Post-operative Management

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Older patients with hip fractures are a heterogeneous population [1]. Only 15% are fully independent and with a low level of comorbidity prior to fracture occurrence, while the broad majority presents multiple comorbidities and some frailty-related characteristics. Despite advances in surgical and anaesthetic techniques over time, the risk of complications after hip fracture surgery remains high. The main goal of the post-operative management is to prevent or promptly detect complications in order to reduce morbidity and mortality. A second goal is to mobilise patients as soon as practical in order to avoid the risks of immobilisation and to foster the recovery of pre-fracture walking ability.

11.1 Multidisciplinary Management

The high clinical and functional complexity of hip fracture older patients requires a multidisciplinary approach. Orthogeriatric co-management currently is the standard of care, having been shown to diminish in-hospital stay, time to surgery, in-hospital complications and in-hospital mortality, compared to traditional care [1–5]. Following this model, the orthopaedic surgeon and the orthogeriatrician (a geriatrician skilled in the management of older adults with orthopaedic issues) share

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For an explanation of the grouping of chapters in this book, please see Chapter 1: 'The multidisciplinary approach to fragility fractures around the world—an overview'.

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responsibility and leadership from admission to discharge. The traditional roles are maintained, with the orthopaedic surgeon assessing the trauma and managing the fracture, and the geriatrician responsible for medical issues and coordinating discharge. Several other healthcare professionals (anaesthesiologist, therapists, specialist nurses, nutritionist and social worker) may be included in the interdisciplinary team during the pathway of care.

In the post-operative period, most needs of older patients with hip fractures are related to medical or geriatric issues; therefore the geriatric team usually contributes to joint preoperative patient assessment, and increasingly takes the lead in post-operative medical care. The orthopaedic surgeon is involved in any issue regarding the surgical site. On the basis of local organisational features, different orthogeriatric models may be implemented, although a dedicated orthogeriatric ward seems to have more consistent results in reducing mortality, compared to other models of orthopaedic/geriatric collaboration [4]. In any case, whatever type of ward the patient is admitted to, it is important that a coordinated multidisciplinary approach ensures continuity of care and responsibility across the clinical pathway from admission to discharge. Former experience, characterised by the use of a geriatric consulting team without continual responsibility for care, demonstrated only small benefits compared to traditional care, and that approach should now be considered outdated [5].

Essential quality standards related to the organisation of orthogeriatric collaboration include senior experience of the members of the team, clinical and service governance responsibility for all stages of the pathway of care, established procedures for communication between different specialists including briefings and meetings, development of shared protocols for the main features of the perioperative phase, continued multidisciplinary reviews, integration with a centre for bone health for secondary prevention and liaison with primary care and social services [6, 7].

11.2 Predicting the Risk of Post-operative Complications

As described in Chap. 7, a key goal of pre-operative orthogeriatric co-management is to identify, and where possible prevent, conditions that predispose to post-operative complications. Several studies have focused on identifying patients at risk after hip fracture surgery [8]. The risk of 30-day mortality has been also explored using scoring systems, some of them very simple, such as the Nottingham Hip Fracture Score [9], which includes relatively few variables.

Specific predictors related to patient risk are not fully consistent, mainly because of a different selection of potential factors across studies. Indeed, patients with the highest pre-fracture comorbidity and disability are those at greater risk of developing clinical complications postoperatively. From an operational point of view, most of the individual preoperative parameters are non-modifiable risk factors. They are useful for identifying patients that require high attention and intensive care. The American College of Surgeons together with the American Geriatrics Society

recommends the preoperative evaluation of the older patient for frailty syndrome [10]. This has been defined as a syndrome with multiple reduced physiologic functions that increases an individual's vulnerability for developing increased dependency and/or death. Evidence suggests that frailty, measured with different instruments including those based on Comprehensive Geriatric Assessment, predicts post-operative mortality, complications and prolonged length of stay [11]. Among the hip fracture population, about one-third of patients have significant frailty with a high risk of poor outcomes, one-third with no markers of frailty, and about one-third with an intermediate condition [12].

In clinical practice, a very high risk of complications and short-term mortality is observed in very sick patients with severe organ failure, such as a person with a history of ascites, or end-stage chronic kidney disease on dialysis or dyspnoea at rest [13]. A substantial increase in mortality occurs mainly in severe conditions [14]. Similarly, patients suffering from congestive heart failure or chronic obstructive pulmonary disease are at higher risk of poor outcomes depending on the severity of the underlying disease. Finally, a history of disseminated cancer and full functional dependency increases three to four times the likelihood of death within 30 days [13].

Malnutrition and sarcopenia are other conditions that can increase the occurrence of post-operative complications, but they mainly affect the likelihood of achieving a complete functional recovery. On the other hand, obesity is also associated with negative outcomes. A simple parameter as the BMI shows a U-shaped relationship with respect to the risk of post-operative complications [15], with the highest rates occurring in low-weight (BMI < 20) and morbidly obese (BMI > 40) patients. In particular, the risk of deep surgical site infection increases linearly with increasing BMI.

Among routine admission laboratory testing, several parameters have been found related to negative outcomes including low haemoglobin level, high creatinine value, electrolyte derangements or high Brain Natriuretic Peptide, all of which may be considered an expression of an underlying disease. Probably the most studied laboratory predictor of post-operative outcome is albumin level. There is consistent evidence that albumin lower than 3.5 g/dL is associated with two to three times risk of post-operative complications and mortality [16]. Albumin has commonly been studied as a dichotomous variable, but some data suggest an increasing risk with decreasing values. Serum albumin level is a well-established serum marker of nutritional status, but it is a better predictor of post-operative outcomes than other nutritional indicators, including nutritional assessment [16]. In fact, albumin may have a wider implication, since it is also a negative acute-phase protein, and hypoalbuminemia might represent an increased inflammatory status of the patient—also potentially leading to poor outcomes [17].

Beyond patient-related risk factors, several potentially modifiable process factors may affect the rate of post-operative complications. The most consistently demonstrated across the various studies have been timing of surgery and multidisciplinary management, while inconsistent effects have been found for anaesthetic type and transfusion strategy [8]. A study based on the National Danish Database, analysing post-operative process performance measures, found that mobilisation of patients

within 24 h postoperatively was the process with the strongest association with lower 30-day mortality, readmission risk and shorter length of stay [18].

11.3 Early Mobilisation

One of the quality standards developed by NICE for improvement of hip fracture management states that adults with a hip fracture should start mobilisation, at least once a day, no later than the day after surgery [6]. That means assisting patients to quickly re-establish the ability to move between postures, to maintain an upright posture and to ambulate with increasing levels of complexity. Shortening the time of bed rest after hip fracture surgery contributes to a reduction of the length of hospital stay and complications such as thrombosis, pneumonia, respiratory failure, delirium and pressure sores. Early mobilisation impacts especially on the long-term functional status and improves the likelihood of achieving full ambulation recovery [19]. Analyses of data from large databases confirm that patients mobilised on the day of, or the day following surgery have better mobility function 30 days after discharge [20].

Mobilisation involves an early physiotherapist assessment. However, support with mobilisation can be given either by the physiotherapist or by the nursing team, when the physiotherapist is not present [20]. The NICE quality standard recommends that local arrangements (teams) should monitor the accomplishment of early mobilisation by calculating the proportion of hip fracture operations in which the person starts mobilisation within 24 h from surgery [6]. A useful and widespread tool for monitoring basic mobility during acute hospitalisation is the Cumulated Ambulation Score (CAS) that assesses the ability to get in and out of bed, rise from a chair and walk around indoors with a walking aid during the first three post-operative days [21]. With suitable rehabilitation programmes addressing critical issues in the post-operative phase, almost 80% of patients who were able to walk before fracture achieve the ability to walk with aid within the first two post-operative days [22].

Pre-injury functional status and baseline characteristics of patients may clearly affect inpatient rehabilitation as well as final outcomes. Subjects walking with assistive devices before fracture may need more time to be able to transfer postoperatively. Delayed time to mobilisation may be also due to system factors, such as fewer physiotherapists available during the weekends, which may explain why patients undergoing surgery on Friday have a higher risk of delayed mobilisation [22]. Also, surgery performed after 24 h from arrival has been reported to delay the recovery of post-operative ambulatory function, although this finding is not consistent across studies [23, 24].

An essential condition to achieve the goal of early mobilisation is a stable surgical repair, allowing the patient to bear weight as tolerated. When deciding about weight-bearing after surgery, orthopaedic surgeons should take into account that any restriction has the potential to affect recovery and that unrestricted allowance of immediate full weight-bearing should be the standard protocol for the aftercare following fracture fixation in geriatric patients with hip fracture. In addition, it has been proven that older patients treated for hip fractures are not able to adequately follow any

weight-bearing restrictions [25], so the patients should be either weight-bearing as tolerated or non-weight-bearing if there is real concern about fixation stability.

In a recent observational study, the most frequent reasons for not completing planned physiotherapy, and not regaining basic mobility independence during the first three post-operative days, were poorly controlled pain and fatigue [26]. The latter is one of the most common limiting symptoms and may occur for multiple reasons such as incomplete volume adequacy, low haemoglobin level or the overall impact of surgery on a patient with frailty. To support early mobilisation, clinicians have to face two main issues: adequate pain control and prevention of post-operative hypotension. Coordinated care pathways addressing both clinical and system issues with the goal to improve functional outcomes after hip fracture surgery should be developed and implemented.

11.4 Pain Management

Standard protocols to manage hip fracture-related pain are currently based on multimodal analgesia that includes a panel of drugs such as IV acetaminophen, pregabalin, oxycodone and—very cautiously—nonsteroidal anti-inflammatory drugs, along with nerve block methods (e.g. femoral nerve or lumbar plexus block or continuous epidural block). Multimodal analgesia offers the advantage of reducing opiate consumption, which has been associated in older patients with nausea, vomiting, sedation, delirium and respiratory depression, particularly in debilitated patients or those with compromised respiratory function [27]. Appropriate parenteral analgesia should start in the Emergency Department and the presence of pain should be regularly checked throughout the peri-operative period in order to ensure that the patient is feeling comfortable. The fascia iliaca compartment block is now quite common, as supplementary pain management in the preoperative phase and seems to have a greater analgesic effect than opioids during movement [28].

Postoperatively, pain is generally higher in patients with trochanteric fractures treated with intramedullary nail than in those with femoral neck fractures who underwent total or partial hip replacements. Nevertheless, patients should continue most of the medications that they received preoperatively. Particularly useful is continuous peripheral nerve block analgesia, through a catheter placed pre- or intraoperatively, connected to a small portable pump, and maintained for some days after surgery. These procedures may offer advantages in early mobilisation since they are more effective than systemic drugs in making the patient feel comfortable enough to ambulate and fully participate in their rehabilitation therapy [27].

11.5 Post-operative Hypotension and Fluid Management

A significant drop in blood pressure can occur early in the post-operative phase, with a further drop when the patient is taking part in rehabilitation, during weight-bearing and in the standing position. In some cases, this may produce symptomatic

hypotension, reducing participation in rehabilitation. Several factors may contribute to post-operative hypotension in older adults; these include:

- The effect of ageing, decreasing the ability to compensate and maintain pressure homeostasis when the body is stressed.
- Anaemia due to acute blood loss.
- Dehydration secondary to poor oral intake of fluids.
- The effects of anaesthetic agents.
- The side effects of drugs frequently used in the post-operative phase (e.g. opiates and antiemetics).

Strategies for preventing post-operative hypotension include medication adjustment and fluid management. All antihypertensive drugs should be checked and stopped, starting from the preoperative phase, with the exception of beta-blockers and those with rebound effects like clonidine. Beta-blocker use should be continued during the perioperative phase, while it is no longer recommended for use in naïve patients, as was suggested by earlier studies. Preoperative introduction of beta-blockers can reduce myocardial complications, but may increase the rate of stroke and mortality, possibly due to hypotension [29]. The preoperative pharmaceutical review may also contribute to preventing the intra-operative blood pressure fall that has been found to increase the risk of death within 5 days after surgery [30]. Antihypertensive drugs discontinued before surgical intervention should be resumed in the post-operative period on the basis of the clinical condition and blood pressure values. In some cases, it can be advisable to resume these pharmacological agents only after discharge.

Providing adequate fluid therapy is one of the most important and challenging issues of the management of hip fractures in elderly patients. Fluid administration of 1000 mL is commonly initiated on arrival to compensate for blood loss and maintain basic requirements. During surgery, the anaesthetist usually administers intravenous fluids, on the basis of clinical judgement and according to clinical signs. In the post-operative phase, the administration of about 1.5–2 L of crystalloid is usual practice to attain and maintain intravascular volume [31]. The aim is clearly to optimise cardiac output avoiding cardiovascular overload. In general, this practice is also safe in patients with acknowledged ventricular dysfunction, since the risk of dehydration and hypotension probably exceeds the risks of excessive volume administration. The only exceptions are:

- Patients with severe kidney failure or on dialysis, who require a cautious and controlled fluid administration with control and measurement of fluid balance.
- Patients with severe heart failure or previous episodes of acute pulmonary oedema.

Nevertheless, fluid management should be tailored. In clinical practice, the effect of a standardised fluid protocol should be weighed up by simple available clinical measures such as tissue turgor, heart rate, blood pressure and urine output, in order to decide whether less or extra fluid will provide benefits for the patient. Bedside

ultrasound may add further information by measuring inferior vena cava diameter and its collapsibility during one respiratory cycle, while more sensitive methods to assess fluid responsiveness using advanced haemodynamic monitoring techniques to detect cardiovascular changes are not routinely used.

11.6 Management of Postsurgical Anaemia

Anaemia has traditionally been attributed to surgical or post-surgical bleeding, but around 40% of patients with hip fracture have haemoglobin levels below population norms on admission, and values further drop before surgery with an average fall of 0.9 g/dL after 1 day, greater in extracapsular than intracapsular fractures [32]. The maximum post-operative fall is often around 2–3 g/dL and usually occurs 3 days postoperatively.

Current guidelines, based on randomised controlled trials [33], recommend a restrictive transfusion strategy with a safe trigger threshold not greater than 8 g/dL of haemoglobin; as a result, the proportion of patients receiving packed blood cell transfusion has decreased over time. Furthermore, it has been suggested that blood transfusions may be harmful to patients, by reducing the recipient's immune response and thereby increasing the susceptibility to infections [34]. However, blood transfusion should not be dictated by a haemoglobin trigger alone but should be based on an assessment of the patient's clinical status. In particular, the presence of coronary artery diseases or specific signs of haemodynamic instability could suggest a need to transfuse, despite a haemoglobin value greater than 8 g/dL. Some data also suggest that patients with significant frailty, such as nursing home residents, may have some benefit by a more liberal transfusion strategy [35]. On the other hand, in fit and independent patients an even more restrictive transfusion threshold of less than 7 g/dL of haemoglobin might not impair perioperative outcomes [36].

Post-operative anaemia in older subjects is not only related to blood loss during the surgical procedure but also to several other factors which include the effects of intravenous rehydration, inflammation-induced blunted erythropoiesis, pre-existing nutrient deficiency or poor post-operative nutrition that prevents the replenishment of iron stores. The administration of intravenous iron could reduce the need for transfusion but the effect on haemoglobin level in the at-risk days after surgery is small. Benefits have also been seen in post-operative infection and even mortality [37]. Intravenous iron should preferentially be used in post-operative anaemia management, whereas oral iron is of little value because of its even later effect and poor efficacy in functional iron deficiency when iron stores are normal and intestinal absorption suppressed. In some studies, subcutaneous erythropoietin has been administered along with intravenous iron but even, in this case, the effect is too slow to affect significantly the need for transfusion.

Pharmacological reduction of blood loss with tranexamic acid, which is widely implemented in elective orthopaedic surgery and major trauma, is becoming increasingly popular for use in hip fractures too. Some early concerns on the safety in patients with frailty at high risk of thrombotic events seem not to be confirmed by

meta-analysis [38]. Either topical or systemic tranexamic acid, or the combined administration of both, have been used in older patients with hip fracture.

11.7 Nutritional Supplementation

Routine nutritional assessment is the standard procedure to draw attention to patients already malnourished on admission. In addition, a huge number of patients may undergo deterioration of their nutritional status during the hospital stay, due to increased energy expenditure related to metabolic stress, and reduced food intake related to lack of appetite, nausea and psychological factors. It has been estimated that in the post-operative days, a quarter of patients ingest less than 25% of meals offered by the hospital, and about half of patients consume between 25 and 50% of meals [39]. The current European and American guidelines recommend at least 1 g protein per kilogram bodyweight per day and around 30 calories per kilogram bodyweight of energy for the majority of sick older patients to maintain nutritional status. In a recent survey on a cohort of geriatric orthopaedic patients, half of them with hip fractures, only 1.5% were able to achieve the energy need and only 21% the resting energy expenditure estimated at 20 calories per kg bodyweight per day [40]. Low dietary intake exposes patients to the risk of infections, pulmonary complications, pressure ulcers and impaired mobility resulting from muscle wasting and reduced muscle power.

Albeit based on low-quality studies, there is evidence that oral supplementation results in fewer complications and also affects mortality [41]. Protein supplementation started before or after surgery, in the form of a commercial protein powder or beverage package is a safe and relatively low-cost means to improve results and promote early rehabilitation. More aggressive nutritional interventions, such as a tube or parenteral feeding, should be reserved for patients with a low level of consciousness, or to malnourished patients unable to eat.

Another part of the nutritional approach is the reduction of preoperative fasting time, in order to improve the comfort of patients and to attenuate the neuroendocrine stress response. Current guidelines have cut the hours of fasting to 6 h for solids and 2 h for clear liquids. An oral carbohydrate preloading beverage is also recommended 3 h prior to surgery to allow the patient to be in a metabolically fed state, which has beneficial effects on reducing insulin resistance and catabolism.

Inconsistent results have been found on the effect of vitamin D supplementation in the perioperative phase. However, vitamin D deficiency is largely prevalent in hip fracture subject and it has been associated with poor functional recovery in frail subjects [42]. The administration of 1000–2000 U per day is, in any case, part of the pharmacological interventions for osteoporosis that should be started before discharge.

To sum up, the nutritional approach includes:

- The reduction of preoperative fasting time to 6 h for solids and 2 h for clear liquids
- Offering an oral carbohydrate preloading beverage 3 h prior to surgery to allow the patient to be in a metabolically fed state

- Implementing a protocol for pharmacologic management of post-operative nausea and vomiting
- Nutrition training for health care staff in order to improve the quality and quantity of feeding assistance
- Involvement of relatives (and volunteers) to help with mealtime assistance
- Providing multiple small meals and snacks throughout the day
- Protein supplementation before or after surgery, in the form of commercial protein powder or beverage package

11.8 Post-operative Medical Complications

Medical complications after hip fracture repair are very common and may significantly influence even long-term outcomes, by increasing length of stay and delaying functional recovery. Major complications affect about 20% of patients with hip fracture but up to 50% of patients may require pharmacological interventions due to clinical issues arising during the first post-operative days. Mortality at 30 days, rather than in-hospital mortality, has been recognised as an important care quality indicator and is used by healthcare systems of several countries in Europe. The data from large national databases show that mortality within 30 days is approximately 6.9–8.2% [43–45]. The most common causes of death are respiratory or cardiac failure and infections, mainly pneumonia or sepsis from other sources [46]. Since pre-existing organ dysfunctions are known risk factors, patients with a history of cardiac or lung diseases should be strictly monitored during the post-operative period, with attention particularly focused on signs and symptoms of organ deterioration or infections. Most of the severe adverse events occur early in the post-operative days. Myocardial infarction, stroke, pneumonia and pulmonary embolism are commonly diagnosed within a week from the surgery, while surgical-site infection and deep vein thrombosis are often diagnosed later [47].

Only a few complications are probably really preventable, but some modifiable features of management may significantly improve outcomes:

- Avoiding surgical delay. Delay to surgery is an established risk factor for mortality and post-operative complications such as pneumonia and pressure ulcers [48]. Patients with significant frailty have likely the greatest advantages in reducing the time of immobilisation and in receiving an intensive approach [49].
- Implementing a standardised approach. In the post-operative phase, several issues should be regularly checked, and all patients should undergo standardised procedures. The best way to face the complex needs of older adults with hip fracture, to improve the quality of the interventions, to minimise errors and omissions, and to reduce post-operative complications is to:
  - Define check-lists individualised for each healthcare professional that should guide healthcare decisions.
  - Standardise and implement specific protocols for the most common issues.

Tailored and individualised interventions based on patients' characteristics, specific needs or clinical instability should be an integral part of daily healthcare, but the overall post-operative management should be as highly standardised as possible. A general principle for each feature of the care should be an intensive approach for a limited time after surgery, followed by recovering of usual function as soon as possible, including removing tubes and catheters and shifting toward oral therapies. In this context, protocols, based on the best available evidence, must be developed, shared, and implemented by the multidisciplinary team, taking into account local resources. A minimum set of standardised protocols that should be implemented in the orthogeriatric setting include the following:

- Prophylaxis of venous thromboembolism
- Antibiotic prophylaxis
- Urinary catheter utilisation
- Pain control
- Skincare and pressure-relieving mattresses
- Constipation and stool impaction prevention
- Delirium prevention
- Post-operative haemoglobin monitoring and management of anaemia
- Malnutrition detection and correction/nutritional support
- Monitoring of vital physiological parameters
- Supplemental oxygen as appropriate
- Early mobilisation

11.9 Prevention and Management of Specific Complications

11.9.1 Delirium

Delirium is a common complication that affects about one-third of older patients with hip fracture in the perioperative period. It has a detrimental effect on functional and clinical outcomes, producing longer length of hospitalisation and slow and incomplete recovery. All the known subtypes may occur after hip fracture. In about two-third of the patients, delirium arises without agitation, as hypoactive or normal psychomotor variants, and therefore is often underdiagnosed [50]. Common symptoms of the hypoactive subtype are decreased levels of activity, speech and alertness as well as apathy, withdrawal and hypersomnolence. In contrast, the hyperactive or mixed variants are characterised by hyperactivity, loudness, and psychomotor agitation, interfering with patients' care and safety and can easily be diagnosed. To avoid missed presentation of delirium all patients must be screened daily and assessed using standardised tools. Both geriatric nurses and physicians should be involved in the early detection of delirium.

11.9.1.1 Prevention of Post-operative Delirium

Patients at risk of developing incident post-operative delirium can already be identified at hospital admission since a number of risk factors have been described [51]. Pre-fracture cognitive impairment is the most weighty risk factor, followed by respiratory failure, low albumin, alcohol consumption and prevalent multiple comorbidities. The type of anaesthesia (particularly neuraxial vs. general anaesthesia) does not appear to affect the incidence of delirium, but deep sedation has been associated with a higher risk of post-operative delirium [52]. Thus, the use of intra-operative monitoring of the depth of anaesthesia and the choice of lighter sedation seems to be effective in reducing post-operative delirium.

Although prevention of delirium in hip fracture patients is possible with preoperative screening and simple interventions, nevertheless early consideration of all risk factors and prompt correction of clinical and laboratory abnormalities is mandatory. This approach requires a multi-component intervention, with good adherence by suitably-trained members of staff, physicians and nurses. When carefully applied, the multi-component intervention has been demonstrated to decrease the incidence of delirium by 40%, compared to traditional care, as well as reducing its duration and severity [53]. Taking into account that for delirium prevention, multiple small interventions can provide substantial benefit, multi-component interventions include:

- Monitoring of vital physiological parameters.
- Reduction of immobilisation and bed rest, mobilising by nursing staff as tolerated to the bathroom, taking meals at the table.
- Improved fluid and nutritional intake, dentures used properly, extra drinks.
- Supplemental oxygen to keep saturation >90%.
- Urinary catheters removed by post-operative day 2, unless otherwise ordered, post-void residual assessment.
- Improved sensory stimulation, appropriate use of glasses and hearing aids.
- Attention to bowel movements by scheduling laxatives.
- Promoting sleep by non-pharmacological measures, if needed trazodone should be used for night-time sedation while benzodiazepines should not be initiated (nor abruptly withdrawn).
- Cognitive activation with environmental aids (calendar, clock) or individual interventions.
- Involvement of relatives to support the patient.
- Post-operative blood tests to detect metabolic/laboratory abnormalities.
- Effective control of pain obtained with acetaminophen, non-opioid medication and nerve blocks rather than opiates, which may increase the risk of delirium.

Pharmacological prevention of delirium through the administration of a low dose of neuroleptic drugs is still a matter of debate [64]. Current evidence does not support the routine use of antipsychotics, albeit, in some trials, they demonstrated a reduced incidence of post-operative delirium, particularly in orthopaedic patients at higher risk.

11.9.1.2 Management of Post-operative Delirium

If delirium occurs, it should be borne in mind that it can represent the first symptom of an underlying/undercurrent complication, such as an infection, coronary syndrome, urinary retention, constipation or dehydration. Therefore, when a patient presents with a new episode of delirium, it is mandatory to undertake a comprehensive clinical assessment, accompanied, as appropriate, by a complete laboratory diagnostic work-up and other specific diagnostic tests. Electrocardiogram and chest radiography may be part of the assessment, while neuroimaging is typically limited to patients with new focal neurologic signs.

The treatment includes addressing all modifiable contributors to delirium that are identified in the evaluation along with a full review of medications, stopping when possible those known to be associated with delirium. Moreover, non-pharmacological measures, listed in the prevention paragraph earlier, should be carefully pursued to help the patient recover from their brain dysfunction.

In case of agitation that can hamper the healthcare or rehabilitation, or even be dangerous for patient and caregiver, pharmacological treatment with antipsychotics is usually employed, but note that antipsychotics do not treat delirium, they simply reduce the symptoms. Antipsychotics should never be used in the hypoactive variant. These pharmacological agents should be used at the lowest effective dose, dosing regimens should be individualised for each patient, and the treatment effects should be monitored daily to correct the dose or discontinue the therapy when appropriate. The antipsychotics commonly used are haloperidol (0.25–2 mg oral or intramuscular), risperidone (0.5–2 mg oral), quetiapine (12.5–50 mg oral), olanzapine (2.5–10 mg oral). QT prolongation contraindicates all these drugs. Benzodiazepines should be avoided in patients with delirium, except for subjects with severe agitation and violent inclination, in which a short-acting formulation (e.g. midazolam 1–5 mg intravenous or intramuscular) may produce rapid tranquillisation. In patients with sleep deprivation, the drug of choice is trazodone (25–100 mg oral).

11.9.1.3 Post-operative Cognitive Dysfunction

Some patients experience a more subtle cognitive disorder, affecting a wide range of cognitive domains, particularly memory and executive function. This condition, dissimilar from delirium, is generally designated as post-operative cognitive dysfunction (POCD) and it may not be evident during the first post-operative days. Compared to delirium, POCD shows a less acute onset, is characterised by normal consciousness and may last weeks to months.

For an accurate diagnosis, neuropsychological testing is required, but, usually, a pre-fracture evaluation for comparison is lacking in patients with hip fractures. The incidence after hip fracture surgery is consequently not known while in older patients undergoing elective arthroplasty, a prevalence of approximately 10% has been found 3 months postoperatively [54]. There are many risk factors for POCD: advanced age, pre-existing cardiovascular disease and mild cognitive impairment. Patients with a level of education more than high school have a lower incidence of POCD compared to those with lower educational levels. In orthopaedic elective

interventions, a fast-track approach seems to reduce the incidence of POCD, at least early after surgery [55].

POCD is generally reversible, albeit, in some patients with persistent dysfunction, the apolipoprotein E4 genotype has been found, suggesting a link with the development of dementia [56]. Preventing strategies against POCD include reducing the preoperative stress response, monitoring of anaesthetic depth intraoperatively, maintaining of perioperative hemodynamic stability, a multimodal analgesic approach with cautious use of opioids, early post-operative mobilisation, and all nursing measures described for preventing post-operative delirium [55].

11.9.2 Cardiovascular Complications

Ischemic heart disease and cardiac failure account for more than one-third of early deaths after hip fracture [46] although the incidence of cardiac complications after hip fracture is quite variable in epidemiological studies, depending on the diagnostic criteria considered.

11.9.2.1 Myocardial Infarction

Risk factors for the occurrence of myocardial infarction after hip fracture are all atherosclerotic conditions, not only a history of cardiac disease but also stroke or peripheral vascular disease [57]. Most patients do not experience typical chest pain, while they may present with delirium or congestive heart failure, or even be asymptomatic. Therefore, high-risk subjects or those with suspicious symptoms although atypical should be assessed by recording an electrocardiogram (ECG) and measuring troponin level. Patients with clear myocardial infarction should be considered for coronary angiography and cardiology review.

However, after hip fracture, a considerable number of patients show a subtle and isolated increase of troponin without meeting the full criteria of myocardial infarction that include significant ECG changes and/or new wall motion anomalies and/or typical clinical symptoms. In some studies, up to one-third of patients show an increase of troponin just before or early after surgery, most of them without ECG ischaemic changes [58]. Other clinical conditions associated with isolated troponin increase, such as sepsis, pulmonary embolism, renal failure or acute respiratory failure, explain only a small proportion of such increases in this perioperative biomarker. The prognostic significance of an isolated small troponin increase in older patients with hip fractures is still uncertain, given the inconsistent relationship with short- and long-term mortality [58, 59]. In one study a subgroup of patients with a post-operative isolated increase of troponin >0.5 μg/L, considered a cut-off for more definite myocardial damage, were studied with coronary angiography [60]. All patients were found to have severe coronary disease and underwent percutaneous or surgical revascularisation with a significant improvement in 1-year survival.

11.9.2.2 Heart Failure

Congestive heart failure is another important post-operative complication, related to surgical stress, blood loss, transfusion, or inappropriate fluid administration. The onset may be either typical with dyspnoea, or insidious with a change in functional status, reduction of food intake or delirium.

Diuretic agents are frequently discontinued, as part of the pre-operative drug revision, in order to reduce the risk of dehydration and hypotension. It is important to bear in mind that in patients with ventricular dysfunction, diuresis may be loop diuretic dependent. Therefore, it may be advisable, in patients with pre-fracture congestive heart failure, to continue these pharmacological agents, or discontinue them only for a short period of time. Urinary output measurement is critical for hemodynamic assessment in the early post-operative days. Oliguria could be related either to inadequate volume restoration (most frequent in the first 24–48 h after surgery) or heart and renal failure. Thus, contrasting interventions, such as extra fluid or diuretics administration, require patient-specific decision making. Measurement of the N-terminal fragment of brain natriuretic peptide (NT-proBNP) has been proposed to evaluate post-operative cardiac dysfunction [61], but it has a decreased specificity in older patients.

11.9.2.3 Supraventricular Arrhythmias

New onset atrial fibrillation is particularly frequent after hip fracture surgery occurring in 3–6% of patients [62, 63]. A previous history of atrial fibrillation is the most consistent risk factor. The rapid ventricular rate in atrial fibrillation results in inadequate diastolic filling and a reduced cardiac output leading to hemodynamic instability. Atrial fibrillation may cause exacerbation of heart failure, poor exercise tolerance and thromboembolic events including stroke. The occurrence of atrial fibrillation in the early post-operative days has been consistently associated with a higher risk of mortality within 1 year after fracture [62, 63]. It could be a marker of greater vulnerability, rather than a complication increasing mortality directly. Moreover, evidence links atrial fibrillation after surgery as a risk factor for POCD [55].

Current treatment modalities include anti-arrhythmic medications, radiofrequency ablation, and anticoagulation. Beta-blockers can reduce the risk of this arrhythmia, but their beneficial effects should be balanced against the risk of drug-induced hypotension.

11.9.3 Infections

11.9.3.1 Post-operative Fever

Fever occurs frequently during the post-operative phase; it can either indicate the presence of an infection or be produced by a non-infective cause. The challenge is to identify which patients need immediate screening and which can be skilfully managed with a ‘wait and see’ approach.

Surgery of any type causes significant cellular injury leading to the release of cytokines into the bloodstream and then fever, as a normal physiologic response. The more tissue is damaged, the greater is the cytokine release. Febrile events occurring within 2 post-operative days in the absence of localising symptoms should be closely monitored, but not acted upon, while they are more suggestive of infection when they occur later than the third post-operative day or if the temperature is greater than 38.5 °C and multiple fever spikes are observed [64].

Studies agree that investigations, particularly chest X-rays or blood and urine cultures, performed to study early post-operative febrile episodes without clinical symptoms or signs of infections are rarely positive and are therefore an inappropriate use of hospital resources [65]. On the other hand, patients with hip fracture with a high degree of frailty, malnutrition, multiple comorbidities, polypharmacy, may have a compromised immune response that predisposes to infection. Early detection of pneumonia or urinary tract infections that are the most common post-operative infections is crucial, since a late diagnosis may have severe detrimental consequences.

Clinical judgement, based on the presence of signs and symptoms of infections, is the only guide to decide when diagnostic procedures and possibly antibiotic therapy should be started. It should be also highlighted that infections in frail older adults may occur without fever, presenting with insidious onset symptoms, such as fatigue and delirium. Traditional biomarkers such as white blood cell count or C-reactive protein may be used to aid in the diagnosis but in the early post-operative days, these blood parameters lack sensitivity and specificity in discriminating inflammation due to a bacterial infection from that of surgical injury response. There is increasing evidence supporting the use of procalcitonin as a useful marker to detect bacterial infections in post-operative days [66, 67]. It is true that, following surgical tissue damage, procalcitonin may have a small and transient increase, but higher and persistent values have a high likelihood of being related to infections. However, at present, it is not clear which is the best cut-off with the most correct balance between specificity and sensitivity. When laboratory biomarkers are required for sepsis confirmation in the first days after hip fracture repair it is probably better to set a high procalcitonin threshold, that is, >0.9 ng/mL, as in trauma patients.

11.9.3.2 Pneumonia

Pneumonia and exacerbation of chronic lung disease occur in about 4% of older patients with hip fractures and account for one-third of post-operative deaths [46]. Predisposing factors are spending most of the day sitting or lying in bed, which leads to incomplete lung expansion and resulting atelectasis. Poor inspiratory effort may also be due to sedation or pain leading to difficulty clearing pulmonary secretions. Moreover, dysphagia or an impaired swallowing function, frequent in frail older patients with declining brain function or decreased muscle mass, may worsen after surgery and cause aspiration and, consequently, aspiration pneumonia.

Patients with an admission diagnosis of COPD have about 2.5 times the risk of developing chest infections during a hospital stay and a substantial excess of

mortality compared with patients without COPD [68]. Other reported risk factors for post-operative pneumonia include disorders of the central nervous system, anaemia, diabetes and the use of medication that reduces alertness [69].

Measures and interventions to prevent pneumonia should be implemented in clinical practice in order to quickly restore the capacity of expansion of the lung–chest wall and to avoid aspiration:

- Oral hygiene
- Control of gastroesophageal reflux
- Avoidance of excessive sedation
- Early ambulation
- Adequate nutrition
- Respiratory exercises improving the patient's ability to take deep breaths

11.9.3.3 Urinary Tract Infection

Urinary tract infection is the most common complication after hip fracture surgery occurring in almost one-quarter of all patients. It has been associated with an increased incidence of delirium, prolonged length of hospital stay and even lower functional outcomes [70]. A urinary catheter is the single most important risk factor for this type of infection, but other causes are post-operative urinary retention or neurogenic bladder dysfunction.

Measures to prevent urinary tract infection are:

- Avoiding unnecessary placement of indwelling urinary catheters even intraoperatively.
- Removing a urinary catheter as soon as possible, preferably within the first post-operative day.
- Considering the use of intermittent catheterisation to relieve post-operative urinary retention.
- Planning education of all healthcare professionals around a specific protocol on perioperative use of a urinary catheter and the management of post-operative bladder incontinence or retention.
- Early and repeated mobilisation.

Urinary retention is common among patients with hip fracture, and it is related to urinary infection, prostatic enlargement in males, underlying bladder dysfunction (e.g. diabetic neuropathy, Parkinsonism), and opiate use. Although it is uncertain if a premature removal of the indwelling catheter could favour urinary retention, it should be removed as soon as possible to prevent urinary infections and promote early mobilisation if necessary, patients can be managed through voiding methods, including intermittent catheterisation.

11.9.3.4 Surgical Site Infection

Surgical site infection is the third most frequent cause of infections, and it is discussed among surgical complications. It is less frequent compared to other infections, occurring in 2–4% of patients and usually later, often after discharge.

Patient-specific risk factors are older age, poor nutrition, history of diabetes, smoking, obesity, other concomitant infections and previous history of colonisation. Prevention measures include peri-operative antimicrobial prophylaxis using cefazolin or other antimicrobial agents according to local guidelines, a number of hygiene measures minimising microbial inoculums, and clinical optimisation of the patients. Modifiable patient-related risk factors are malnutrition and uncompensated diabetes. Particularly, blood glucose levels greater than 200 mg/dL in the peri-operative period increase the risk of surgical site infection [71]. Furthermore, patients without a history of diabetes but showing stress-induced hyperglycaemia, with glucose levels greater than 220 mg/day, also have a higher risk of surgical site infection [72]. Close monitoring in the peri-operative period is required to detect and manage glucose fluctuations and is advised before meals. To achieve and maintain good control of glycaemia, fast-acting insulin or basal–bolus regime should be preferred in patients using oral diabetic agents before hospital admission, to limit the risk of hypoglycaemia or other metabolic derangements associated with oral diabetic agents.

11.9.4 Other Complications

Truly, this overview may not be comprehensive, describing the overall constellation of clinical complications presenting in older adults with hip fracture, but a number of other complications should be acknowledged (Table 11.1). Patients with frailty are characterised by an age-associated decline in physiological reserve and function

Table 11.1 Standardised procedures and prevention/management protocols to be implemented for selected medical complications in hip fracture in older adults

Complication	Main goal(s)	Strategies prevention/management
Delirium	Prevention	• Identify high-risk patients on admission • Check daily risk factors • Correct (when possible) modifiable risk factors • Remove delirium-causing medications • Monitoring of vital physiological parameters • Correct clinical/laboratory abnormalities • Control pain, limiting opiates usage • Reduce immobilisation and encourage time out of bed • Improved fluid and nutritional intake • Supplemental oxygen to keep saturation >90% • Remove any catheters and tubes as soon as possible • Attention to bowel movements • Promoting sleep by non-pharmacological measure • Cognitive activation with environmental aids • Involvement of relatives • Pharmacological prevention for patients at very high risk
	Early detection and management	• Assess patients daily using a standardised tool • Look for underlying causes • Remove (when possible) underlying causes • Implement prevention strategies (see Prevention) • Pharmacological intervention to reduce symptoms

(continued)

Table 11.1 (continued)

Complication	Main goal(s)	Strategies prevention/management
Post-operative hypotension	Prevention	• Discontinue or reduce doses of antihypertensive drugs and diuretics • Limit the use of hypotensive pharmacological agents • Transfuse patient according to established haemoglobin thresholds • Administer isotonic intravenous fluids pre-, intra- and postoperatively • Tailor fluid management through clinical measures/ bedside ultrasound or advanced haemodynamic monitoring techniques if necessary and available
Coronary artery disease	Prevention	• Check for risk factors • Identify high-risk patients on admission • Continue antiplatelet drugs in the perioperative period (in high-risk patients)
	Early detection	• Check for atypical signs/symptoms of ischemia • Measure troponin and ECG in patients with typical or atypical signs/symptoms • Monitor troponin regularly in high-risk patients
Heart failure	Prevention	• Continue beta-blockers • Continue loop diuretics if possible (alternatively, discontinue them briefly and resume rapidly) • Manage fluid administration carefully, checking pulmonary status and early signs/symptoms of acute failure • Measure urine output in the early post-operative days in high-risk patients
Pneumonia	Prevention	• Nutritional supplementation • Avoid excessive sedation • Maintain adequate oral hygiene • Control of gastro-oesophageal reflux • Detect swallowing disorders and modify food consistency • Early surgical repair and ambulation • Deep breathing exercises
	Early detection	• Check daily for typical and atypical signs/symptoms • Laboratory tests and/or chest X-rays in patients at high risk or with clinical signs/symptoms • Measure procalcitonin in selected high-risk patients
Urinary tract infection	Prevention	• Avoiding unnecessary placement on indwelling urinary catheters even intraoperatively • Remove the urinary catheter within the first post-operative day • Considering the use of intermittent catheterisation to relieve post-operative urinary retention • Early and repeated mobilisation • Planning education of all healthcare professional on the management of perioperative use of a urinary catheter and post-operative bladder incontinence or retention • Optimise diabetes control
	Early detection	• Check daily for typical and atypical signs/symptoms • Laboratory tests and/or urine culture in patients at high risk or with clinical signs/symptoms • Measure procalcitonin in selected high-risk patients with signs/symptoms of urinary sepsis

Table 11.1 (continued)

Complication	Main goal(s)	Strategies prevention/management
Surgical site infection	Prevention	• Peri-operative antimicrobial prophylaxis according to guidelines • Hygienic measures in the operating room • Hygienic measures in the management of surgical site minimising the risk of microbial inoculums • Improve malnourishment with nutritional supplementation • Optimise diabetic control maintaining glucose level <220 mg/dL
Acute kidney injury	Prevention	• Identify patients with chronic kidney disease on admission • Monitor perioperative glomerular filtration rate • Manage fluid administration, preventing dehydration and volume overload • Avoid nephrotoxic drug use, including NSAID and certain antimicrobial agents • Avoid intraoperative and post-operative hypotension
Urinary retention	Prevention	• Avoid anticholinergic medications • Manage constipation • Early detection and prompt treatment of urinary infection • Promote early mobilisation
Constipation	Prevention	• Promote early mobilisation • Reducing opioids for pain control • Increasing fluid intake to 1.5 L/day • Reducing fasting time and planning a nutritional support postoperatively • Use laxative when appropriate starting on the day of surgery
Pressure ulcers	Prevention	• Use special beds and equipment to relieve pressure in patients at risk • Improve malnourishment and use nutritional supplements • Reduce time to surgery and promote early mobilisation

across multi-organ systems. Thus, almost every organ is vulnerable, and patients with hip fractures are at risk of multiple adverse health outcomes.

11.9.4.1 Acute Kidney Injury (AKI)

Another very common post-operative complication is a transient worsening of renal function, particularly in patients with pre-fracture impairment of glomerular filtration. Interestingly patients with stage 1 and 2 AKI have similar survival curves but worse when compared to those with no AKI [73], suggesting that a post-operative deterioration of renal function is probably a marker of frailty rather than the direct cause of death. Close monitoring of renal function should be undertaken in the early post-operative days, taking into account the fact that creatinine level overestimates glomerular filtration rate due to the age-related loss of skeletal muscle mass. Estimation of the kidney function with the Cockcroft-Gault method may be useful, being more accurate. Electrolyte imbalances, especially hyponatremia and hypokalaemia, are described frequently and should be promptly corrected.

AKI is potentially preventable in some patients and important measures that should be implemented are:

- Avoidance of nephrotoxic drugs including non-steroidal anti-inflammatory drugs and nephrotoxic antibiotics.
- Appropriate management of fluids, avoiding hypovolaemia by reducing fasting times and by intravenous fluid administration before surgery so that the patient does not arrive in theatre with dehydration.
- Prioritising intraoperative blood pressure control avoiding intraoperative hypotension, irrespective of the type of anaesthesia.
- Temporary discontinuation of antihypertensive drugs, particularly angiotensin converting enzyme (ACE) inhibitors and angiotensin receptor blockers (even if not nephrotoxins per se) especially when AKI or hypotension has developed.

Dialysis-dependent patients are a subgroup of patients with significant frailty and with a high risk of post-operative complications, particularly pneumonia and sepsis/septic shock [74]. Intra-hospital and 30-day mortality rates are 2.5-fold higher than non-dialysis patients. A challenging issue in these patients is well-judged fluid administration in the perioperative period, avoiding both hypovolemia and cardiovascular overload. A team approach, involving an expert nephrologist and orthogeriatrician is essential to reduce early complications and early mortality.

11.9.4.2 Gastrointestinal Complications

Common gastrointestinal complications after hip fracture surgery include dyspepsia, constipation, paralytic ileus and haemorrhage.

The reported incidence of perioperative acute upper gastrointestinal bleeding varies widely in the literature but nowadays seems low [75]. Pre-existing peptic ulcer disease and non-steroidal anti-inflammatory drugs are known risk factors while post-operative use of aspirin is not likely to be a strong risk factor. However, it is possible that the combination of an antiplatelet agent and a prophylactic low molecular weight heparin may exacerbate upper gastrointestinal bleeding. A suspicion of gastrointestinal bleeding requires prompt endoscopic evaluation.

Most patients following hip fracture surgery have problems with the evacuation of faeces during the first post-operative days and a normal defecation pattern is re-established only after several days [76]. In orthopaedic surgery, the effects of constipation on patients are often minor, but sometimes prolonged bowel dysfunction can lead to faecal impaction or post-operative ileus.

Although post-operative nausea and vomiting are rarely associated with a life-threatening condition, they are frequent undesirable side effects of surgery and anaesthesia. Several drugs have been studied to prevent such unpleasant symptoms and the most effective seems to be dexamethasone given pre or intraoperatively at the time of anaesthesia [77].

General measures to prevent gastrointestinal complications are:

- Reducing fasting time (i.e. 2 h for clear liquids) and planning nutritional support postoperatively (i.e. oral nutritional supplement drinks) effective in preventing gastrointestinal stress ulceration, post-operative nausea and vomiting and constipation.
- Increasing fluid intake to 1.5 L/day.
- Early and appropriate mobility.
- Introduction of proton pump inhibitors in patients at risk of bleeding or their continuation if previously taken.
- Avoiding NSAIDs in patients at high risk of bleeding; however, aspirin should not be stopped if it was a regular pre-fracture medication.
- Reducing the use of opioids for pain control.
- Introduction of a laxative, starting on the day of surgery.

11.9.4.3 Pressure Ulcers

Even with the widespread dissemination of nursing protocols, based on attentive skincare and on the use of special bed equipment to relieve pressure, the incidence of pressure ulcers is still approximately 10% which doubles when grade 1 is included [78, 79]. Several features of management have been found to negatively affect the occurrence of pressure ulcers, such as the use of traction and foam splints, while frequent manual repositioning has a positive effect. However, the best strategy for reducing pressure ulcers in patients with hip fracture is shortening the time of bed rest by means of early surgery and mobilisation, along with protein-caloric supplementation.

11.10 Final Remarks

The management of older patients with hip fracture in the post-operative phase requires a comprehensive orthogeriatric approach. Frailty and comorbidity in combination with the hip fracture and surgical repair procedures create a degree of vulnerability that cannot be faced using traditional care models. Currently, orthogeriatric management for patients with a fragility fracture is the gold standard of care all over the world, to prevent complications where possible, or manage them appropriately when they occur. For acute conditions, such as hip fracture, the healthcare needs do not cease after the acute phase, as most patients require treatment in the post-acute phase for further clinical stabilisation and rehabilitation. The susceptibility to complications for these patients may last for several weeks after surgical repair. Thus, discharge destination should match the stability and vulnerability of the patient, his/her rehabilitation program and goals, and the pre-existing level of independence, to ensure long-term positive clinical outcomes. Discharge planning based on discharge needs, patient social supports, patient and family desires is a crucial point in acute management. In recent years, the appropriateness of post-acute settings has become

a topic for debate. Similar patients with hip fracture discharged to different post-acute settings (i.e., home-based rehabilitation, post-acute care facilities and inpatient rehabilitation) seem to have different outcomes [80, 81]. The quality of care of post-acute and rehabilitation facilities is another variable that may affect long-term outcomes. Outcomes and standards of care should be monitored in the acute care setting as well as in post-acute care.

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