CORONERS ACT, 2003

SOUTH *AUSTRALIA*

FINDING OF INQUEST

An Inquest taken on behalf of our Sovereign Lady the Queen at Adelaide in the State of South Australia, on the 16th, 17th, 18th and 19th days of November 2015, the 22nd, 23rd, 24th, 25th, 26th and 29th days of February 2016 and the 3rd day of August 2016, by the Coroner's Court of the said State, constituted of Mark Frederick Johns, State Coroner, into the death of Andrea Lambropoulos.

The said Court finds that Andrea Lambropoulos aged 34 years, late of 18 Troon Avenue, Seaton, South Australia died at Ashford Private Hospital, 55 Anzac Highway, Ashford, South Australia on the 30th day of November 2013 as a result of hypoxic-ischaemic encephalopathy following laparoscopic bariatric surgery with iatrogenic spleen and liver damage on a background of ischaemic heart disease, obesity and obstructive sleep apnoea. The said Court finds that the circumstances of his death were as follows:

1. Introduction and cause of death

1.1. Mr Andrea Lambropoulos was barely 34 years old when he died on 30 November 2013 in the Ashford Hospital. An autopsy was carried out by Dr Neil Langlois, a forensic pathologist from Forensic Science South Australia, on 5 December 2013. He produced a post mortem report dated 11 February 2014[1] in which he gave the cause of death as hypoxic ischaemic encephalopathy following laparoscopic bariatric surgery with iatrogenic spleen and liver damage on a background of ischaemic heart disease, obesity and obstructive sleep apnoea, and I so find.

[1] See Exhibit C3a

2. Background

2.1. Mr Lambropoulos had been admitted to the Ashford Hospital for sleeve gastrectomy surgery which was performed on 25 November 2013 by surgeon Dr Teague. The anaesthetist was Dr van Renen. Mr Lambropoulos had been booked into the HDU (HDU) for his immediate post-operative care by Dr Teague and following a period in the recovery room. Mr Lambropoulos was duly admitted to the HDU as planned. The cardiac arrest that ultimately led to his death occurred while he was in the HDU. It was plain from the whole of the evidence, and in particular the opinion of the expert witness Professor Cade, Intensive Care Specialist[2] that Mr Lambropoulos' cardiac arrest in the HDU was the result of hypoxia caused by a combination of narcotic post-operative pain relief, the anaesthetic agents in his body, his obesity and sleep apnoea. As Professor Cade said:

> 'So that's the cause of the respiratory failure because it causes airway obstruction and failure to breathe; they're the causes and that's the mechanism. The mechanism then is the obstruction and the failure to breathe. A consequence then is the hypoxia.' [3]

2.2. As Professor Cade explained, the cardiac arrest was followed by what is often referred to as 'downtime' where oxygenated blood was not being circulated to Mr Lambropoulos' brain, thus resulting in encephalopathy from hypoxic brain damage and severe irreversible ischaemic brain damage that was the ultimate cause of death.

2.3. During the Inquest there was considerable debate about the decision by the surgeon and the anaesthetist that Mr Lambropoulos could be managed post-operatively in the HDU. It was suggested that this was an error of judgment and that he should have been sent to the Intensive Care Unit (ICU). It was also suggested that even if the initial decision to send him to the HDU was justifiable, his progress in the recovery room was such that, because of fluctuating oxygen saturation levels, the decision should have been changed following his period in the recovery room and he should have been sent not to the HDU but the ICU at that point.

2.4. It was clear on all of the evidence that Mr Lambropoulos' death would almost certainly not have occurred had he been admitted to the ICU rather than the HDU. As Professor Cade observed in his evidence, it is virtually impossible to die in an ICU of

[2] Transcript, page 808
[3] Transcript, page 808

something preventable and the level of monitoring is extremely high[4]. However, Professor Cade emphasised it is not the label that is important, it is the level of care[5]. Professor Cade said that most patients such as Mr Lambropoulos should be able to be looked after very safely and well in a properly equipped and properly staffed HDU[6], and that the problem in the HDU in this instance was not the fact of Mr Lambropoulos' referral there, but the care that he received in the HDU[7].

2.5. To my mind the issue in this case does not centre upon the correctness or otherwise of a decision to send Mr Lambropoulos to the HDU. Rather, the issue was the failure of proper care in the HDU.

3. A preventable death

3.1. The evidence shows that Mr Lambropoulos' death was preventable. As Professor Cade said in language that might be regarded as something of an understatement, there was 'blemished care' in the HDU[8] in that respiratory alarms from the oximetry monitoring equipment were not acted upon[9]. It is perfectly clear, and I find, that Mr Lambropoulos' death was the result of a lack of proper nursing care in the HDU at Ashford Hospital. Over a period of some 40 or 45 minutes there were 33 recorded alarms from Mr Lambropoulos' pulse oximetry monitoring equipment including three crisis alarms. Remarkably these alarms, or the majority of them, went unheeded. They indicated that for the bulk of his time in the HDU Mr Lambropoulos was not getting a sufficient amount of oxygen into his bloodstream. This was reflected in the oximetry equipment which was alarming frequently. It is clear on the evidence that during his time in the HDU there was a pattern in which Mr Lambropoulos would drop his oxygen levels, almost certainly as a result of his sleep apnoea combined with the effects of the morphine pain relief he had received in the recovery room. On the occasions that the respiratory alarms were responded to by the nursing staff, Mr Lambropoulos would be roused from his apnoeic state by the staff who would then see an improvement in his oxygen saturations and assume that there was no problem and that the alarm was not indicative of some chronic problem that required attention. The evidence in my opinion shows that the staff assumed that the oximetry equipment was not providing accurate

[4] Transcript, page 794
[5] Transcript, page 793
[6] Transcript, page 795
[7] Transcript, page 796
[8] Transcript, page 796
[9] Transcript, page 797

readings and that there was in fact no real problem with Mr Lambropoulos' oxygen saturations. This meant that proper action was not taken to deal with his situation. The level of care he received was insufficient. Had he been closely observed and diligently nursed, he would have survived. In effect, it was a matter of ensuring that he did not stop breathing while asleep. As Professor Cade said:

> 'There is nothing mysterious about sleep apnoea, it's been known in this sort of detail for very many years. I understand from Dr Teague's report that he has admitted other patients for sleep apnoea to the HDU. I'd imagine that the HDU would be able to look through their log book and tell you how many patients they've had with sleep apnoea per year, and it wouldn't be an uncommon condition for them to have had experience with. So it's not rare and it's not difficult.'[10]

3.2. I will describe the events in the HDU in greater detail later in this finding.

4. The consultations with Drs Teague and van Renen

4.1. Mr Lambropoulos saw Dr Teague on 11 September 2013. Mr Lambropoulos had a BMI of 43 (class three obesity range). Dr Teague discussed treatment options both surgical and non-surgical. Dr Teague was aware that Mr Lambropoulos used a CPAP machine and that he had sleep apnoea. Mr Lambropoulos elected for sleeve gastrectomy and Dr Teague explained the risks. A medical consent form was signed. Mr Lambropoulos told Dr Teague about a prior difficulty with breathing he had had following an endoscopy. Mr Lambropoulos told Dr Teague that he had stopped breathing[11]. Accordingly, Dr Teague quite properly referred Mr Lambropoulos to the anaesthetist Dr van Renen.

4.2. Dr van Renen saw Mr Lambropoulos on 14 November 2013. He noted a number of relevant factors which he set out in a letter to Dr Teague dated the same day[12]. Dr van Renen considered that Mr Lambropoulos was suitable for the proposed surgery. Dr Teague completed the admissions form and as was his standard practice, booked Mr Lambropoulos into the HDU.

4.3. Prior to his attendance at the Ashford Hospital Mrs Lambropoulos filled out a patient health questionnaire form on behalf of her husband. The form was not worded particularly helpfully in relation to issues with anaesthetics in previous operations. As

[10] Transcript, pages 797-798
[11] Transcript, page 34
[12] Exhibit C10

a consequence nothing was put on the form about Mr Lambropoulos' previous problems with anaesthetic during the course of the endoscopy in 2012. However Mrs Lambropoulos was told by her husband that this issue was discussed at the preoperative appointments with both Dr Teague and Dr van Renen[13].

4.4. The incident in 2012 had occurred at the Flinders Private Hospital. The doctors and Ashford staff did have access to the relevant notes from Flinders Private Hospital during Mr Lambropoulos' admission in 2013. The notes of the Flinders Private Hospital admission contained an anaesthetic record which disclosed that he had suffered a period of rapid desaturation which resulted in a MET call. The MET data collection form disclosed that at the time the MET call was made his oxygen saturations fell to 40%.

4.5. Neither Dr Teague nor Dr van Renen had read the Flinders Private Hospital notes and so were not aware of this matter. Although Dr van Renen knew that a problem had been experienced during the endoscopy, he was not aware that the oxygen saturations had fallen to 40% and a MET call was made. When giving evidence Dr van Renen conceded that he did not know about the drop in oxygen saturations to 40% and the fact of the MET call in the endoscopy procedure. He stated that Mr Lambropoulos certainly did not tell him that there had been a MET call[14]. Of course, Mr Lambropoulos may not have known that there was a MET call in 2012 because he was under sedation at the time and was the very subject of the MET call itself. He was hardly an objective observer and it is unrealistic for Dr van Renen to expect a patient to be able to describe previous surgical complications in that level of detail. However, Dr van Renen maintained that even if he had been fully informed in relation to the previous procedure it would not have resulted in him recommending that Mr Lambropoulos go to the ICU post operatively[15].

4.6. While these matters are worthy of note in describing the circumstances of this case, as I have said, having heard all of the evidence, it is my opinion that the question of whether Mr Lambropoulos should have been admitted to the ICU rather the HDU was not the real issue here.

4.7. Professor Cade was of the opinion that a properly staffed and functional HDU should have been able to deal with Mr Lambropoulos quite easily. True it is that he would

[13] Transcript, page 25
[14] Transcript, page 127
[15] Transcript, page 128

have almost certainly survived had he been admitted to the ICU, but a decision to admit to an ICU rather than a HDU should not be based upon a lack of competence, functionality or adequacy in the HDU. As Professor Cade said, a HDU ought readily to be able to deal with a patient such as Mr Lambropoulos.

4.8. Mr Lambropoulos' surgery commenced with the administration of anaesthetic at 1403 hours with surgery starting at 1422 hours. The surgery was completed at 1658 hours and he was discharged from theatre at 1717 hours[16]. During the surgery there was bleeding from a split liver and bleeding from the splenic hilum[17]. The operative anaesthetic record[18] is incomplete with no observations having been recorded by Dr van Renen after approximately 1515 hours. In particular, this means that there is no documentation of blood pressure, SpO2 and CO2 for the period of more than an hour and a half before discharge from theatre.

5. Recovery

5.1. The recovery record document shows that there were two episodes where Mr Lambropoulos' saturation levels fell below 90% at 1820 and 1835 hours. At about that time Nurse Morrow noted 'severe sleep apnoea' on the recovery record[19]. The recovery staff were in contact with Dr van Renen regarding Mr Lambropoulos' pain levels and he gave the order for the pain protocol to be administered[20]. It was decided to use Mr Lambropoulos' CPAP machine in the recovery room. This was unsuccessful because either the seal was not working correctly or it was not possible to maintain oxygen saturation without supplementary oxygen, and Mr Lambropoulos' CPAP machine did not permit the running of supplementary oxygen[21]. Dr van Renen was present and made the decision to abandon the CPAP machine and maintain supplementary oxygen only.

5.2. In any event Mr Lambropoulos' desaturations in recovery caused Dr Teague to discuss with Dr van Renen whether or not Mr Lambropoulos should go to ICU instead of HDU[22]. Nursing staff witnessed the discussion[23]. Dr Teague gave evidence that he

[16] See perioperative nursing care record Exhibit C9
[17] See Exhibit C9
[18] See Exhibit C9
[19] See Exhibit C9
[20] Transcript, page 210
[21] Transcript, page 229
[22] Transcript, page 56
[23] Transcript, pages 177 and 232

discussed the decision with Dr van Renen and following that discussion Dr Teague felt that Mr Lambropoulos was stable and would be adequately observed in the HDU on the basis that if he deteriorated they would have an opportunity to change that decision[24].

6. Dr Everest's opinion about ICU

6.1. In his statement Dr Everest expressed the following opinions:

1. 'It is my understanding that the patient when admitted to the HDU was not subject to constant electronic monitoring, that would have included monitoring of his heart rate, pulse and oxygen saturations. In my view this was unsatisfactory.' [25]
2. 'I am of the opinion that this patient should not have been considered low risk, in view of the problems obtaining adequate oxygen saturations in the recovery. I believe it was an oversight that he was not constantly electronically monitored in HDU.' [26]
3. 'There's a recovery note made on his charts at 1915hrs (25/11/2013) that it was difficult to maintain adequate saturation levels and respiratory rate, saturations fluctuating 80-95%. In my view that note was a pretty clear indicator that there was a problem in recovery.' [27]

6.2. In his oral evidence Dr Everest said that he would have directed Mr Lambropoulos to ICU:

> '… really, the fact is that if I'd been rung up saying I've got a patient who's post a sleeve gastrectomy, there's been some problem intraoperatively with some bleeding etc, it's a prolonged procedure, we've got difficulty with pain control, and he's desaturating, and we've failed on our CPAP, there would have been no question that I would have debited him to intensive care.' [28]

I agree with Counsel for the Lambropoulos family that it would seem that the word 'debited' might be a transcription error and it is more likely that Dr Everest said he would have directed Mr Lambropoulos to intensive care.

6.3. Dr Everest also said that he works on a principle of having 'a low threshold to admission' to ICU[29]. It is also the case that Dr Everest is himself an intensivist and is himself responsible for the Ashford ICU. As I have already said, Professor Cade was of a different view about this subject. He saw it more as a question of labelling and

[24] Transcript, page 61
[25] See Exhibit C30
[26] See Exhibit C30
[27] See Exhibit C30
[28] Transcript, page 879
[29] Transcript, page 879

was firmly of the view that given proper and appropriate care in a HDU Mr Lambropoulos could have been accommodated there. While I have been urged by the Lambropoulos family and the Ashford Hospital to prefer the evidence of Dr Everest to Professor Cade on this subject, I remain of the view that the problem in this case did not originate in the decision to send Mr Lambropoulos to HDU instead of ICU. He should have been safe in HDU.

7. The absence of ECG monitoring in HDU

7.1. The evidence disclosed that ECG monitoring was available in the HDU, but was not used as a matter of course for every patient. Rather it was only used for patients with cardiac issues. Following Mr Lambropoulos' death the Ashford Hospital introduced ECG monitoring for all patients in HDU under a revised policy.

7.2. Professor Cade explained that because the leads of an ECG machine are on the chest and they move with the chest during the act of breathing, the ECG monitors are able by means of what Professor Cade described as 'a very clever algorithm'[30] to monitor respiration as well as heart rate. Thus the use of an ECG machine in a patient such as Mr Lambropoulos would have a twofold use in that it would monitor respiratory rate and alarm if the respiratory rate were abnormal. Secondly, a patient with respiratory failure who is about to have a cardiac arrest will have ECG abnormalities in the data relating to their heart condition and the ECG will flag a pending arrest before it has occurred[31].

7.3. It was submitted that Drs Teague and van Renen should have ordered that Mr Lambropoulos have ECG monitoring in HDU bearing in mind his progress and saturation problems in the recovery room. However, the fact is that there was no ECG monitoring in the recovery room either. As Professor Cade pointed out, it would be odd to expect that a patient who had ECG monitoring in theatre would then be without ECG monitoring in the recovery room, but that there would be an expectation that it would be added back again in the HDU. Professor Cade described it as a 'strange gap'[32]. Thus he was reluctant to agree with the proposition that the surgeon or anaesthetist should 'have directed the use of the ECG monitoring in the HDU'[33]. Professor Cade said that he agreed it would have been highly desirable for

[30] Transcript, page 792
[31] Transcript, page 793
[32] Transcript, page 823
[33] Transcript, page 823

Mr Lambropoulos to have had ECG monitoring in the HDU, but he added that he had never seen postoperative orders or surgical orders specifically asking for ECG monitoring. Professor Cade said that a level of monitoring is 'part of the deal of the unit to which you send the patient'[34].

7.4. Furthermore, as Professor Cade said on this topic, the ECG monitoring would only be effective in the same way pulse oximetry monitoring would be effective, namely if the monitoring equipment is actually responded to appropriately. As he said, it appears that the oximetry monitoring equipment attached to Mr Lambropoulos was not responded to as it should have been, and the same may well have applied to ECG monitoring equipment if it had been used[35].

7.5. I agree with the submission of counsel for Dr Teague that the fact is that the oximetry monitoring did do the job that it was meant to do. It alarmed 33 times over the period of approximately 7:40pm to 8:20pm. As counsel said, there was no need for an ECG monitor during that period because the oximetry alarms were more than sufficient to have alerted the nursing staff to at least call for medical assistance in the early stage, or to make a MET call before or after 8pm. If the nurses had responded appropriately then it is almost certain that Mr Lambropoulos would have survived.

7.6. It is also noteworthy that Dr Everest emphasised the primacy of electronic monitoring over nursing observations:

> 'One of the requirements or one of the beliefs of HDU is that they're actually monitored and monitoring can take two forms: electronic monitoring plus also observation of the patients. Electronic monitoring is probably more accurate and isn't subject to the human vagaries of not taking notice of things. I would put a greater store on electronic monitoring than observing or clinical monitoring by a nurse who's probably got a number of other patients to look after as well.' [36]

8. <u>Pulse oximetry monitoring</u>

8.1. There was a considerable amount of evidence devoted to the nature of the pulse oximetry devices that were in use at Ashford Hospital HDU in November 2013. Mr Brett Randell gave evidence usefully explaining the operation of these devices. Mr Randell is a biomedical engineer who works at the Ashford Hospital and is

[34] Transcript, page 822
[35] Transcript, page 793
[36] Transcript, page 873

responsible for managing the pulse oximetry machines in the HDU[37]. Mr Randell was involved shortly after Mr Lambropoulos' death in assisting with printing information that had been electronically stored on the monitoring equipment. He also performed tests as to the functionality of the equipment at that time, and concluded that the equipment was in proper working order. Mr Randell said that the monitoring equipment when attached to a patient produces an electronic trace of a wave form which is recorded by the monitoring equipment. The wave form together with various other pieces of information is displayed on the monitor of the unit during operation. The machine also stores the wave form and other information for a period after a patient is 'discharged' from the machine. During that period it is possible to print a copy of the data displaying, amongst other things, the wave form as recorded by the machine over a period of time. The wave form is called a plethysmograph and is also referred to as the SpO2 wave form[38].

8.2. Mr Randell described the components of the machinery. He explained that there is a monitor which remains permanently fixed to the wall in the bay containing the patient's bed[39]. There is a second item which is a module which plugs in to the monitor but can be detached from it and which can move with the patient if the patient needs to move from the bay[40]. Thirdly, there is a central monitor consisting of two computer screens at the central nurses' station which mirrors the information from the individual patient monitor screens in each of the patient bays[41].

8.3. The evidence in this case showed that Mr Lambropoulos was in bay three of the HDU. Some of the printed information that was eventually admitted into evidence bears bay number references other than bay number three. Mr Randell said that this seeming anomaly was readily explicable by virtue of the fact that the machine, when subsequently used for downloading information to a printer, will reflect the bay number that it is in at the relevant time. Thus it was common ground that despite the existence of other bay numbers on some of the printed information, all of the data that was eventually produced and ascribed to Mr Lambropoulos was indeed an accurate

[37] Transcript, pages 354-355. In fact his employer is a company called Chemtronics which provides services to Ashford Hospital. Mr Randell is engaged at the Ashford Hospital site full time.
[38] Transcript, page 355
[39] Transcript, page 359
[40] Transcript, page 359
[41] Transcript, page 360

depiction of the recordings made by the monitoring equipment while he was in bay three of the HDU on the evening in question.

9. Ashford's attitude to the downloaded data

9.1. It is noteworthy that when Mr Paul Evans, the general manager of Ashford Hospital, made his statement[42] on 16 November 2015 before the explanations given by Mr Randell in relation to the bay numbers had been given in evidence, he regarded the reference to the different bed numbers in the documents that had been printed from the machine as being evidence of 'incompatible readings, anomalies and inconsistences between the print out and the observations documented by the nurses'. He went on to say 'the anomalies and inconsistences made no sense and as the document was of a questionable value and weight, it was not relied upon by the hospital in relation to any specific actions or review of the matter'[43]. Subsequently, Mr Evans when giving his evidence some months later was still not prepared to openly and willingly concede that the data was accurate and reliable[44]. Mr Evans rested on the position that it was almost inconceivable that the alarm could have sounded so many times and that his nurses had failed to respond[45]. Despite this, Mr Evans nevertheless conceded that 'the whole incident is unforgivable'[46].

9.2. Mr Evans was not prepared to unequivocally accept the accuracy of the data that was downloaded from the equipment that was operating in the hospital of which he was the general manager in November 2013. The evidence was that the same equipment has continued in operation to this day. Mr Evans did not explain how it was that he doubted or was reluctant to accept its accuracy in relation to Mr Lambropoulos' case, but was content to allow it to continue to be used for the care of patients in the HDU and other parts of the hospital subsequently, up to and including the very day he was giving evidence.

9.3. Furthermore, the fact is that there is an ongoing relationship between Mr Evans and Mr Randell in that Mr Randell continues to be the employee of Chemtronics who is responsible for the ongoing maintenance and proper functioning of the pulse oximetry

[42] See Exhibit C27
[43] See Exhibit C27
[44] Transcript, pages 703-707 & 730-732
[45] Transcript, page 731, I note that he could no longer rely on the supposed anomaly of the bay numbers on the printouts as that had been explained in the meantime by Mr Randell's oral evidence.
[46] Transcript, page 773

equipment in Ashford Hospital to this day. If Mr Evans were serious in his reservations about the accuracy of the data from the machines one would think that he would have acted on those reservations in some concrete way, rather than to merely express doubt as to their accuracy when it came to giving evidence in the Coroners Court. It was put to Mr Evans by counsel for the Lambropoulos family that he was keen to diminish the importance of the data[47]. Indeed, he gave evidence that he only learnt that Mr Randell had a clear and cogent explanation for the apparent disparity in the bed bay numbers shortly before he gave his evidence[48]. It is astounding that he had not made further enquiries with Mr Randell or Mr Randell's employer Chemtronics in order to clear the matter up one way or another in the two years between Mr Lambropoulos' death and the commencement of the Inquest. Even after the Inquest commenced in November 2015 he had three months in which to carry out that task before giving his own evidence in February 2016 and yet he did not do so. I accept and agree with the submissions of counsel for the Lambropoulos family that the Ashford Hospital was reluctant to accept or acknowledge through its principal witness Mr Evans that the staff had persistently failed to respond to repeated alarms including three crisis alarms. I find that the hospital refused to accept the necessary implications arising from the documentation, namely that their nurses had failed to respond either appropriately or at all to some 33 alarms sounding almost continuously over a period of some 40 minutes including three crisis alarms.

9.4. In considering Mr Evans' reluctance to accept the accuracy of the data I take into account that neither Professor Cade nor Dr Everest showed any reluctance in their willingness to accept the accuracy of the data. Both of them accepted the accuracy of the data. This carries special significance in the case of Dr Everest who is in charge of the Ashford Hospital ICU. He expressly mentioned in his evidence that he drew the significance of the data to the attention of counsel assisting[49]. That he would readily accept the data for the purposes of his evidence and opinions in this case is in itself reassuring.

9.5. I reject any suggestion by Ashford that the data should not be accepted as an accurate record of what occurred.

[47] Transcript, page 705
[48] Transcript, page 704
[49] Transcript, pages 874-875

10. The detailed operation of the pulse oximetry machines

10.1. I return to Mr Randell's evidence about the detailed operation of the pulse oximetry machinery and the proper interpretation of the data that was downloaded. I do not propose to rehearse the considerable evidence that was given by Mr Randell and Ms Fuller about the circumstances in which the data was downloaded. It is sufficient for me to say that I accept that all of the data is accurate and it all relates to Mr Lambropoulos. I specifically note a significant piece of that data, namely what was referred to in the Inquest as the screenshot or photograph of the monitor screen showing the event review. In particular I accept Ms Fullers' evidence and I find that she took a photograph on her mobile phone of the event review screen on 26 November 2013[50]. This was well within the 48 hour timeframe nominated by Mr Randell[51] during which the data could be retrieved and depicted on the screen as recorded in that photograph.

10.2. Mr Randell explained that the machine operates by use of a finger clip which attaches to a patient's finger and it has a cable that runs to the module. It is used to measure the SpO2 as well as the pulse rate. There is also a blood pressure cuff. Mr Randell said the data is displayed at the bedside monitor and at the central monitor and there is also a small display on the module that travels with the patient. Mr Randell said the data is kept for 48 hours after a patient is discharged from the module[52]. He said that after 48 hours an hour is lost for every piece of data older than 48 hours[53]. It therefore follows that even after 48 hours some of the later data in relation to the patient would continue to be kept in the machine with the last of it being deleted 48 hours from the patient's final discharge from the machine.

10.3. Mr Randell gave evidence as to the service history of the machines and I am satisfied that the machines were working correctly at the relevant time[54]. Mr Randell also explained that the time stamps on the data were likely to be out by some minutes compared to objective time[55]. I attach below the summary of SpO2 alarms that was referred to during Mr Randell's evidence and which is intended to summarise this aspect of his statement[56].

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[50] Transcript, page 659
[51] Transcript, pages 364-365
[52] Transcript, page 364
[53] Transcript, page 365
[54] Transcript, page 371
[55] Transcript, page 375
[56] Exhibit C20d

M8002A monitor/X2 MMS
Summary of SpO2 Alarms

Condition	Default setting	SOUND				VISUAL			
		Monitor	Central Monitor	Silence ?	Resume	Monitor	Central Monitor	Clear	Resume
High SpO2	100%	Tone 1	Tone 1	Yes	2 mins	Yellow Bar	Yellow Bar, PW	M-No	AR
Low SpO2	90%	Tone 1	Tone 1	Yes	2 mins	Yellow Bar	Yellow Bar, PW	M-No	AR
DESAT	80%	Tone 2	Tone 2	Yes	30 secs	Red Bar	Red Bar, PW	M-No	AR
INOP		Tone 3	Tone 3	Yes		Blue Bar, M/Q	Blue Bar, PW, M/Q	M-No	AR

PW – Patient window on central monitor changes colour
M/Q – Message/question mark
M-No – Visual alarm cannot be manually cleared
AR – Visual alarm clears if patient condition returns to normal

10.4. The important things to note from the table and the operation of the machine are that the machine has particular alarms to record particular events in relation to the patient's oxygen saturation level. As the table shows there is a high SpO2 alarm which was not relevant at all in this case, but is mentioned for completeness. The low SpO2 alarm operates at oxygen concentrations between 80% and 90% and has its own distinct tone. The evidence was that at the bedside monitor a button on the screen can be pressed which will silence the alarm. Typically a staff member would silence it when attending to the patient after responding to the alarm. If the saturation level remains between 80% and 90% for two minutes following the silencing of the alarm, the audible alarm will reactivate. However there will be a yellow bar displayed on the monitor and on the central monitor indicating the low oxygen saturation status. That will not be cleared even if the audible alarm is silenced but will remain until the SpO2 saturation exceeds 90%.

10.5. The next level of alarm is the desaturation alarm or crisis alarm which is activated when the oxygen concentration falls below 80%. That alarm has a more urgent, louder tone and can also be silenced by the pressing of a button on the screen at the bedside. However if the desaturation state continues for more than 30 seconds the alarm will reactivate. Furthermore, the bedside module and the central monitor will display a red bar indicating that the desaturation is below 80%. Like the yellow bar for the low SpO2 level, the red bar will not be extinguished by the silencing of the audible alarm but will continue to appear until the SpO2 exceeds 80%.

10.6. Finally, there is an inoperative alarm which has a quieter less insistent tone than either of the other two. The inoperative alarm can also be silenced and once silenced it remains silent. However the monitor will display a blue bar during the inoperative period and there will be a question mark showing as well.

10.7. Mr Randell explained that once either of the low saturation or desaturation alarms sounds, the alarm will continue until manually silenced or the reading goes back into the normal range. In the case of the low saturation alarm, if that alarm is silenced it will resume after a period of two minutes if the reading has not returned into the normal range. In the case of the crisis alarm, if it is silenced the alarm will resume after 30 seconds unless in the meantime the saturation has returned to the normal range[57]. The low saturation alarm beeps every two seconds and the desaturation alarm is louder and beeps every half a second[58]. In the case of the low saturation alarm there is a yellow bar in the central and patient monitor[59] and in the case of the crisis alarm there is a red bar in both screens[60].

11. The Data from the pulse oximetry monitor

11.1. The data from the pulse oximeter is depicted in the screenshot or colour photograph of the events review screen[61]. There is other data comprising various reports printed from the monitor by Mr Randell and Ms Fuller[62]. There is also data contained in a report from a program operated within Ashford Hospital known as RiskMan[63]. This data is, as I have already found, accurate and reliable and it does relate to Mr Lambropoulos. The data printed out by Ms Fuller and Mr Randell can also conveniently be found in the appendices to Ms Fuller's statement[64].

11.2. I will not attempt to describe the data in great detail. However the data consists of what are described as trend reviews, alarms reviews and wave reviews. It covers the period during which Mr Lambropoulos was in the HDU, although some of the reports do not cover the whole of that period. I find there is nothing sinister in this. It is a result of the fact that the two people who attempted to capture the data (Randell & Fuller) were not entirely successful in their efforts at the time.

11.3. The wave reviews depict the plethysmograph SpO2 wave form. The evidence of all witnesses was that the plethysmograph wave form showed a reliable wave form indicating a reliable reading was being shown by the pulse oximetry equipment during almost the entire period covered by the data. As I will explain in more detail below,

[57] Transcript, page 378
[58] Transcript, page 380
[59] Transcript, page 380
[60] Transcript, page 381
[61] See Appendix F2 Exhibit C20
[62] See Appendix E2 Exhibit C20
[63] See Appendix A2 Exhibit C25
[64] See Exhibit C26 and the appendices thereto

the existence of a reliable wave form is a form of quality assurance that the SpO2 readings given by the machine are an accurate depiction of the SpO2 levels actually being experienced by the patient. There were one or two brief periods during which the wave form was briefly interrupted, and then there was a lengthy period during which the wave form flat lined from approximately 8:22pm and that will be the subject of further discussion hereafter. Leaving that aside, the wave forms prior to that were only briefly interrupted and it can safely be said that there were only very brief periods during which the data may not have accurately depicted Mr Lambropoulos' true oxygen saturation status. In short, the SpO2 results that are displayed in the data and the numerous alarms that are reported by the data (33 alarms in the relevant period including 3 crisis alarms) are, I find, reliable and reflect what actually transpired with Mr Lambropoulos.

12. Evidence about false readings from the pulse oximetry probe

12.1. There was evidence from, predominantly, the nursing staff and Mr Evans (whose background is in nursing), to the effect that the pulse oximetry equipment can give false readings if the probe is not properly connected or attached to the patient's finger. The evidence that was given by these witnesses was that the equipment can give a lower reading than the actual saturation being experienced by the patient. This evidence tended to cast doubt on whether the numerous alarms being triggered in respect of Mr Lambropoulos were in fact false readings, or at least some significant number of them were false readings.

12.2. The evidence in relation to this topic was as follows. Firstly the Ashford Hospital Pulse Oximetry Policy which is a policy applicable to all ACHA hospitals[65]. That policy explains that pulse oximetry provides non-invasive monitoring of oxygen saturation of haemoglobin in arterial blood. It states as follows:

> 'Clinical assessment must always be used in conjunction with the reading produced by the pulse oximetry. Artefact/wrong readings may result if:
>
> - Patients hands are cold;
> - Light in the room is extremely bright;
> - Probe has not been applied correctly;
> - Probe is faulty or dirty;
> - Wrong sized probe has been used dependent on the person's age (eg a child cannot use the same sized probe as an adult);

[65] See Exhibit C7z

- The patient is restless, constant movement of limb;
- Patient with a low haemoglobin level;
- Probe is applied over nail polish, false nails, damaged or thickened nails;
- Presence of chronic disease.'

12.3. I have referred to Sue Fuller previously. She is the assistant director of nursing at Ashford Hospital. She made the following comment in her statement:

> 'I have had experience of situations where the saturation probe has come loose and resulted in low saturation levels. In my mind, that was a possibility here – although I can now see that the same documents suggest a relatively normal pulse during the relevant time.' [66]

12.4. When Ms Fuller refers in that comment to the same documents, she is referring to the printouts which are contained in the appendices to her statement and which I have discussed above. When she refers to a 'relatively normal pulse' being suggested by the documents she is in fact referring to the plethysmograph SpO2 wave form material I have already referred to. She is correctly recognising that the wave forms do not give any reason to suggest that the data about oxygen saturation levels is in any way incorrect. Nevertheless, I include this evidence as part of the body of material referring to the supposed unreliability of pulse oximetry equipment.

12.5. The anaesthetist Dr van Renen gave evidence that 'erroneous readings are fairly common in people who move'[67], however Dr van Renen was not closely questioned on this subject and in particular was not provided with an opportunity to comment on the reliability of the saturation readings in the presence of a good SpO2 wave form or plethysmograph. His evidence therefore has to be read in that context.

12.6. Ms Paprota was the team leader on duty in the HDU on the night of Mr Lambropoulos' admission. She was not his primary nurse, but she was involved in the events of the night and, as I say, she was the team leader.

12.7. Her evidence on this subject was as follows:

> 'Sometimes if the probe moves off the patients finger slightly but not completely off, it can give an inaccurate reading of what the patient's oxygen level is.'
>
> 'When you do a critical care course, it is one of the things you are taught to look for with oxygen saturation. That it is not always an accurate measurement of someone's oxygen saturation.'

[66] See Exhibit C26 page 3
[67] Transcript, page 161 (see also Transcript, page 137)

> 'I've learnt it through looking after patients and the probe moves off their finger, you reposition it and their saturation levels come up to where they should be.'
>
> 'So they might be giving a false reading, 70% odd, you know, it wouldn't say zero it would be a percentage.'
>
> 'It happens very frequently.'
>
> 'A couple of times a week.'[68]

12.8. There was no evidence adduced from Ms Paprota about the reliability of the SpO2 readings in the presence of a reliable SpO2 wave form or plethysmograph.

12.9. Ms Grant was the clinical manager of the HDU and a registered nurse. She was not involved in the events of the night. She was involved in entering data in the RiskMan computer system however. She was questioned about the reliability of pulse oximetry however. Her evidence on this topic was as follows;

> 'I've been working as a nurse for 20 years and I've spent 10 years working in intensive care and saturation probes quite often give the wrong reading…'[69]
>
> 'They can be very unreliable'[70].

12.10. When asked how she would know if reading was wrong:

> 'Because of the wave form on the monitor. So if it's a really good reading it will have a very peaked wave form and you'll know whether or not the probe is actually having a problem picking up or not and that's something that you're taught as a nurse'[71].

12.11. When it was put to her that Mr Randell the biomedical engineer had given evidence that the pulse oximetry machinery would give a true or no reading she responded:

> 'That's not true'.
>
> 'I completely disagree with that'[72].

12.12. Mr Randell the biomedical engineer gave evidence that the reading from the pulse oximetry equipment is either accurate or there is no reading[73]. He said:

> 'I would expect if there's making a calculation because there is a signal there, then it would be a wave form. If the wave form looks noisy, I mean there could be that chance then'[74].

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[68] Transcript, page 469
[69] Transcript, page 621
[70] Transcript, page 623
[71] Transcript, page 623
[72] Transcript, page 624
[73] Transcript, page 419
[74] Transcript, page 427

12.13. Later he said that it was either an accurate reading or nothing[75].

12.14. The import of Mr Randell's evidence was that if there was a true wave form on the plethysmograph the reading would be reliable and that the device will not show a false low reading in the presence of a reliable wave form.

12.15. It is important to note that the monitor displays the wave form at the same time as it displays the concentration of oxygen. Thus, the reader of the monitor can tell at once if the reading is being given in the presence of a reliable wave form. This is the context in which the data from the machine should be interpreted by the user. For example, Dr Everest stated:

> 'If you've got a good pleth form, or a good waveform, and you've got a poor number, you have probably got - you will have an accurate saturation'[76].

12.16. He also agreed to the proposition put to him as to the reasonable expectation one would have of a HDU nurse as follows: the nurse hears an alarm indicating the saturations are below 80%. The nurse goes to the patient and sees that the monitor shows a number such as 68%. They re-adjust the probe and then immediately the saturations return above 90% and the nurse then says words to the effect 'problem fixed' and leaves the patient. Dr Everest accepted that would not be sufficient. He would expect the nurse also to consider the pleth wave form and to reassure themselves that what they were seeing was, because of the nature of the pleth wave, not a false or aberrant reading due to the probe not being properly applied to the patient. On the other hand if they had seen that there was a proper pleth wave form then they would recognise that the reading was correct and analyse the situation further.

12.17. Dr Everest said that that was his expectation of a HDU nurse[77].

12.18. Dr Everest also said that this would be his expectation of any nurse appointed to the task of working in an HDU to operate at that standard and reach a proper conclusion about whether what they had seen was a true reading or not a true reading by reference to the nature of the wave form shown on the plethysmograph[78]. Dr Everest's evidence about whether an inaccurate SpO2 reading might be given if the probe was partly dislodged was that he thought that the monitor might show an inaccurate reading, but

[75] Transcript, page 452
[76] Transcript, page 884
[77] Transcript, page 884
[78] Transcript, page 885

that it would be unlikely be out by more than 1% or 2%[79]. He also said that if the probe is not attached the numbers might be apparently random in some ways and rapidly changing[80]. He added:

> 'Whereas a patient who has a good probe which - with a tracing which you can see quite easily on the monitoring and the data that has been shown shows that in fact the majority of times the tracing - that is the pulse characteristics - had demonstrated a good contact and therefore the value that you would actually get would be correct.' [81]

12.19. Professor Cade was also asked about this topic. His evidence on this topic was that where a probe is partially off, the plethysmograph signal will be abnormal or unsatisfactory. He said it should be perfectly obvious from just looking at the trace that it is an unreliable or an invalid reading. He said that any SpO2 read under those circumstances cannot be relied upon and the probe needs to be repositioned[82]. Professor Cade subsequently wrote to counsel assisting by letter dated 2 March 2016. All interested parties consented to me receiving his letter as evidence. He said that he had done relevant experiments at the bedside with a comparable Philips system to that used in Mr Lambropoulos' case. He wrote as follows;

> 'If the SpO2 probe becomes partially dislodged, does it give an erroneous reading?
>
> The answer is no. The reading is 'all or nothing'.
>
> The probe tries to read even under somewhat adverse circumstances, and the pulsatile pleth trace reflects the success or failure of this attempt. The resultant reading is then either valid (ie the same reading as for a properly positioned probe) or absent altogether (ie ? is displayed).
>
> The nurses who claimed that a partially dislodged probe could give a reduced SpO2 value are incorrect'[83].

12.20. Professor Cade in his oral evidence noted that the documentary evidence in Ms Fuller's appendices indicated that the pleth wave form was excellent apart from a few seconds in places[84] and that they looked very good to him apart from the odd second or two[85]. He added that by far the majority of the quality looked pretty good to him up until it stopped altogether shortly after 2020:35[86]. I have already referred to the post 2020

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[79] Transcript, page 882
[80] Transcript, page 883
[81] Transcript, page 883 – Note Dr Everest commented that 'the majority of times' Mr Lambropoulos' tracing demonstrated good contact and therefore a correct value
[82] Transcript, page 839
[83] Letter from Professor Cade to counsel assisting 2 March 2016 which I attach to this finding
[84] Transcript, page 802
[85] Transcript, page 802
[86] Transcript, page 804

hours pleth trace which will be dealt with hereafter. His evidence was consistent with that of Dr Everest.

12.21. Professor Cade also gave evidence consistent with that of Dr Everest about his expectations of nursing staff in the context of saturation readings:

> 'In the setting of a partially on, partially off probe, the pleth signal will be abnormal - the pleth signal will be unsatisfactory and in other words, the quality control and it should be perfectly obvious from just looking at the trace that it's an unreliable or invalid reading. Any Sp02 read under those circumstances cannot be relied upon and that the probe needs positioning, re-positioning.' [87]

12.22. He was asked if a properly trained nurse would look at the pleth form when they go to the monitor and his response was affirmative and he noted that the oxygen concentration and the wave form can be seen simultaneously on the monitor[88].

12.23. In summary, from all of that evidence I conclude that the readings that were shown by the pulse oximetry machinery on the night as depicted in the various appendices to Ms Fuller's statement were accurate and true readings having regard to the good quality of the plethysmograph signal for the majority of the time that Mr Lambropoulos was in the HDU. I therefore reject the suggestions that the data as depicted was in any way unreliable or inaccurate. This is implicit in the evidence of Dr Everest when he discussed the high concentration of carbon dioxide in Mr Lambropoulos' arterial gas reports following his cardiac arrest.

> 'I would - I would have thought that <u>this man would have had a considerable period of time</u>, probably more than five minutes but - but you've also got to look at that <u>he's probably had periods of hypoxia leading into this</u> and episodes of high CO2s as well and remembering that in fact in the lungs your - there's a balance - you can only have so much oxygen - you can only have so much gas in the lungs and if you have got more CO2 in the lungs you have got less room for oxygen. And so <u>the likelihood is that he has been chronically hypoxic</u> and has probably been running carbon dioxide levels significantly higher and therefore there is less oxygen available…' [89] (the underlining is mine)

12.24. The portions of that passage that I have underlined demonstrate that Dr Everest was confident in the data and that it showed a lengthy period of chronic hypoxia or low oxygen saturations. That is consistent with Dr Everest's acceptance of the accuracy of the printouts contained in the appendices to Ms Fuller's statement.

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[87] Transcript, page 839
[88] Transcript, page 839
[89] Transcript, page 891

12.25. I entirely agree with counsel assisting's submission about the absence of wave form data in the printed material in the appendices to Ms Fuller's statement that do not contain SpO2 waves between 7:30pm and 7:54pm. The fact is that the wave review documents thereafter are for the vast bulk of the time, reflective of a proper signal until 8:22pm. There is no reason to think that the monitor was not giving an accurate reading between 7:30pm and 7:54pm.

13. The evidence of the HDU nurses

13.1. The only narrative record in the progress notes dealing with Mr Lambropoulos' stay in the HDU was a record timed at 20:00 hours by Nurse Lan Ge:

> 'Nursing note: patient returned to ward 1930 with lap sleeve. Past history of knee surgery, sleep apnoea (on CPAP at home). No known allergies. Patient is alert and orientated. OBS stable, afebrile SAO2 95% on 8 litres of oxygen via mask. Very drowsy but rouseable. IVT continue via jelco. Fasting for GGS tomorrow, ice chips for comfort. Commence clexane tomorrow. Nil other issues at time of record'[90].

13.2. I have already referred to Ms Paprota. She was the team leader on the night. Her evidence is that she was present in the HDU when Mr Lambropoulos arrived but she did not participate in the handover and went on her 30 minute break at about that time[91]. Ms Paprota gave evidence that she had, prior to Mr Lambropoulos arriving in the HDU, spoken with a nurse from the recovery room and she was aware that Mr Lambropoulos had had desaturation episodes in recovery, that he had concerningly low respiration rates in recovery, that he had sleep apnoea and that he used a CPAP machine[92]. Ms Paprota said that after that call she remembered thinking that there was a good chance Mr Lambropoulos would not end up going to the HDU[93].

13.3. Ms Paprota said that while she was in the tea room on her break Ms Ge came into the tea room and they spoke about Mr Lambropoulos. Both Ms Paprota and Ms Ge said that this conversation occurred at approximately 7:45pm. Ms Ge gave evidence that at 1940 hours she heard Mr Lambropoulos' alarm sound and noticed that his SpO2 reading was 83%[94]. It follows that her conversation with Ms Paprota at 1945 hours occurred after this incident. Ms Ge could not recall if she told Ms Paprota about this

[90] See Exhibit C9 page 44
[91] See Exhibit C21 paragraph 11
[92] Transcript, pages 522-523
[93] Transcript, page 523
[94] See Exhibit C22 paragraph 25

desaturation episode in the tea room[95]. Ms Paprota's evidence is that Ms Ge did not tell her about it[96]. I accept Ms Paprota's evidence on this topic. So when Ms Paprota returned to the HDU after her break she was not aware that there had been a desaturation episode at 1940 hours.

13.4. After Ms Paprota's break she went to the Marleston Ward[97] and may have been there for as long as 15 minutes. On her return to the HDU she then attended to her own patients and the effect of her evidence is that she probably returned to the ward shortly before hearing a crisis alarm for Mr Lambropoulos.

13.5. The screenshot to which I have previously referred shows crisis alarms occurring at approximately 2008 hours, 2015 hours and 2018 hours. It was the last of these alarms that Ms Paprota heard and gave an account of. Ms Paprota's evidence was that when that third crisis alarm sounded she noted the SpO2 reading to be 68%. It is not entirely clear whether she noted the reading while she was in the nurses' station or when she attended at Mr Lambropoulos' bedside. Ms Paprota said that she first repositioned the probe to make sure that Mr Lambropoulos was getting an accurate reading and then she roused Mr Lambropoulos and he responded and then she noted that the oxygen levels went up to 90%[98]. Ms Paprota did not say that she checked the wave form to determine whether the 68% reading was a true reading or not. It is plain from her evidence that she assumed that the probe was not correctly positioned and was giving a false reading because Mr Lambropoulos' SpO2 level came back up to, she said 90% straight away.

13.6. Having regard to the documentary evidence, I find that at the time of the attendance by Ms Paprota, Mr Lambropoulos had probably stopped breathing because of sleep apnoea. This caused his oxygen saturation to drop to a genuine 68%. When he was roused by the attendance of Ms Paprota at his bedside I find that his oxygen levels returned to a higher level. Presumably this was because when she roused him, he started breathing again with good effect on his SpO2 levels. Whether it went as high as 90% as claimed by Ms Paprota or not cannot now be known. Certainly there is some support to be found for this in the trend review entry at 2019 hours which records a SpO2 average 85% for that minute. It is therefore conceivable that she did see a 90% reading. Her evidence was that she was only very briefly at Mr Lambropoulos' bedside;

[95] Transcript, page 600
[96] Transcript, page 528
[97] Transcript, page 494
[98] Transcript, page 488

probably for 30 seconds[99]. I find that indeed her visit to the bedside was very brief. It certainly was not long enough properly to assess Mr Lambropoulos' condition, nor to verify that the reading had indeed, as she assumed incorrectly, been a false reading. Had she carefully looked at the monitor and the trace, something that she should have done almost automatically as Professor Cade suggested, she would have realised that the reading was indeed a true reading.

13.7. Ms Paprota's next recollection of dealing with Mr Lambropoulos was when she heard Ms Ge yelling out to her. She had not heard another alarm having sounded at that time. She said that Ms Ge called a code blue. This event occurred I find at 8:38pm which was the time at which the code blue was called[100].

13.8. Ms Ge was Mr Lambropoulos' primary nurse. Her account as given in her witness statement[101] was that Mr Lambropoulos' alarm had sounded twice. The first time according to her was at 1940 hours when there was a low SpO2 alarm of 83%. The second occasion was when there was a crisis alarm and she attended together with Ms Paprota. She gave the time as approximately 2015 hours but it is clear to me that it was the last of the crisis alarms at 2018 hours.

13.9. The effect of her evidence in relation to the alarm at 1940 hours is that she attended Mr Lambropoulos, woke him up, increased his oxygen rate from 6 litres to 8 litres and that his saturation quickly increased from 83% to 95% which was satisfactory[102].

13.10. I believe that this desaturation was caused by an episode of apnoea that occurred shortly before 1940 hours. When she gave oral evidence at the Inquest she admitted[103] that she heard Mr Lambropoulos' low saturation alarm go off occasionally between that 1940 hours alarm and 2000 hours[104]. During most of that period Mr Lambropoulos' wife was at his bedside. I will deal with her evidence shortly. However, Mrs Lambropoulos left at approximately 7:55pm. Ms Ge's evidence is that she cannot say how many times during the period between 1940 hours and 2000 hours the low saturation alarm went off but she agreed that she did go check on Mr Lambropoulos during that time in

[99] Transcript, page 511
[100] See Exhibit C21 paragraphs 15-16
[101] See Exhibit C22
[102] See Exhibit C22 paragraphs 25-26 and Transcript, pages 554, 578 and 595
[103] Transcript, pages 556-557
[104] This evidence lends further support to my conclusion as to the reliability of the data before 7:45pm despite the absence of pleth data during that period

response to low saturation alarms[105]. She said that she was observing Mr Lambropoulos and that he was alright because his wife was with him[106]. There were occasions when she did not respond to the alarm[107]. Ms Ge did not know what the SpO2 readings were on the occasions when she did not attend[108] and she could not recall the readings on the occasions when she did attend[109], but that it was between 80% and 90%[110]. This evidence is consistent with the screenshot or photograph of the event review screen which indicates that the low SpO2 alarm was repeatedly sounded between 1940 hours and 2000 hours. Counsel assisting very properly pointed out that the screenshot of the event review screen shows yellow for both high and low oxygen saturations. In other words, in the event that the oxygen saturation reached as high as 100% an alarm would sound just as if the saturation fell below 90% but above 80%. In the circumstances of this case, and particularly having regard to the chronic hypoxia referred to by Dr Everest, I have no hesitation in concluding that there was no occasion when Mr Lambropoulos' bed alarm was triggered by a high oxygen event. I conclude on all of the evidence that all of these alarms were in fact low SpO2 alarms, that is, alarms between 80% and 89%.

13.11. Mrs Lambropoulos' evidence was that she could not recall alarms sounding while she was present in the HDU. In fact she could not recall one way or the other whether alarms sounded. Her evidence was that she had difficulty in recalling the events in question. However she was clear in her evidence that her husband was demonstrating seriously abnormal breathing. She described it as being like he was breathing without his home CPAP machine but worse[111]. Mrs Lambropoulos did recall Ms Ge attending upon her husband and rousing him.

13.12. The photograph of the event review screen shows that there were a series of alarms after 2000 hours up until approximately 2022 hours. In her evidence Ms Ge did not admit that she heard further low saturation alarms and she did not admit to hearing the two crisis alarms before the alarm to which she responded with Ms Paprota. She did admit in her evidence that her memory was not 100% accurate but that it was a possibility that such alarms had occurred. In short, I do not consider that Ms Ge's

[105] Transcript, page 579
[106] Transcript, pages 556-557
[107] Transcript, pages 600-601
[108] Transcript, page 602
[109] Transcript, page 602
[110] Transcript, page 602
[111] See Exhibit C11 page 5

account can be regarded as reliable and insofar as it differed from the documentary evidence contained in the appendices to Ms Fuller's statement, I prefer the latter.

13.13. There was some inconsistency in the evidence about who actually responded to the final alarm. Ms Paprota's account was that she attended, Ms Ge attended, and that another nurse, Ms Andary, also attended. However, in her earlier accounts she did not mention Ms Andary. Ms Ge gave two different accounts in her oral evidence. Firstly, that she did not attend at the bedside while Ms Paprota was there[112]. Later in cross- examination her evidence appeared to be that she did in fact attend the bedside when Ms Paprota was there[113]. I accept Ms Ge was somewhat confused and I do find that both Ms Ge and Ms Paprota attended the bedside. On the balance of probabilities I do not believe that Ms Andary attended. Certainly it was the latter's evidence that she did not attend. In any event that is not of particular significance.

13.14. On the occasion of the crisis alarm that Ms Paprota and Ms Ge both attended, it was Ms Ge's evidence that she could not recall whether she told Ms Paprota about the other earlier alarm[114]. On the other hand, Ms Paprota's evidence was that at no stage did Ms Ge tell her about the prior desaturation episode at 1940 hours[115]. I prefer the evidence of Ms Paprota in this regard. Ms Paprota agreed that had she known about the earlier episode of desaturation she may have acted differently at approximately 2018 hours when she heard the final crisis alarm[116].

14. Period between 2022 hours and 2038 hours

14.1. The documentary evidence shows that from approximately 2022 hours Mr Lambropoulos' oximetry was not recording any wave form, nor any concentration of oxygen. The evidence of Mr Randell taken with that of Professor Cade and Dr Everest shows that during this period the monitor would have been displaying a question mark and emitting the inoperative alarm. It would appear that Mr Lambropoulos' circulation had dropped to the point where it was unrecordable after 2022 hours. At some point between 2022 hours and when he was attended to at 2038 hours when Ms Ge eventually noticed that his monitor was not showing any saturation,

[112] Transcript, pages 559-560
[113] Transcript, pages 572-574
[114] Transcript, pages 603-604
[115] Transcript, page 535
[116] Transcript, page 535

he suffered a cardiac arrest. The precise timing of that cardiac arrest cannot now be established.

14.2. In any event after Ms Paprota and Ms Ge attended the crisis alarm at approximately 2018 hours, no further attention was paid to Mr Lambropoulos by any of the nurses until 2038 hours when the code blue was called. Following the attendance at 2018 hours by Ms Paprota and Ms Ge, the screenshot shows that for approximately two minutes between then and 2022 hours the low saturation alarm sounded. On the evidence of Mr Randell the inoperative alarm would have sounded after 2022 hours.

14.3. Ms Ge's recollection was that shortly before the code blue was called she looked at the monitor in Mr Lambropoulos' room and saw there was a question mark, but she claimed that she could hear no alarm. She walked over to Mr Lambropoulos because she thought the oxygen saturation probe had come off. She saw that he was not responsive and was not taking any breaths. She shook him but his chest was not moving. She called the code blue. Ms Andary's account of the event is supportive of that version[117]. Ms Andary said that she recalled sitting in the nurses station with Ms Ge completing their paperwork when she observed that Ms Ge noticed that Mr Lambropoulos' saturation level on the monitor had 'flat lined'. Ms Andary said Ms Ge jumped up immediately to check the patient and immediately called out for help. Ms Andary jumped up from the desk and looked at Mr Lambropoulos and 'knew straight away he was gone'[118].

15. A continuum of one crisis alarm rather than three?

15.1. In its written submissions[119] Ashford Hospital said that it 'still holds concerns as to the reliability and accuracy of the data, particularly the interpretation of the data which suggests that alarms were ringing almost continuously between 1945 and 2020 and depicted in the photograph of the event review screenshot'. A submission was made that in his evidence Mr Randell had conceded that the three crisis alarms depicted in the screenshot to which I have already made reference and in respect of which Ms Paprota and Ms Ge could only recall one crisis alarm 'that these three alarms could have been a continuum of one alarm'[120]. The difficulty with this submission is that the crisis alarms occurred at approximately 2008 hours, 2015 hours and 2018 hours.

[117] See Exhibit C29
[118] See Exhibit C29
[119] Ashford Hospitals Written Submissions 7 March 2016 paragraphs 30-33
[120] Ashford Hospitals Written Submissions 7 March 2016 paragraph 30

Mr Randell's clear evidence was that if a crisis alarm was silenced but the patient's saturations remained below 80%, the alarm would reactivate after 30 seconds. In giving his answers to the proposition put to him by counsel for Ashford that there may have been one continuous alarm, Mr Randell pointed out that this theory would be dependent on whether the crisis alarm was silenced[121]. It is almost inconceivable that the crisis alarm, loud and insistent as it was, would not have been silenced if the staff were indeed at Mr Lambropoulos' bedside at that time. As I have said the alarm reactivates after 30 seconds even if silenced[122]. Furthermore, as Ms Paprota said it was her belief that all of the nurses silenced alarms when attending to them[123]. I therefore reject the suggestion that there was only one continuing alarm. The only way that could have happened would be that the alarm would reactivate and be silenced every 30 seconds. If that had happened it is inconceivable that neither Ms Ge nor Ms Paprota would mention it and highlight it. Neither of them did that at any stage.

15.2. It is unfortunate that even after the completion of all of the evidence Ashford Hospital in its submissions would deny or even question the accuracy of the data produced from its own equipment by its own staff and a contractor who for all intents and purposes is effectively a staff member stationed at Ashford fulltime. Certainly no move had been made by Ashford at any time between Mr Lambropoulos' death and the hearing of the inquest to dispense with the services of Mr Randell. At the time of giving his evidence he continued to be employed by Chemtronics at Ashford Hospital. Furthermore, it was plain from Mr Randell's evidence that the very equipment used by Ashford for Mr Lambropoulos was still in service well after Mr Lambropoulos' death if not at the time of the hearing of the Inquest. It is not consistent for Ashford to doubt the accuracy of data downloaded from the machine when Ashford continued to rely on that machine to report on the vital signs of patients in the HDU after Mr Lambropoulos' death. In short, Ashford is inconsistent in purporting to doubt the reliability of the data produced from the very machine that it continued to reply on for the purposes of patient safety in the HDU after Mr Lambropoulos' death.

16. <u>The evidence of Professor Cade</u>

16.1. Professor Cade provided expert evidence for the Court in this matter and I have no hesitation in accepting his evidence and his conclusions. I have already made some

[121] Transcript, page 416
[122] Transcript, page 380
[123] Transcript, page 518

references to the evidence that he gave and I will not repeat what I have said already. Professor Cade was only mildly critical of the failure to use the ECG equipment in the HDU. As he pointed out the purpose of a second form of alarm when the primary form of alarm was not being observed would seem to be fruitless[124].

16.2. As to the question of whether Mr Lambropoulos should have been sent to the ICU, as I have said it was Professor Cade's opinion that he would have been extremely likely to have survived in the ICU. But on the other hand the HDU should have been able to produce the same result[125]. In short, it was his opinion that patients such as Mr Lambropoulos should be able to be looked after very safely in a properly equipped and properly staffed HDU[126]. It was Professor Cade's opinion that the problem in the HDU was not the fact of Mr Lambropoulos' referral there, but the care that he received there[127]. Professor Cade thought that the documentary evidence of the low oxygen alarm sounding 30 times and the crisis alarm three times was a reflection of blemished care. He said that as a consequence Mr Lambropoulos suffered a hypoxic episode which led to his cardiac arrest[128]. Professor Cade agreed that there was a pattern of desaturation followed by a return to acceptable levels of saturation between 1940 hours and 2020 hours. He said that the pattern was consistent with Mr Lambropoulos having episodes of apnoea. He said it was typical for a patient with sleep apnoea[129]. It was Professor Cade's opinion that the MET criteria were met very early on, in his opinion shortly after the first alarms and at least well before 2000 hours[130]. He said that had a MET call been made Mr Lambropoulos would almost certainly have survived[131]. As to the period of 16 minutes during which the SpO2 monitor did not give any readings, Professor Cade described it as an extraordinarily long gap. He said that in a special care unit such as a HDU he would not expect such a gap or defect in the monitoring[132]. He said that if it had been noted earlier and it was found that Mr Lambropoulos had arrested he may well have been capable of resuscitation early in the arrest process[133]. It was Professor Cade's opinion that Mr Lambropoulos had clearly arrested well before the code blue was called at 2038 hours and he referred in that respect to the high level

[124] Transcript, page 793
[125] Transcript, pages 793-794
[126] Transcript, page 795
[127] Transcript, page 796
[128] Transcript, pages 796-797
[129] Transcript, page 797
[130] Transcript, page 798
[131] Transcript, page 798
[132] Transcript, page 800
[133] Transcript, page 800

of the PCO2 recorded following the code blue. As he noted in his first report dated 19 May 2015:

> 'I note that the arterial blood gas results at 8:58pm (ie during the resuscitation and 20 min after its commencement) showed severe hypoxia (PaO2 39), severe acidosis (pH 6.86) and severe hypercapnia (PaCo2 125). This level of PaCO2 is much too high to have occurred during just 20 min (especially when some ventilator assistance was being provided by the resuscitation team during this time), and thus there must have been marked hypercapnia (indicating preceding ventilatory failure) at the time of the cardiac arrest.'[134]

16.3. I have referred to Professor Cade's evidence about the quality of the plethysmograph traces and will not repeat it[135].

16.4. It was Professor Cade's opinion that in all probability Mr Lambropoulos' cardiac arrest probably occurred within five minutes of the cessation of the PCO2 readings at 2022 hours[136]. Professor Cade said that during the period between the cessation of SpO2 recordings and the code blue, the screen would have been showing an inoperative reading and this would have continued after a cardiac event occurred[137]. Professor Cade summarised the position concerning the pattern of repeated very low saturations followed by arousal as follows:

> 'The usual reason for a very low sat in this setting is failure to breathe. When the patient is roused, as the patient is roused and they take a few big breaths, it comes up over a few seconds, it might come up over 20, 30 seconds but it won't come up over two seconds, for example.' [138]

17. Conclusions

17.1. I find that during his time in recovery between approximately 1940 hours and 2022 hours Mr Lambropoulos was suffering from sleep apnoea. His oxygen saturation levels repeatedly fell below 90% but he either of his own accord, or because he was roused, recommenced breathing. It is particularly likely during the period between 1940 hours and 1955 hours when his wife was present that she would have been able to rouse him and indeed we have Ms Ge's concession that she may have gone over and roused him as well during this period. There may have been occasions when he roused himself, as he would with sleep apnoea when at home. Around the period of 2000 hours nursing observations were taken and there would have been nursing activity at his bedside

[134] See Exhibit C28a
[135] Transcript, pages 802-804
[136] Transcript, page 832
[137] Transcript, page 832
[138] Transcript, page 840

during that period. Thus the screenshot, consistently with this, records no episodes of low saturations before or just after 2000 hours. However from about 2005 hours onwards there are many low saturation alarms and three crisis alarms. It is probable that Mr Lambropoulos remained in a state of oxygen saturation between 80% and 90% for most of that time, except during the crisis periods. There were, according to the screenshot, three or four brief occasions when he was not at an oxygen saturation below 90%. It is probable that during those periods he had roused himself sufficiently to recommence breathing sufficiently to maintain his saturations. Certainly the period suggesting normal saturations immediately after the third crisis alarm is consistent with the nursing staff responding to that crisis alarm and rousing him. However within a short period of time, perhaps no more than a minute, he had returned to his low saturation levels and it would appear his pulsatile flow was insufficient to activate the machine after 2022 hours and that his cardiac arrest occurred sometime thereafter.

17.2. The evidence of the nursing staff in relation to the propensity of oximetry monitoring to give false low readings has, in my opinion, contributed to a lack of urgency in responding to Mr Lambropoulos' alarms. This attitude of nursing staff was clear from the evidence I have set out above. It is not surprising that nursing staff might wrongly assume that low readings followed by a return to a normal reading are indicative of some inaccuracy in the machine when one has regard to the fact that ACHA's own policy[139] in relation to pulse oximetry suggests that the machines are capable of 'artefact/wrong readings'. It is concerning that there is nothing in that policy document to explain that the existence of an artefact or wrong reading can readily be checked by reference to the SpO2 trace that does accompany the oxygen saturation number appearing on the screens. As Professor Cade said it is a simple matter for a competently trained person to verify that there is a proper reading. Professor Cade described it as a process of 'quality control'. Rather than having a proper understanding of this, the staff, with the possible exception of Ms Grant, appear to have gained an opinion that oximetry is less than reliable. While this may not matter on a general ward with reasonable healthy patients, it is clearly unsatisfactory in a HDU. By contrast, the evidence suggested that in the ICU staff would respond to all oximetry alarms[140]. It would appear that on each of the occasions that Mr Lambropoulos' saturations have fallen to a point where an alarm has sounded, if it has been noted by the staff at all, it

[139] See Exhibit C7z
[140] See the evidence of Dr Everest

has been assumed that the reading is inaccurate and the first line of response is to check his probe. On his probe being checked, and no doubt because staff are present, Mr Lambropoulos was roused from his apnoeic state, and was taking breaths, staff would then note that his saturation levels returned a higher level, thus reinforcing the perception that the problem was an inaccuracy of reading, or an artefact reading to use the language of the ACHA policy document. It is easy to see that the readings in the case of Mr Lambropoulos were true readings. This is demonstrated by his very high loading of carbon dioxide at 2058 hours according to the arterial gas results taken at that time.

18. Recommendations

18.1. Pursuant to Section 25(2) of the Coroners Act 2003 I am empowered to make recommendations that in the opinion of the Court might prevent, or reduce the likelihood of, a recurrence of an event similar to the event that was the subject of the Inquest.

18.2. The Court recommends that the Minister of Health ensure that nursing staff throughout the State are given refresher training in the proper use of pulse oximetry monitoring equipment, including training about the need to ensure that low readings are not wrongly assumed to be erroneous, and the proper use of the plethysmograph wave form in determining the reliability of the SpO2 data shown on the monitor.

Key Words: Hospital Treatment; Nursing Care; Sleep Apnoea; Preventable Death

In witness whereof the said Coroner has hereunto set and subscribed his hand and Seal the 3rd day of August, 2016.

State Coroner