Safety Incidents in Critical Care

January 2022 | Issue 4

The Faculty of Intensive Care Medicine

Introduction

This is the fourth of a series of safety bulletins, taken from NHSE/I-sourced data on 486 incidents on critical care classified as moderate or severe. Once again it cannot be regarded as a precise quantitative account of all incidents, because it relies on reporting by individuals, but it does give a strong indication of the type of episodes which are occurring and therefore lessons that can be learnt.

The aim of the bulletin is to try to present these incidents in a digestible way, because the raw data is very difficult to take in. A limitation and also a strength of the data, is that it is anonymous, and it is not normally possible to ask for more information. Therefore, when writing a report or datix, it is important to describe the event in such a way that an independent person can understand what is being reported, why, what was involved and the outcome.

Airway, respiratory support, ventilation and oxygen

19 incidents involving the airway were reported. These were largely centred around disconnections and dislodgements, which in some cases were not observed because staff were not immediately present or in some cases were not noticed when staff were present, especially when under pressure. Being able to see patients easily, even from outside their room is often not possible with current intensive care designs. One patient, who was not visible, was identified by a passing staff member as having airways obstruction from the noise they were making. Even when patients are visible and under direct supervision it is not always possible to prevent loss of the airway. One patient whose sedation was lightened, was reported as pulling out their endotracheal tube, even though the nurse was in the room and attempted to restrain them.

A CPAP circuit and two NIV circuits became disconnected, resulting in marked hypoxia, hypotension and bradycardias, necessitating urgent intubation and ventilation.

A CPAP mask became disconnected from the CPAP valve, resulting in patient deterioration.

A stable patient on a CPAP hood was left alone with a buzzer, whilst the nurse assisted with equipment in another area. The CPAP hood became deflated and the patient was found with a bradycardia and no cardiac output. CPR was commenced.

A patient developed rigors and bit down on their ET tube, resulting in airway obstruction and hypoxia. Deepening of sedation relieved the tube compression. A Guedel airway was inserted, because no bite blocks were available. A subsequent rigor and biting episode resulted in loss of teeth when the patient bit against the airway.

Airway occlusion occurred in a patient whose tracheostomy cuff was re-inflated without his speaking valve being removed. Fortunately, a passing physiotherapist spotted the patient's efforts to breathe out and removed the valve, relieving the obstruction.

Three tracheostomies were lost during turning, including one inserted a few hours earlier, resulting in desaturation. A fourth tracheostomy was dislodged leading to airway obstruction, so it was removed. Initially the patient improved, and a decision was taken not to reinsert. Over subsequent hours the patient deteriorated and reinsertion failed. Therefore, the patient was reintubated orally.

Damage to the posterior tracheal wall was reported during a tracheostomy tube change. In another case, bleeding from the first division of the left main bronchus was seen on bronchoscopy and thought to be due to trauma from suction catheters, which were too long being designed for endotracheal tube use rather than a tracheostomy.

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A percutaneous tracheostomy was complicated by a pneumothorax. The patient deteriorated and died within hours.

Missing, faulty or turned off equipment also led to patient deterioration. The risk of producing a covid aerosol led to a nurse temporarily switching off a ventilator whilst disconnecting and untangling ventilator tubing. The nurse was then distracted by a request from another bed space and forgot to put the ventilator back on, resulting in cardiac arrest.

Reintubation, especially in an emergency, requires immediate access to relevant equipment. In one case the difficult airway equipment lacked any type of video laryngoscope, resulting in desaturation and cardiac arrest before a patient who had a failed extubation could be reintubated. In another case unspecified equipment was missing, also resulting in a delayed reintubation.

A faulty oxygen cylinder used on an internal transfer failed to deliver oxygen, resulting in desaturation to SpO2 of 60% during transfer from the CT scanner to the ICU. In another incident ventilator tubing was examined in a patient with recurrent VAPs. It had not been changed for four months.

A wrong setting on a VV ECMO- FiO2 blender gave 70% oxygen rather than 100%.

Comment

Disconnections of CPAP circuits and NIV occur in patients. Alarms to indicate disconnection that are visible and audible outside patient rooms which are often relatively soundproof are needed. This is an issue described in previous Safety Bulletins and also outside critical care[1].

Speaking valves are commonly used in the recovery of patients' laryngeal/pharyngeal function and provide psychological benefits with better communication. However, all staff dealing with tracheostomies should understand the routes of inspiration and the potential difficulties with expiration together with the vital need for cuff deflation when a speaking valve is in place.

During turning or significant movement an individual should be allocated the task of physically protecting the tracheostomy or endotracheal tube. Consider temporarily disconnecting the breathing circuit during turning to minimise traction on the tube.

Fully stocked airway and difficult airway trolleys should be immediately available during tracheostomy/endotracheal tube change, reinsertion, or reintubation. To help speed access to contents DAS has developed guidance on difficult airway trolley contents and trolley signage.[2, 3, 4]

Arterial, central venous and peripheral lines

Arterial Lines

Incidents happen during removal of lines. Two similar incidents occurred whilst attempts were made to remove the dressing before removing the arterial line. As a result, the arterial line was cut and lost into the radial artery, requiring removal by the vascular surgeons.

A right femoral arterial line was damaged during suturing of adjacent femoral vein CVC line, resulting in loss of part of the line into the artery. The patient required x-ray, CT scan and surgery to remove the missing portion of arterial line.

In another case a bleed from a radial artery pseudoaneurysm developed after an arterial line was removed.

Radial artery occlusion occurred after a right radial arterial line was removed, resulting in necrosis of the tip of the right index finger. Ischaemic injury to a hand followed the insertion of a brachial arterial line.

An acutely ischaemic leg was detected, resulting in rapid rise in potassium, renal impairment and bradycardia and ultimately requiring above knee amputation. This occurred after a coiling of an acute subarachnoid bleed 24 hours earlier. This had been accessed via the right common femoral artery.

Central venous catheters (CVC)

Insertion

Complications have occurred with CVC placement, including loss of Seldinger wires into the patient, lines being left open to air or catheters being pulled out.

A CVC was accidentally inserted into the carotid artery in an awake confused septic patient despite ultrasound guidance. Another CVC line was accidentally inserted into the right subclavian artery using the landmark technique. The problem was detected when the line was transduced. A further CVC line was passed into subclavian artery despite ultrasound guidance. Incorrect placement was initially detected by blood gas sample analysis.

The patient underwent interventional radiology to remove the line.

A double puncture of the left femoral vein for CVC and CRRT line was done under ultrasound guidance. CVC insertion was satisfactory, but when passing the CRRT line over its guidewire, the wire started to unravel resulting in loss of the guidewire into the patient.

Air embolism

A CVC lumen was found unclamped with the three-way tap lumen open to air. This was quickly closed, but shortly afterwards the patient deteriorated again, with respiratory and cardiovascular compromise. A bedside ECHO revealed air bubbles in the chambers of both sides of the heart. A CT scan then revealed air bubbles in the cerebral circulation. Subsequently the patient developed cerebral oedema and eventually brain stem death. The resulting investigation noted a 300% increase in patient admissions due to COVID at the time of this incident.

A seated patient suffered cardiac arrest, from which they were resuscitated. During resuscitation blood was seen flowing from an open vascath port. The cause of the collapse was thought to have been an air embolism via the open port.

Removal

A CVC line was accidentally pulled out, possibly during bed movement, resulting in sudden loss of a noradrenaline and vasopressin infusion. Adrenalin boluses were given whilst a new CVC line was inserted. Unfortunately, the patient subsequently deteriorated and died. The bed controls were at the foot of the bed, so two people were needed for adjustments of bed to allow one of them to protect the lines.

A CVC line was pulled out because there was no suture in the line hub itself. The sudden loss of noradrenaline led to a cardiac arrest.

A femoral vascath was inserted for CRRT. Following removal, a haematoma developed which became infected.

Peripheral Lines

A peripheral cannula used for administration of 20ml/hr of 50% glucose overnight. Extravasation occurred leading to inflammation and compartment syndrome in the arm[5].

Comment

These incidents highlight the potential serious complications that may occur following arterial and central venous cannulation and the importance that all staff involved in their management are appropriately trained.

Safe central line cannulation should ensure confirmation of correct placement of guidewire within the vein before proceeding to dilatation and catheter insertion. If inadvertent arterial cannulation occurs referral to vascular surgery or interventional radiology is recommended to ensure safe removal in order to minimise the risk of stroke.

Manual pressure should be applied to arterial line sites on removal to reduce haematoma formation and pseudoaneurysm risk. CVC catheter hubs should be sutured. Scissor use near line CVC or arterial hubs should be avoided on removing dressings.

Staff setting up continuous infusions must ensure they are aware of any safety issues relating to such administration, including considering whether a solution is appropriate for such administration due to high osmolarity (or vasoconstrictor properties).

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Nasogastric (NG) tubes

Misplacement of NG tubes was reported multiple times, often complicated by a pneumothorax.

A nasogastric tube was inserted in conscious spontaneously breathing patient. The pH of the aspirate was 4, so NG feeding was commenced. The patient began to cough and so feed stopped. A chest Xray then showed the NG tube had passed down the right main bronchus. The patient deteriorated, requiring NIV.

An NG tube was inserted in theatre. The NG aspirate had a pH 4 and so the tube was used for administration of carbamazepine. A later chest Xray showed that the NG tube had passed down the right main bronchus into the lung.

A nasogastric tube was inserted after cardiac arrest in a hypoxic covid patient. Chest Xray showed an NG tube passing via the left main bronchus into the lung and pleural space with an associated pneumothorax. Feed had not been commenced. The NG tube was removed, and a chest drain inserted. Unfortunately, the patient subsequently died.

Two attempts to pass a nasogastric tube resulted in passage both times down the right main bronchus. Soon afterwards the patient developed a right sided pneumothorax.

A nasogastric tube was passed via the trachea into the right lung. This was detected on chest Xray, which also revealed a right sided pneumothorax.

A nasogastric tube was inserted in a patient on argatroban. The NG tube passed into the right main bronchus and into the pleura, resulting in a pneumothorax. Chest drain insertion was delayed because of the argatroban.

A nasogastric tube was inserted and found to be in the right main bronchus on chest Xray.

The NG tube was not visible on the CxR. Therefore, a small amount of contrast was injected down the NG tube resulting in coughing and deterioration. The NG tube had passed into the lungs.

A pneumothorax was identified in a patient who recently had an NG tube in the lung.

Comment

Pneumothorax is a recognised complication following NG tube insertion and is likely to be a greater risk in unconscious patients due to suppression of the cough reflex. The possibility that a pneumothorax may occur, should always be considered and looked for on clinical examination. Monitoring should be put in place to quickly detect any respiratory or cardiovascular deterioration that might be consistent with a pneumothorax. Alongside CxR for placement, bedside checks should include NG aspiration and pH testing prior to access/feed.

Nasogastric tube insertion is associated in some cases with serious complications. As a result, the BAPEN Position Paper on NG tube Safety Oct 2020 stated: 'The perception of nasogastric feeding tube insertion as a "simple" procedure must be changed to that of a "complex" and dangerous procedure and limited to properly trained and competent healthcare professionals'.[6]

Never Events (i.e. feeding with intrapulmonary placement) associated with aspirate pH ≤5.5 may indicate that aspiration of gastric contents has already occurred prior to tube placement.

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Urinary catheters

A patient with COVID-19 and worsening renal function was transferred to another hospital because of bed pressures. The urinary catheter inserted in the first hospital was found on CT to have perforated the "renal tract" leading to sepsis and worsening renal failure. An initial request for an ultrasound of the renal tract six days before abdominal symptoms appeared, was not performed- the reason for this was unclear.

A Urinary catheter was not inserted far enough before the balloon was inflated, resulting in urethral injury.

A Urinary catheter was inserted and immediately followed by haematuria which resulted in the need for transfusion of blood. The catheter became blocked and was replaced by the urologists using a three-way catheter. Bleeding then settled rapidly.

The urinary catheter was blocked causing retention. Unfortunately, it was not possible to deflate the urinary catheter even during cystoscopy. It was speculated that the wrong liquid had been used to inflate the balloon.

Chest drains

A bleed from an intercostal artery occurred following chest drain insertion, requiring "massive" transfusion and embolization. Epidurals, rectus sheath catheters and surgical drains.

ECMO

An ECMO cannula became dislodged leading to death.

"The urinary catheter was blocked causing retention. Unfortunately, it was not possible to deflate the urinary catheter even during cystoscopy. It was speculated that the wrong liquid had been used to inflate the balloon.

Medication

Drug problems reported involved monitoring, route of administration and dosage, infusions including rate, syringes running out and allergies.

Monitoring of the patient and the infusion

Two errors were reported with insulin and glucose control, both resulting in hypoglycaemia. In the first case, insulin was infused at 5 iu/h during daylight hours, but glucose levels were not monitored until the following day at 5am, when it was found to be 0.2 mmol/litre. Nasogastric feed had not been started, because the chest x-ray to confirm its position had not been completed until after midnight. In the second case the blood glucose was not checked for 8 hours whilst on an insulin sliding scale. Blood sugar was then found to be 1.7 mmoles/litre.

Four problems occurred with noradrenaline infusions, which led to rapid deterioration: A noradrenaline syringe ran out and the systolic blood pressure fell to 50 mmHg. A noradrenaline syringe change resulted in the systolic BP falling to 45 systolic. A faulty syringe caused noradrenaline to leak from plunger. As a result, the patient became hypotensive and suffered a PEA arrest. Noradrenaline was accidentally administered at 90ml/hr for a brief period, after confusion between pumps when resetting doses resulted in ventricular tachycardia and initially hypertension with BP 240/110.

A mannitol infusion was attached but not running in a patient being transferred for treatment of raised ICP- during which the ICP remained elevated and a pupil became dilated.

Intravenous moxifloxacin prescribed on the advice of microbiology at 7pm, but was not administered until at least the following day, despite two messages relating to this being sent on the EPIC EPR system.

Dosage

A patient arrived from theatres on dopamine (120mg in 50ml 5% glucose). In PICU an infusion syringe was changed to the PICU protocol (600mg in 50ml 5% glucose), but without an appropriate change in rate and without a reset of the concentration in the syringe software. As a result, five times the intended dose was given resulting in an SVT, which was treated with two doses of adenosine, amiodarone, fluid and adrenaline. The error was realised 1.5 hours later.

Argatroban was prescribed as 50mg in 250ml as suggested by the local electronic system. However, the nurses prepared 250mg in 250ml, as per alternative local paper guidelines. Therefore, the patient received five times the intended rate. Fortunately, there were no clinical consequences. The electronic and paper systems should have been standardised to be the same.

Previously prescribed tinzaparin was given to a patient with symptoms of a new stroke, who was soon afterwards referred to the stroke team for possible thrombolysis. Thrombolysis was not undertaken because of recent tinzaparin dose.

Following a right venous femoral vein to external iliac vein bypass a bd dose of therapeutic enoxaparin was prescribed on the drug card and made clear in surgical notes. However critical care nurses did not give this, because trust guidelines indicated dalteparin instead. The registrar was contacted, who agreed with therapeutic dalteparin. Unfortunately, this was not given, and the patient developed a DVT and a thrombectomy was required.

Route

A laevobupivacaine 0.1% bag was attached accidentally to an intravenous patient-controlled analgesia system, which was set on a maximum of 12ml per hour.

Sando K (12 mmol), intended for the enteral route, was administered via a central venous catheter, resulting in 15 seconds of asystole.

Septrin was given after full risk benefit assessment including extensive review of history, community and ED notes, to a patient with PCP pneumonia, who had a reported a septrin allergy. Unfortunately, the patient developed anaphylaxis.

A patient with a history of intravenous drug abuse was nursed in a side room and became unrousable. The patient was thought to have taken opiod drugs which had been smuggled in.

Transfusion reactions

A reaction to a platelet transfusion resulted in hypotension, urticarial rash, facial oedema, bronchospasm and desaturation to saturations of 80% on FiO2 of 100%.

Comment

The vignettes above highlight the frequency of drug related errors in ICU and the potential for serious harm.

Care is needed when changing syringes in patients from other areas where alternative concentrations may be in use. Different rate of infusions will then be required. Standardisation of drug concentrations would reduce this type of problem. There is a move to develop standard national concentrations for common ICU infusions which may also encourage industry to develop more prediluted drugs.

ICUs, or ideally hospitals, should have clear policies that standardise practices in infusion management and drug libraries[7].

Any attempts to draw up drugs designed for enteral administration including via enfit connectors for any other purpose should immediately be questioned. Although drugs are commonly for IV administration on ICU, this cannot be assumed.

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Delayed reports, actions and organisational or staffing issues

Many of the reports below are complex or organisational and some related to staffing, but all involved or resulted in a major delay in patient treatment.

Low BMs recorded after admission to ICU. Initially 1.9 and then one hour later BM-1.8. No changes instituted for 3 hours after the first measurement.

Initial CT scan of the aorta and thorax was reported as showing no PE, but a pericardial effusion and thickened pericardium. Two days later a phone call alerted staff to a new final report, which indicated a leaking penetrating atherosclerotic ulcer with blood in the mediastinum and pericardium.

Initial CT was reported as small bowel obstruction due to an incarcerated inguinal hernia, which was then repaired. Unfortunately, symptoms continued, and the patient developed a HAP. A further report was then issued, adding areas of ischaemic bowel and lower obstruction.

Delayed diagnosis of a pneumothorax on chest Xray by the requesting specialty and another specialty. The timing of any radiology report was not clear.

Second Troponin of 43000 missed and so diagnosis of MI was delayed.

A complex patient developed cardiac tamponade. Despite efforts by the consultant intensivist to bring surgeons and cardiologists to the bedside to reach a consensus as to whether a cardiothoracic surgical procedure or a medical cardiological drainage should be used, no decision could be reached, and intervention was put off for 8 hours, until the morning, at which point the patient arrested.

Postop liver resection patient cared for in PACU overnight due to HDU bed shortages and then died the following day. Care being investigated.

Delays in instituting CRRT because of technical problems. First circuit retaining air and so discarded. Second circuit, effluent contaminated with blood. Before new circuit could be connected potassium reached 7.8 and patient suffered cardiac arrest. Third circuit showed high right sided pressures when connected to patient and as a result the system could not be used. Despite medical management with glucose and insulin, bicarbonate and calcium chloride the patient deteriorated and died.

CPAP was thought to be medically required, but none instituted for over 24 hrs despite inspired oxygen exceeding 65%.

Unobserved fall of three patients. Another patient was observed to stand, but then leant on a moveable bedside table and fell to the ground.

Patient was admitted into a side room on the ICU overflow and looked after by an agency nurse. However, no observations were documented for many hours and later the patient was found to be in fast AF.

Delay in transfer of a patient from the ward. Accepted by ICM Consultant at 19.30. Bed space available at 2300hrs. Ward staff said they would bring patient at midnight but delayed until 0100hrs. On arrival the patient was on CPAP with an FiO2 of 1.0 and required immediate intubation. Relevant medication prescribed for 2200 had not been given on the ward.

Seven-hour delay in admission to ICU because of ICU staffing shortage.

Specific reference to between 4 and 6 hours between patient turns, due to staffing availability resulting in sacral sores on a patient.

Inability to perform patient urgent transfer, because only one anaesthetist of any grade available.

No provision of psychological support for highly distressed parents of two children admitted to ICU, including one patient who had attempted suicide.

Patient with major haemorrhage- X matched, but long delay before it became clear that this sample had not reached the laboratory, followed by a second prolonged delay when major haemorrhage protocol was activated.

Delay in cooling mattress effectiveness, because the mattress was set incorrectly.

Comment

Increased frequency of blood sugar monitoring is even more essential in unconscious patients in whom symptoms of hypoglycaemia will be obscured. If nasogastric feeds are stopped/not being absorbed or cannot be started for any reason, immediate attentions should be given to blood sugar measurement and the rate/dose of insulin being administered, which may have to be stopped.

Delay in ICU admission or commencement of therapy is often associated with deterioration in the patient. Prompt admission and institution of critical care treatments should be a priority.

Diagnosing death using neurological criteria

A patient who was diagnosed deceased using neurological criteria began to breathe spontaneously and pupils began to react. However, the underlying condition was complex and so may have made the patient unsuitable for conventional testing[8], therefore see the Diagnosing Death using Neurological Criteria webpage.

Infection

Hospital acquired COVID was reported in 10 patients, including one patient who was transferred to another hospital. Four patients reported with hospital acquired COVID died.

A patient was admitted to a non-COVID bay in ICU having been in a bed adjacent to a patient who then tested positive for COVID but did not have COVID symptoms. A patient in a non-COVID bay of ICU tested positive for COVID.

A patient was reported because they developed a cerebral vein thrombosis 10 days post-COVID vaccination.

Eight cases were reported as positive for clostridium difficile. There were three cases of blood culture positive MRSA and three that were thought to be hospital acquired.

Klebsiella bacteraemias were identified in an ICU patient, thought to be respiratory in origin and two thought to be CVP line related. A cluster of seven patients were identified on the adult intensive care unit with multiple drug resistance pseudomonas "in a short space of time."

One patient was admitted to ICU with CPE, following which three more ICU patients also tested positive for CPE.

One patient with VRE was moved into six different bed spaces, including one side room on the ward after ED admission, then to two bays on ICU and subsequently an ICU side room, resulting in infections in nearby patients and then also in their contacts on other wards. A second unconnected patient was reported with VRE and multiple bed moves.

Comment

Multiple moves of patients within and between hospitals increases the risk of spreading infection and being infected. Multiple reports of transmission of COVID within hospitals have occurred and safety recommendations have been made [9, 10, 11].

High patient/staff ratios also increase contact. Attempts to accommodate more patients through transfer rather than expanding current facilities are likely to promote this. Adequate staffing and suitably sized facilities are needed.

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Pressure sores

The position of the patient was not always specified in reports. However, many were clearly associated with prone or supine position or both. These are described below.

Prone

Two patients were reported with possible brachial plexus injuries possibly associated with the swimmer's position during proning. One of these patients was very large and had difficulty turning his head. Similar cases have been reported elsewhere[12].

Two patients developed ulcers on their cheeks where the anchor fast technique was used to secure the ET tube. In one of these cases the Anchor Fast was replaced with ET tube ties. The same patient developed sores on the neck where these conventional ties had been pressurising the skin.

A very unstable COVID patient developed sores on the corners of her mouth, when she couldn't be moved out of the prone position for 48 Hours. Another similar patient who was unstable after turning developed buttock sores, sores in the corners of the mouth and on the cheeks. A third very unstable COVID patient developed a sacral sore.

A forehead sore was seen in one proned patient. Chin sores were reported in one proned patient and two who were unspecified. Sores on the ears were seen in one proned patients and seven with no position given. Big toe sores were reported in another proned patient. Tongue ulcers were found in two proned patients. An upper abdominal sore was described in a proned patient.

A further three cheek sores were reported in prone patients and five more where positioning was not indicated. Mouth ulcers were reported in two proned patients and eight whose positioning was not specified. Penile ulceration was reported in one prone patient and a further three where position was not specified.

Mixed prone and supine

Lip sores were reported in six patients. Occipital sores were reported in three patients. Elbow sores in three more.

A thigh sore was reported, but the positioning was unclear. A penile meatus erosion due to a urinary catheter was reported and a scrotal sore in another patient. Blisters were reported on the right and left hips in two patients, five buttock sores were reported and 54 sacral sores. An upper back sore was reported. An ankle sore was reported in one patient and heel ulcers in seven. Four toe ulcers were reported.

Pressure ulcers related to equipment

Ten sores on the bridge of the nose were reported secondary to CPAP or NIV masks including one that occurred despite derma gel. One sore occurred from hood straps passing under the axilla.

Five tracheostomy sites suffered pressure related ulceration. Four nasal erosions secondary to NG tube including one specified as being prone. One arterial line hub caused a pressure ulcer.

A grade three pressure ulcer was reported due to a flexiseal, which was then removed, but replaced four days later. A second flexiseal ulcer incident was also reported.

A bunion pressure sore developed due to ill-fitting TED stockings and an ulcer developed from pressure from a plaster cast on the heel after major trauma. Tearing of the skin on the arm related to dressings was reported in three patients with poor tissue.

Comment

Pressure ulcers are common with unstable patients and those requiring prone positioning posing a particular challenge. Attention to detail on all common pressure points is essential with a head-to-toe check on positioning, including positioning of lines, nasogastric tubes and urinary catheters, ETT ties. Frequent repositioning (2 hourly) is an essential component of prevention. Anchor Fast tube ties are not normally recommended for prone positioning. Tissue viability teams may be able to advise/provide further equipment in complex cases where patients are at extremely high risk of pressure areas.

Conclusions

Incidents can be associated with lack of training or preparation, such as the non-availability of the correct emergency equipment. Checklists may be valuable in these situations. Delay in treatment and admission is a common cause of deterioration.

Adequate provision of staffing and space for rapid emergency admission should be a priority.

Transfers may be a source of hazard in terms of oxygen, ventilation and drug administration and may lead to errors due to alternative drug regimens being in use, so exact understanding of drug concentrations and rates is important.

Team approaches to care, and initiatives such as 'fresh eyes' when covering staff oversee breaks and recheck safety parameters, can also help in checking, and avoiding harm.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7665709/pdf/pzaa191.pdf.

SBAR Report: If pressure alarms are set too low on Armstrong FD140 CPAP machines oxygen/air flow is cut to one litre/minute

S: A patient who was self-proning with COVID-19 had required an increase in his CPAP. Soon afterwards his breathlessness increased, and his saturations fell into the mid 80%. Respiratory rate increased to over 40 breaths per minute. Inspired oxygen was increased to 100% and medical staff were called.

B: CPAP has been used in critical care even more than normal during the COVID pandemic. Devices with alarms for low or high pressure may be desirable to alert staff to clogged filters, damaged CPAP valves or disconnections. This is especially important when staffing ratios are low and inexperienced staff are present. Alarms are fitted to the Armstrong FD140 CPAP/HIFLO machine.

A: In the noisy environment of the ICU and constrained by PPE it was hard to detect or feel expiratory flow from the expiratory CPAP valve on the CPAP helmet. A "tissue test" was performed where a piece of tissue or paper was held close to the outlet of the expiratory CPAP valve. Normally the paper would be blown about by the expiratory flow, but no movement was seen; indicating that there was no gas flow exiting the helmet and so little or no flow entering the helmet from the supply side. The pressure alarms were sounding and when their settings were checked it was found that the alarms had not been reset to allow for the higher CPAP valve. The max pressure settings were increased to more than 3 cmH2O above the CPAP valve pressure.

Air/oxygen flow was now detected coming from the expiratory valve of the CPAP helmet. The patient immediately felt more comfortable and less breathless. The patient's oxygen saturations rapidly returned to normal.

R: Staff were alerted to the fact that the alarms are not simple alarms. The manufacturers handbook shows this on page 56-7. If the max pressure alarm is activated, then the inspiratory flow will cut abruptly from its current value, which is often around 70 litres/minute, to the much lower value of one litre/minute. This suddenly increases the work of breathing for the patient and this flow change may cut in and out if the pressures are on the borderline of the alarm settings.

The manufacturers were contacted regarding this issue and asked if this could be highlighted more prominently in the handbook and stressed during training. Locally, a 5:5 alert was put out to all staff and new guidance has been developed. This feature will be stressed in the future teaching and training.

> "In the noisy environment of the ICU and constrained by PPE it was hard to detect or feel expiratory flow from the expiratoy CPAP valve on the CPAP helmet.

Confusing a plain breathing circuit filter for a heat and moisture exchanging filter (HMEF) FD140 CPAP machines oxygen/air flow is cut to one litre/minute.

The RCoA and FICM have received a coroner's Regulation 28 report to prevent other deaths. We are sharing the lessons from this tragic case to ensure they are incorporated into our practice.

A patient being ventilated for COVID pneumonitis in a surge ICU sustained a cardiac arrest on day 7. At the time an anaesthetic machine was being used to provide ventilatory support due to lack of conventional ICU ventilators. The cardiac arrest was thought to have been precipitated by the tracheal tube becoming blocked by thick secretions. The patient was successfully resuscitated following replacement of the tracheal tube but subsequently developed acute renal failure.

The patient sustained a further deterioration in ventilation six days later when a partially blocked tracheal tube was identified at bronchoscopy and replaced. The patient was now being ventilated with a conventional ICU ventilator. Following the second episode, it was realised that there was no humidification in the ventilator circuit as what was thought to be a HMEF was in fact a plain bacterial/viral filter. The plain filter included a sampling port (used for capnography) which had made staff incorrectly consider that it was a HMEF.

Sadly, the patient subsequently died from multiple organ failure secondary to COVID pneumonitis and the cardiac arrest was considered a contributory factor.

Further investigation identified up to 10 more patients who were not receiving humidification due to the incorrect use of a plain filter in place of a HMEF. The coroner was concerned that there was confusion between HMEF and filters by many staff over a number of days that could occur and that action is needed to reduce the risk of harm to future patients.

Lessons

HMEF and plain filter may be confused as they can look similar and the labelling may not be clear. Standardisation of labelling including colour coding could reduce the risk of a plain filter being mistaken for an HMEF. This has been referred to the MHRA for consideration. The presence of a sampling port on a plain filter may increase the risk of it being mistaken for a HMEF.

The use of an anaesthetic machine as an ICU ventilator by staff unfamiliar with the equipment is likely to have contributed to the errors. Plain filters with sampling ports are designed only for use in anaesthetic machines when undertaking short cases and they should not be available in an ICU.

All members of the MDT involved with managing ventilated patients must be aware of the difference between the plain filter and HMEF and their correct placement in the ventilator circuit. If an HMEF is being used it must be at the patient end and there should be no other filter in the circuit. If an active humidifier is being used (heated water bath) then a plain filter should be placed in the expiratory limb of the circuit close to the ventilator.

Regular checks of the ventilator circuit must be undertaken. This should be undertaken at least once per shift. A check list may assist the correct procedure. The check should ensure that an appropriate form of humidification (wet circuit with an active humidifier or use of an HMEF at the patient end but never both). The risks of combining a wet circuit and HMEF have been previously highlighted in a national safety alert[13].

"All members of the MDT involved with managing ventilated patients must be aware of the difference between the plain filter and HMEF and their correct placement in the ventilator circuit. If an HMEF is being used it must be at the patient end and there should be no other filter in the circuit.

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