addenbrooke's Cognitive Exam (ACE-III), and the Quick MCI screen (Qmci) (Needham et al., 2017). Funding, training, and time constraints have been cited as barriers to the implementation of widespread testing, however the use of screening tools could identify those who would benefit from further testing and those at risk of postoperative

cognitive decline (Severn, 2018). The differences between screening tools and comprehensive neuropsychological test batteries are highlighted in Table 2.

In terms of diagnosis, the main differences between POCD and NCDs (delayed neurocognitive recovery and postoperative neurocognitive disorder [POCD]) is that the NCDs require subjective (a cognitive concern by the individual, informant, or clinician), functional (impaired activities of daily living [ADL]), and objective evidence of decline to fulfil the diagnostic criteria. This is in contrast to POCD which lacks subjective and functional components.

Management and nursing responsibilities

Definitive treatments for POCD are lacking. As a result, numerous pharmacological (Ottens et al., 2014) and operative strategies (Hogan et al., 2013) have been explored in attempt to prevent POCD, however limited clinically important improvements have been identified to date. Emerging evidence suggests that the use of cognitive interventions could lead to improved cognitive outcomes after surgery, however further research is required to determine the optimum timing and dosage of training to improve adherence, efficacy, and acceptability (Bowden et al., 2022). In the absence of definitive treatment options, Needham et al (2017) have pooled the available evidence and made recommendations for managing patients at high-risk of POCD. These are summarised in Figure 1.

Conclusion

Patients can develop a range of neurological complications after surgery. These occur frequently following cardiac surgery. Healthcare practitioners should have a good understanding of potential complications to improve patient outcomes. This includes identification of patients in high-risk groups, preventative strategies, and prompt recognition of complications. [insert time out 4] [insert time out 5]

Time out 4

Reflect on a time when you looked after a patient with a possible neurologic complication after cardiac surgery. Was it delirium or POCD? What were the signs and symptoms? How did you manage the situation? Is there anything you would have done differently?

Time out 5

Now that you have completed the article you might like to write a reflective account as part of your revalidation.

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Box 1 Summary of the evidence-based and consensus-based guidelines for the prevention and treatment of postoperative delirium

- Implementation of fast-track surgery to prevent POD
- Avoiding routine premedication with benzodiazepines except for patients with severe anxiety
- Monitor the depth of anaesthesia to avoid too deep anaesthesia
- Adequate pain assessment and treatment
- Use of continuous intraoperative analgesia
- Prompt diagnosis of POD, establish a differential diagnosis of POD, and initiate treatment

(Aldecoa et al., 2017)

Box 2 Assessment and possible interventions against underlying causes of delirium

For assessment and possible intervention against underlying causes for delirium, use, the 'I WATCH DEATH'-acronym (Aldecoa et al, 2017):

Infections (e.g. UTI and pneumonia)
Withdrawal (e.g. alcohol, opioids and benzodiazepines)
Acute metabolic disorder (electrolyte imbalance and renal dysfunction)
Trauma (operative trauma)
CNS pathology (e.g. stroke and perfusion)
Hypoxia (e.g. anaemia, cardiac failure and pulmonary failure)
Deficiencies (e.g. vitamin B 12, folic acid and thiamine)
Endocrine pathologies (e.g. T3/T4 and glucose)
Acute vascular (e.g. hyper-/hypotension)
Toxins or drugs (e.g. anaesthetics, drugs with anticholinergic side-effects)
Heavy metals (rare cause)

Box 3 POCD: revised terminology

Perioperative neurocognitive disorder (PND) is an umbrella term for cognitive impairment identified in the preoperative or postoperative period. Cognitive impairment identified preoperatively should be categorised as either a mild or major neurocognitive disorder, according to the DSM-5 criteria (Box 4) (American Psychiatric Association, 2013). Cognitive impairment identified postoperatively includes delirium, *delayed neurocognitive recovery, and* postoperative *neurocognitive disorder (POCD).* Before the new nomenclature was introduced, cognitive impairments identified after anaesthesia and surgery were termed as postoperative delirium or POCD.

Delayed neurocognitive recovery is a cognitive decline meeting the DSM-5 criteria for mild or major NCD (Box 4), diagnosed before the effects of anaesthesia and surgery are expected to have resolved (30-days). *Postoperative neurocognitive disorder (POCD)* is cognitive decline meeting the DSM-5 criteria for mild or major NCD (Box 4) diagnosed from expected recovery (30 days) until 12 months after surgery (Evered et al., 2018). 'POCD' in parentheses helps to acknowledge the temporal relationship to surgery and is recommended for the transition period while the new nomenclature is integrated into practice. This should not be confused with the abbreviation POCD.

(Evered et al., 2018)

Box 4 Diagnostic and Statistical Manual of Mental Disorders (DSM-5) diagnostic criteria for mild and major neurocognitive disorders

Mild neurocognitive disorder
A cognitive concern by the individual, informant, or clinician, **and,** objective evidence of decline (1-2 SD) compared to a normative group[1], **and** maintained ADLs.

Major neurocognitive disorder
A cognitive concern by the individual, informant, or clinician, **and,** objective evidence of decline[1] (≥2 SD) compared to a normative group, **and** impaired ADLs.

[1] Objective evidence of decline from a previous level of performance in one or more cognitive domain.

Abbreviations: ADL – activities of living; SD – standard deviations.

(American Psychiatric Association, 2013)

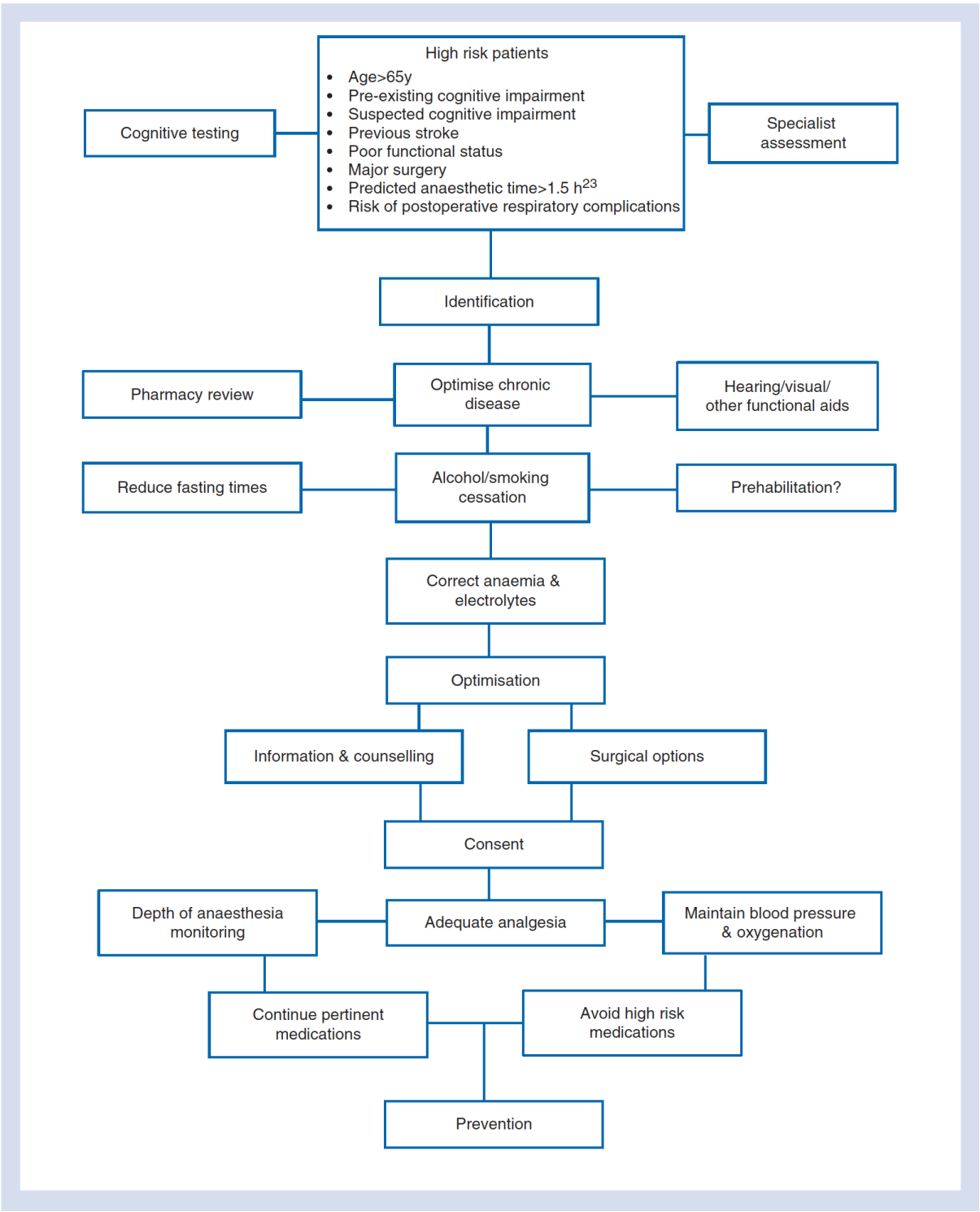

Figure 1 Suggested flow diagram for the perioperative process of patients at high risk of POCD (Author 1 to request permission to preproduce)

Table 1 Commonly identified risk factors for delirium, POCD, and stroke

	Delirium	POCD
Patient related	Increasing age Comorbidities (e.g. stroke, cardiovascular, peripheral vascular disease, diabetes, Parkinson's disease, depression, anxiety disorder, alcohol-use disorder) Fluid status and dehydration Hyponatraemia or hypernatraemia Certain drugs with anticholinergic effects (including antihistamines) Psychoactive drugs Opioids	Increasing age Lower education level Preoperative cognitive impairment or delirium Prior stroke Diabetes Poor functional status
Surgery related	Site / type of surgery Intraoperative bleeding Duration of surgery Urgency of surgery	Type and invasiveness of surgery Duration of surgery Repeat procedures
Anaesthesia related	Pain	Depth of anaesthesia Pain and pain management

(Gaudino et al., 2019, Nelli, 2019, Severn, 2018)

Table 2 Differences between the uses and administration of screening tools and comprehensive neuropsychological test batteries

	Screening tools	Comprehensive neuropsychological test batteries
Uses	• Early identification of those at risk for a specific condition or disorder • Can trigger a more comprehensive neuropsychological evaluation • Can be used to monitor progression or response to an intervention • Does not provide a definitive diagnosis.	• Establish the presence and magnitude of impairment • Establish a diagnosis • Facilitate a treatment plan
Administration	• Brief duration (<30 minutes) • May be administered as part of a routine clinical visit • Minimal training required for the administrator	• Lengthy, ranging from 2.5 hours to all day • Requires specialised training in administration and interpretation

(Roebuck-Spencer et al., 2017)