

CHAPTER 17

Trends in intensive care

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Intensive care: key recommendations

Service provision

High bed occupancy rates in intensive care reduce the availability of emergency beds. It is sometimes possible to create a bed for an emergency and this should be facilitated by early consultant-to-consultant referral.

Early warning scores should be used more often on obstetric wards; they may need modifying for pregnant women.

Elective admissions should be prearranged and this may require the cancellation of other booked intensive care admissions on the day.

Intensive care consultants should be part of the multidisciplinary team planning care for patients with serious co-morbidity.

Intensive care should start as soon as it is needed and does not need to wait for admission to an intensive care unit. It is possible to provide the majority of immediate intensive care in an obstetric theatre. Where available outreach staff should be used.

Individual practice

Arterial lines should be inserted early and samples taken for blood gases, haemoglobin, electrolytes and clotting on a regular basis. Where indicated, fluids and inotropes should be started without delay.

Consideration should be given to improved stabilisation and elective intubation prior to transfer.

Blood gases should be done earlier and a metabolic acidosis should always be taken seriously and investigated.

Fifty years ago...

Fifty years is a long period in any medical specialty; in intensive care medicine it is a lifetime. The first chapter dedicated to intensive care issues in maternal deaths appeared in the 1991–93 triennial Report. Mothers have, of course, made use of intensive care for much longer than this and intensive care as we would recognise it today traces its origins back almost exactly 50 years. Developed in response to a poliomyelitis epidemic in Copenhagen in 1952, intensive care medicine in Europe has grown from the poorly

understood province of a small number of dedicated enthusiasts to a major medical speciality in its own right.¹

Early intensive care units were primarily created around concentrations of particularly sick patients; such a process was adopted by Florence Nightingale and became common practice in military hospitals. We have advanced well beyond this today and modern intensive care thrives on the ability to deliver expert and evidence-based care to critically sick patients from any number of sources and increasingly to commence the process in a variety of different locations. Nevertheless, dedicated intensive care areas are an important feature of modern hospitals if the most efficient use of resources for staffing, equipment and support services is to be made. There are many principles of care common to all critically ill patients and patients are increasingly being classified according to nursing dependency rather than by diagnosis.

Patterns of disease have changed as well; 50 years ago intensive care units were mainly concerned with the ventilation of patients with respiratory failure from poliomyelitis and tetanus. The Copenhagen epidemic saw the introduction of positive pressure ventilation via tracheostomy as a highly effective alternative to tank ventilators (iron lungs). The introduction of effective vaccines changed the population of patients presenting to intensive care units to those we would recognise today, patients with multiple organ dysfunction often secondary to major surgery or sepsis.

50 years ago the critically sick mother could have been ventilated but without access to blood gases or pulse oximetry. Invasive cardiovascular monitoring was entirely experimental with rat-tailed manometers and complex dye dilution methods of estimating cardiac output. Effective renal support was 25 years away and enforced starvation would continue for even longer. Blood transfusions were a complex affair and our understanding of clotting and clotting products was in its infancy. Had she suffered a cardiac arrest then the outlook was bleak, external cardiac massage had yet to be introduced and defibrillation with a pair of insulated spoons connected to the mains electricity supply was a far cry from today's sophisticated biphasic devices.

The 1960s and 1970s were the dawn of the digital era, albeit in forms we would not recognise today. Microprocessor-controlled medical devices began to appear as did the widespread use of cardiopulmonary bypass for open heart surgery. Pulmonary artery catheterisation and thermodilution cardiac output monitoring, although described in London in the 1960s,² would wait until the 1970s to be popularised as a monitoring tool.³ The intra-aortic balloon pump, described in 1958,⁴ only really became an effective tool in the late 1970s with the introduction of a percutaneous version.⁵ This remains an important tool today in the management of peripartum dilated cardiomyopathy. In 1969, intensive care in the United Kingdom was still very much in its infancy but at least the recovering patient, unable to sleep, could have sat up and watched a man land on the moon!

The next 20 years would see intensive care develop into the complex and sophisticated specialty we recognise today. The now widely accepted principles behind the pathogenesis and treatment of critical illness really began to take shape in the 1980s. They began with a marked increase in the understanding about systemic inflammatory processes, cell signalling and the pivotal role of nitric oxide. This led in turn to a proliferation of clinical trials searching for 'silver bullets' with the power to reverse the devastating effects of severe systemic sepsis. This remains an elusive goal with particular relevance

to severe sepsis associated with pregnancy. Despite these disappointments significant progress has been made in the field of organ system support and it is now common for patients to survive periods requiring respiratory, cardiovascular, renal and nutritional support.

The acute respiratory distress syndrome in adults (ARDS) has featured in all the intensive care chapters to date. This complex inflammatory process has a clear association with pre-eclampsia, sepsis and massive haemorrhage. Our understanding of the pathogenesis has increased significantly but treatment remains essentially supportive. Care with this support is important and the last decade has seen an emphasis on the damage that poorly controlled mechanical ventilation can cause. Trials into inflammatory moderators, surfactant and extracorporeal support continue to the present day.⁶

As intensive care moved from the province of the dedicated enthusiast into an important acute service so the complex problems of bed numbers, training and severity scoring came to the fore. Knaus and others introduced APACHE scoring in 1981⁷ and the second version is now widely used as part of a national audit scheme in the UK. Competing interests between anaesthesia, medicine and surgery delayed the introduction of formal intensive care training in the UK. Joint training posts were introduced in 1986 and, since 2000, intensive care training has been supervised by the Intercollegiate Board for Training in Intensive Care Medicine.⁸ The recognition in 2002 of intensive care as a specialty in its own right is an important milestone in a long struggle.

The provision of sufficient intensive care beds is an essential component in minimising the delays in the admission of critically sick emergencies. In 1998, there were just over 1,400 adult beds available for general intensive care for the whole of England and Wales.⁹ By January 2002, this had risen to 1,711 intensive care beds and 1,319 high-dependency beds. Increasingly, these high-dependency beds are to be found on obstetric units. The provision of specially trained staff and a suitably equipped area improves the care of patients while allowing for continued contact between mother and baby.

To the occasional visitor, intensive care in the 21st century is all about sophisticated technology. Bed spaces are filled with computer-controlled ventilators, multichannel monitoring systems and several different methods of measuring cardiac output with varying degrees of invasiveness. Most drugs are given by infusion and ten or more syringe drivers are common. Other, equally important developments in intensive care are less obvious; highly evolved nursing training and in-service development programmes have given us a nursing workforce unrivalled anywhere in the world. Our eventual understanding that intensive care is exactly that, intensive care provided by an experienced member of the nursing staff has encouraged us to take intensive care out of the dedicated unit and to deliver it to a much wider patient base. This is an extremely important development for obstetric services in particular and has yet to reach full potential. Remote obstetric units make this approach more difficult but by no means impossible.

Intensive Care 2000–02

In contrast to many of the other chapters in this Report, intensive care is usually a consequence, rather than a cause, of serious illness and death. As in previous Reports approximately one in three of all maternal deaths have some involvement with intensive care; a detailed analysis of the causes of death in mothers admitted to intensive care

has not been included in this chapter, as it is difficult to draw meaningful conclusions from such data. Either an increase or a decrease in admissions from a particular cause could represent an improvement in the quality of care, and in common with many other chapters denominator data are required.

Recognising sick women

A recurring issue in a significant number of women referred to intensive care is an apparent delay in the recognition of the severity of their illness. Accepting that it is always easier with hindsight to recognise serious illness earlier, there are nonetheless a number of cases in which readily recognisable signs of significant physiological abnormality were either missed or ignored.

Young, previously fit pregnant women have significant physiological reserve in most major organ systems. They make use of some of this reserve to survive the stresses of normal pregnancy but it is evident that a considerable amount remains unused. The effect of this is to mask the physiological signs of a number of important pathological conditions, most notably hypovolaemia and systemic sepsis. A modest tachycardia, mild hypotension and warm well-perfused peripheries are all normal signs in late pregnancy but are also the signs of sepsis. There is no absolute method of distinguishing these in the early phase but a high index of suspicion must be maintained if serious illness is to be diagnosed and treated in time.

Many of the women who went on to become critically ill were tachypnoeic before they deteriorated. This has been described previously and is an important sign worthy of extensive investigation in every case. Pulse oximetry is universally available and any sustained reduction in saturation should be investigated with arterial blood gas analysis. A metabolic acidosis is a serious, always significant, sign and should never be ignored.

Communication issues continue to figure in women becoming unexpectedly critically ill and diagnosis and treatment may be delayed in women from ethnic minorities. Stoicism combined with significant physiological reserve further exacerbates the recognition of impending critical illness. In a small number of cases, significant physiological disturbance appears to have been attributed to anxiety and cultural differences, with tragic sequelae.

Medical student and junior doctor training programmes have started to appreciate the need for improved training in the recognition and management of the acutely sick and deteriorating patient as a separate entity to the management of cardiac arrests.^{10,11} The relative rarity of such women presenting to obstetric services makes the need for effective education and training at all levels, from the most junior healthcare assistant through to senior consultant staff, an important area for improvement.

Early referral and outreach

In some cases, women presented with catastrophic life-threatening disease and were appropriately referred and transferred to an intensive care unit after resuscitation and stabilisation. There were, however, some cases in which the involvement of intensive care and eventual transfer was much delayed.

Early referral and involvement of the intensive care consultant from the start is essential. Most intensive care units in the UK operate at very high bed occupancy rates, often in excess of 90%. The effect of this is to reduce the chance of an intensive care unit having an empty bed for any unexpected emergency. Some units still reserve a bed for 'in-house' emergencies and the case may need to be made at a senior level if this bed is to be released. Early consultant-to-consultant referral also facilitates decisions about discharging or transferring other patients to make space. There can be few patients more deserving of efforts to make a bed than the critically sick mother.

In a small number of cases, women with significant coexisting cardiac disease, for example, the need for an intensive care bed could have been predicted prior to their delivery. Here, a bed must be booked in advance and a management plan agreed between intensive care, obstetric, anaesthetic and cardiology consultants. Bed booking and subsequent cancellation of major surgery is an all too common activity on busy intensive care units. The situation is clearly different here and intensive care units must appreciate that the bed will be required irrespective of other pressures from in-house emergencies and other reasons.

The level of support provided between delivery and eventual admission to an intensive care unit varied enormously between cases. A feature, by no means confined to obstetric emergencies, is that referral to intensive care is almost seen as a treatment in itself and the support provided while waiting for admission is often left to very inexperienced staff.

There is, however, little that is done on an intensive care unit that cannot be performed in an obstetric theatre. Invasive monitoring should be available in all obstetric theatres and the anaesthetists and assistants who work there should be conversant with its use. Intensive care staff are, however, much more comfortable with the use of inotropic infusions, measurements of cardiac output and so on, and so need to be involved as early as possible. Arterial blood gases, haemoglobin levels, electrolytes and clotting profiles all change rapidly in these women and should be taken at regular intervals.

Early involvement of the intensive care consultant should allow for earlier, more effective use of advanced support measures. Increasingly intensive care units are staffing outreach teams and, where available, these can supply invaluable support to the stabilisation of patients prior to transfer. There were several cases in which women deteriorated very rapidly immediately after admission to the intensive care unit requiring emergency intubation and ventilation. While unavoidable in some cases, this does support the view that patients can deteriorate significantly while waiting for transfer. Consideration should be given to elective intubation and ventilation for transfer, done early this will allow for a period of stabilisation in the operating theatre prior to transfer. Obstetric theatres are well equipped to manage difficult intubations, most intensive care units are not; these patients may seriously challenge the intubating abilities of junior intensive care staff, not all of whom have anaesthetic training.

Massive haemorrhage

The management of major blood loss is discussed in a number of other chapters in this Report. Nevertheless, it remains an important event leading up to some of the intensive care unit admissions reported. Significant blood loss is not a rare event in an

obstetric theatre and yet there still appears to be areas for improvement in management. Significant blood loss leads to a disastrous fall in oxygen delivery to mitochondria both from the reduction in capillary blood flow and from the reduced oxygen content as the haemoglobin falls. The effects of this in some patients is to trigger the immunoinflammatory cascade; if intense this cascade may lead to the acute respiratory distress syndrome, acute renal failure and a cardiovascular collapse identical to that seen in severe systemic sepsis.

The conventional management of severe haemorrhage has been questioned recently in the setting of out-of-hospital trauma and has led to a set of recommendations from the National Institute for Clinical Excellence (NICE).¹² Although clearly not intended for use in the bleeding obstetric patient, the physiological basis for the recommendations may prove to be highly relevant.

Evidence from a number of sources suggests that excessive resuscitation with either crystalloid or non-blood colloids may increase the mortality from severe haemorrhage. Faced with significant blood loss the body responds with a number of well-intentioned physiological manoeuvres. Increased sympathetic tone and the release of endogenous catecholamines lead to an appropriate tachycardia in an attempt to maintain cardiac output and intense vasoconstriction diverting blood towards vital organs. From simple physics, the fall in blood pressure both in the arterial and venous circulations reduces the loss of blood from damaged vessels. Clearly, if haemorrhage continues then death from hypovolaemic cardiac arrest will occur.

Transfusing readily available sodium containing crystalloids or non-blood colloids seems an attractive solution and has been widely practised in a variety of arenas, including during obstetric emergencies. The physiological effects of this approach are, however, more complex; restoring circulating volume in this way produces a reassuring rise in blood pressure and a reduction in heart rate. Unfortunately, however, the oxygen carrying capacity of the circulating blood is seriously reduced and oxygen delivery to the tissues will not be restored leaving mitochondria profoundly hypoxic. In addition, the clotting factors in the blood become rapidly diluted leading to further haemorrhage from small vessels and the restoration of arterial and venous pressures will encourage further blood loss from larger vessels. This, in turn, leads to a vicious cycle of events and the effects are compounded.

The NICE recommendations for out-of-hospital trauma are intended to reduce this effect by restricting the amount of non-blood fluid that is given prior to admission. Is this relevant to obstetric emergencies? In the usual situation in which only a small amount of crossmatched blood is available and clotting products may be an hour away then the similarities are apparent. There is no ideal solution but the emphasis should be placed on stopping the bleeding at the earliest opportunity and restoring haemoglobin levels and clotting as early as possible. Trauma anaesthetists are having to learn to anaesthetise patients who are still significantly hypovolaemic so that the sites of blood loss can be controlled before circulating blood volume is restored with transfusions of blood and clotting factors. Anaesthesia for the bleeding obstetric patient is a highly skilled task and senior anaesthetic help must be obtained as early as possible. Several pairs of hands are needed to manage the case properly.

In many of the women admitted to the intensive care unit after severe haemorrhage a marked coagulopathy was still present. It is still common to see clotting factors being

withheld until the results from a clotting screen are available; in the presence of significant blood loss, the delay caused by waiting for these results combined with the delay in obtaining and defrosting fresh frozen plasma will lead to a serious dilutional coagulopathy.

In at least one reported case, simple organisational problems led to a protracted delay in obtaining blood and blood products and there is much to recommend the development of in-house, scenario-based training for the management of severe haemorrhage within the obstetric theatre. In particular, the delays involved in getting blood and blood products actually to the patient need to be built in to the scenario, so that these are ordered much earlier. It is not possible to tell from the records provided how often fluids are being warmed prior to infusion but again it is still common to see large volumes of cold fluids being administered. The relatively high frequency of cardiac arrest following induction of anaesthesia may, in part, be due to this.

The emphasis must be placed on stopping the bleeding and senior surgical input, if necessary from a consultant vascular surgeon, must be obtained as early as possible. It may be necessary to temporarily control the bleeding by pressure alone until more experienced help arrives and until blood and blood products and a blood warmer are available.

Accident and emergency departments

A significant number of women admitted to intensive care came through accident and emergency departments rather than from obstetric units. Almost without exception, the management of cardiac arrest within accident and emergency units was excellent and pays tribute to the highly successful implementation of Advanced Life Support training. In the non-arrested patient, however, the situation is far less satisfactory. Other chapters have alluded to the poor management of these women by some accident and emergency departments and it is apparent in those admitted to intensive care that some accident and emergency departments continue to miss serious illness in the pregnant patient or to put abnormal physical signs down to pregnancy alone.

Pulmonary embolus

The difficulties in diagnosing pulmonary embolus are not exclusive to obstetric patients but there are still cases in which the diagnosis should have been excluded or confirmed much earlier. Pulmonary embolus remains a life-threatening condition, which tends not to be taken seriously enough. Urgent steps should be taken to confirm or exclude the diagnosis including high resolution spiral computed tomography scanning, pulmonary angiography and echocardiography, as available. The management of a significant pulmonary embolus remains a complex and controversial process and death, primarily from right ventricular failure, remains an all too common sequel. Early anticoagulation is essential if further emboli are to be prevented and consideration should be given to thrombolysis if possible. If significant clots can be demonstrated in the lower limbs or inferior vena cava then expert advice about the use of umbrellas etc should be sought.

Intensive care: key learning points

- Abnormal physical signs are masked in young people due to physiological reserve; this reserve is increased further during the second and third trimester.
- Tachypnoea is an important sign of serious illness and should always be investigated.
- Just because someone cannot speak English does not mean that they are not seriously ill.
- Referral to the intensive care unit is not of itself a treatment. Early intensive care admission will not cure everybody but delays cannot help.
- The variable management of massive haemorrhage in obstetric theatres continues and delays still exist in getting senior help: surgical, anaesthesia and pairs of hands. There is also failure to take account of the delay in getting blood and blood products, especially in remote sites and women still arrive on intensive care with severe dilutional coagulopathies. There is a need to practice major haemorrhage drill in obstetric units and it is likely that the theory behind the National Institute for Clinical Excellence (NICE) guidelines for management of 'out-of hospital haemorrhage' will be relevant in obstetric haemorrhage as well.¹²

Conclusions

This Report only deals with mothers who have died and so inevitably gives a distorted view of what can be achieved by modern intensive care. In many cases, detailed records of outstanding intensive care were provided and yet death was still the final outcome. There were also cases in which little or no information was available about the intensive care provided. This is inexcusable and inevitably raises questions about the quality of intensive care actually provided.

Fortunately less than 1:1,000 mothers will end up in intensive care but they still represent an important and challenging group of patients. Often young, previously well and unexpected admissions, these women are very stressful to care for and are not unlike young trauma victims in their effect on intensive care staff, especially when they die.

Mothers who become brainstem dead, usually from intracerebral disasters, can donate organs and it is very encouraging to see this either occurring or at least being discussed.

Intensive care and obstetric units are often remote from each other and present a significant challenge to shared care processes. Obstetric patients on intensive care often need continuing obstetric and midwifery input throughout their stay and arrangements for this should be discussed proactively.

The tragedy of an avoidable death is all too apparent in this Report, none more so than from airway management disasters under general anaesthesia. Intensive care has come a long way in 50 years but it has a long way still to go. We continue to introduce new

therapies; the recent introduction of activated protein-C into the treatment of severe sepsis is an exciting step with obvious relevance to maternal deaths.

Even with excellent management and early referral and admission, we still cannot cure all patients, especially those with multi-organ failure from severe sepsis. Despite this, delays in referral, inadequate resuscitation and the late recognition of severe illness cannot be expected to improve survival.

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