COMPLICATIONS OF CRITICAL CARE

Essay

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by

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Introduction

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Critical care is the component of medical care that addresses the needs of individuals at risk of imminent death from acute illness or injury ***(Groeger et al., 1992)***. The practice of critical care medicine is hospital-based, dedicated to and defined by the needs of critically ill patients. Critically ill patients include those patients who are physiologically unstable, requiring continuous, coordinated, physician, nursing, and respiratory care; and those patients who are at risk of physiologic decompensation and thus require constant monitoring and the ability to provide immediate intervention by the intensive care team to prevent adverse occurrences ***(Guideline Committee; Society of Critical Care Medicine, 1992)***.

An intensive care unit (ICU) is a geographically defined area in the hospital providing care for critically ill patients with specialized personnel and complex equipment. An ICU provides extensive evaluation and monitoring, and access to sophisticated and comprehensive treatment ***(European Society of Intensive Care Medicine, 1994)***.

Iatrogenic complications are major and routine problems in the ICU environment. An iatrogenic complication is defined as an adverse event, occurring during the ICU stays, that is independent of the patient's underlying disease. Iatrogenic complications are associated with increased morbidity and mortality, and extended ICU stay ***(Giraud et al., 1993)***. In the course of critical illness, once specific disease processes are identified and management begun, survival is often determined by the number and severity of complications related to life support and monitoring interventions ***(Pingleton and Hall, 1992)***.

Iatrogenic complications occur in 31% of all ICU admissions but major complications occur in only 13.2% of admissions. Although iatrogenic complications directly contribute to the death of 0.8% of all ICU admissions and 6% of those patients with major iatrogenic complications, 34% of patients with iatrogenic complications die in the ICU, as compared with 10.6% of patients with no iatrogenic complications. Moreover, 52% of patients with major complications die as compared with 12.6% of patients with no, minor, or moderate iatrogenic complications ***(Giraud et al., 1993)***.

Therapeutic errors (e.g., errors in prescription or administration of drugs), mechanical ventilation, extubation, syringe pumps, endotracheal tubes, and venous catheters are the most frequent interventions related to major iatrogenic complications. Human errors and malfunctioning equipment account for 44% of all iatrogenic complications. Nurses are more frequently involved in iatrogenic complications as they commit two times more errors than physicians and three times more major errors. This finding is not surprising since nurses perform the largest part of monitoring and administration of intensive care prescriptions. An extended ICU stay, a high nursing workload, and a high intensity of care may lead to iatrogenic complications, but also may result from these iatrogenic complications. Older patients (≥ 65 years) and those patients who present with high indices of illness severity are more likely to develop iatrogenic complications than younger patients and those patients with a less severe initial health status ***(Giraud et al., 1993)***.

For effective preventive action to be taken, it is important to identify preventable causes of iatrogenic complications so that these complications may become the main targets of a preventive strategy in the ICU. Preventive measures should be targeted primarily on elderly and severely ill patients as they are at high risk of suffering major iatrogenic complications. Extensive efforts should be made to improve monitoring and training. A 1 : 1 nurse / patient ration should be adopted where required by the severity of the patient's condition. In addition, the skills of each nurse and the degree of help by other members of the nursing staff should be taken into account. Non-invasive monitoring should be used for all critically ill patients to detect hypoxia and hypotensive episodes before the occurrence of major organ system dysfunction ***(Giraud et al., 1993)***. Daily rounds of patients in the ICU should attempt to anticipate and prevent these adverse effect ***(Pingleton and Hall, 1992)***.

Complications of Invasive Monitoring and Diagnostic Procedures

Complications of Invasive Monitoring and Diagnostic Procedures

I. Invasive Vascular Monitoring

Since the early 1970s, medicine has become increasingly reliant upon invasive and technically sophisticated procedures, a phenomenon that is particularly noteworthy in critical care. This is largely a reflection of the time lag usually observed between the onset of significant hemodynamic derangement and the development of clinical signs ***(Ginosar et al., 1995)***.

A. Arterial catheterization

The fields of anesthesiology and critical care have as their central tenet the maintenance or restitution of physiologic homeostasis. Arterial pressure and arterial oxygenation are of prime interest, not only because they are of themselves the two most vitally important homeostatic variables, but also because they are readily measurable and treatable and reflect the general physiologic state of the whole organism ***(Ginosar et al.,1995)***.

The use of indwelling catheters in systemic arteries provides a continuous assessment of systolic arterial pressure (SAP), diastolic arterial pressure (DAP), and mean arterial pressure (MAP) and a port from which to sample arterial blood gases. Together with data obtained from pulmonary artery catheterization, they provide a detailed hemodynamic assessment. In addition, arterial pressure waveform analysis may provide independent cardiovascular assessment of ventilated patients. The advent of continuous chromatographic intraarterial blood gas assessment may offer a further advantage for invasive arterial pressure monitoring ***(Ginosar et al.,1995)***.

Indications :

The patients most likely to benefit from invasive arterial pressure monitoring include those in whom (1) non-invasive pressure measurement is unreliable or impossible (morbid obesity, shock, or cardiopulmonary bypass), (2) the blood pressure must be kept within narrow limits (coronary artery disease, valvular heart disease, carotid vascular disease, impaired intracerebral autoregulation, intracerebral or other aneurysm, controlled hypotension), (3) large and rapid swings in blood pressure are predicted (pheochromocytoma, aortic cross-clamping, aggressive vasodilator or inotrope therapy), and (4) repeated arterial blood gas sampling is required (respiratory failure, weaning from ventilation, metabolic and acid base abnormalities, trauma, burns, and shock). In practice, most patients requiring intensive care fulfill one or more of these indications for monitoring. As a result, arterial cannulation is a routine practice in critical care ***(Ginosar et al.,1995)***.

Table (1): Factors Predisposing to Complications with Arterial Cannulation *(Seneff, 1995)*
Large tapered cannulas (>20 gauge except at the large artery sites)
Hypotension
Coagulopathy
Low cardiac output
Multiple puncture attempts
Use of vasopressors
Atherosclerosis
Hypercoagulable state
Placement by surgical cutdown
Site inflammation
Intermittent flushing system
Bacteremia

Complications :

Arterial cannulation is a relatively safe invasive procedure. Although estimates of the total complication rate ranges from 15 to 40 percent, clinically relevant complications occur in 5 percent or less ***(Seneff, 1995)***.

1. Neurovascular Complications :

a. Thrombosis and Embolism :

The most common complication with all routes of arterial access is thrombosis ***(Purdue and Hunt, 1991)***. Thrombosis occurs in 10% of 20-gauge radial artery catheters in place for between 1 and 3 days ***(Bedford, 1990)***. The incidence of thrombosis depends both on factors related to the patient and on factors related to the catheter. Severe hemodynamic instability, hypercoagulability, and pre-existing arterial disease such as atherosclerosis or Raynaud's disease may increase the incidence of thrombosis ***(Kaye and Dubin, 1988)***.

Thrombosis is common with radial and dorsalis pedis catheters, but very rare with femoral or axillary catheters ***(Seneff, 1995)***. The incidence probably increases significantly with duration of cannulation, this risk ranges from 11% for vessels cannulated for less than 4 days to 29% in those cannulated for more than 4 days ***(Bedford, 1978)***. Small diameter catheters are recommended as the incidence of arterial occlusion increases linearly as the ratio of cannula diameter to vessel diameter increases. It has been postulated that if the relationship between wrist circumference and radial artery size is linear, the critical wrist circumference for a 20-gauge catheter is 15 cm. These data explain why women (with presumably smaller arteries than men) represent a preponderance of patients who experience flow abnormalities following radial artery cannulation *(Gravenstein, 1991)*. The use of large bore catheters (larger than 20 gauge for radial artery cannulation) is associated with greater incidence of thrombosis. The incidence of thrombosis is less frequent when a continuous heparin flush device (3 ml/hr. irrigation of 2 units/ml heparinized saline) is used than if the catheter is kept clear by intermittent irrigation. The use of Teflon non-tapered catheters considerably reduces the risk of thrombosis *(Ginosar et al.,1995)*.

The consequences of thrombosis in and around an indwelling arterial catheter are variable and controversial. Damping of the arterial waveform, systolic accentuation, or complete inability to withdraw blood samples may be the first and only "clinical" consequence. Thrombosis has been noted to be asymptomatic in 96% of patients *(Ginosar et al.,1995)*. Despite the high incidence of Doppler-detected thrombosis, clinical ischemia of the hand is rare and usually resolves following catheter removal. All patients eventually recanalize, generally by 3 weeks after removal of the catheter *(Seneff, 1995)*. However, ischemic necrosis of overlying skin, distal ischemia, and distal (and even retrograde) embolization have all been described *(Ginosar et al., 1995)*. Symptomatic occlusion requiring surgical intervention occurs in less than 1% of cases. Most patients who develop clinical ischemia have an associated contributory cause, such as prolonged circulatory failure with high dose vasopressor therapy *(Slogoff et al., 1983)*.

Ischemic necrosis of the overlying skin has been described in 0.5% to 3% of all radial artery cannulations and in 10% of all thrombosed arteries. The cause is probably the occlusion of small perforating branches supplying the skin by thrombus around the catheter *(Clark and Harman, 1988)*.

Distal ischemia as a complication of thrombosis is often a function of the adequacy of the collateral circulation. Allen's test of ulnar collateral flow distal to radial artery cannulation has been estimated at 0.01%, and it is doubtful whether routine assessment of collateral supply will have any effect on this statistic ***(Wilkins, 1985)***.

Distal ischemia may also result from embolization of air or thrombus from the catheter. Similarly, pre-existing atheromatous plaques may be dislodged by cannulation and may embolize to cause distal ischemia. One method of avoiding the embolization of thrombus is to avoid flushing obstructed catheters. Instead, obstructed catheters should be aspirated or removed, while aspirating and compressing distal and proximal to the site of cannulation ***(Ginosar et al., 1995)***.

Catheter sites should be inspected frequently. If areas of adjacent skin blanching, distal temperature change, or ischemia are present, the inciting catheter is immediately removed. Although acute arterial insufficiency is usually apparent on removal of the catheter, this is often secondary to spasm. Continued findings of ischemia or failure of pulses to return within 6 hours are indications for intervention ***(Purdue and Hunt, 1991)***. Treatment options include thrombolytic therapy, radiologic or surgical embolectomy, or cervical sympathetic blockade ***(Wilkins, 1985)***.

Retrograde embolization of air or thrombus is a recognized complication causing focal cerebral ischemia or infarction. This a phenomenon described particularly in axillary arterial catheterization (especially right sided) because of the presence of the catheter tip lying in close proximity to the origin of the cerebral circulation. However, only 6 to 7 ml of flush solution is required to cause a retrograde embolism from the radial artery to the subclavian-vertebral artery junction ***(Ginosar et al.,1995)***.

b. Neurovascular Trauma

Bleeding, hematoma, and pseudoaneurysm formation are potential complications at any site. These are a particular problem with femoral artery cannulation in which retroperitoneal hemorrhage and infected, expanding hematomas may occur. These complications are inevitably more frequent after traumatic cannulation (multiple attempts, cutdown surgical approach) and in the presence of a coagulopathy ***(Ginosar et al.,1995)***.

Neurologic injury is occasionally the result of hematoma formation within the confines of fibrous sheaths; examples include damage to the median nerve at the wrist (radial artery) and the distal brachial plexus in the axilla (axillary artery). Severe prolonged extension of the wrist during radial artery cannulation may also be the cause of median nerve injury ***(Ginosar et al., 1995)***.

2. Infection :

Infections continue to be a common complication associated with arterial catheters. Important factors include inflammation at the insertion site, catheters left in situ for more than 4 days, and catheters placed by surgical cutdown ***(Band and Maki, 1979)***.

Most infections appear to be caused by invasion of the skin flora into the intracutaneous catheter tract; however, hematogenous seeding of organisms from other sites and contaminated catheter system are other mechanisms of infection ***(Maki and Hassemer, 1981)***. When arterial catheter infection does occur, staphylococcus species, especially S. epidermidis, are most commonly isolated. Gram negative organisms are less frequent, but predominate in contaminated infusate or equipment-related infection. Candida species are