

## Nurses' Technological Dependency in Practice

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### **Abstract**

The aim of this thesis is to explore nurses' understanding of technology in the intensive care unit. The study brings together empirical data gathered from nurses' practice in the ICU environment, along with theoretical insights from science and technology studies, to illuminate how nurses' understanding informs their use of technology in their care activities. The empirical data was gathered through intensive fieldwork over a period of 5 months in an ICU department within a large teaching hospital. In addition, recorded in-depth interviews were carried out with ICU nursing staff. The interviews uncover themes such as nurses' practice with technology; nurses' ambivalence around the use of technology in relation to patient care; and nursing identity and professional status. Current theories of technological determinism, social essentialism and technology-in-practice within science and technology studies are examined for their usefulness in illuminating the world of ICU nursing research. In particular, Actor-Network Theory, as an example of technology-in-practice, is utilised as a theoretical lens to explore the contingent nature of social and technological relations on the ICU, where nurses' understanding of technology emerges as an effect of multiple associations between human and non-human actors. The thesis informs existing research by offering further empirical insight into the ICU world through in depth analysis of the semiological and material qualities of technology in the ICU, and develops a number of conceptual themes such as 'balancing patients,' 'chasing numbers' and the 'technology vigil' to frame nurses' understanding of technology. The study also adds insight into the construction of nursing identity, suggesting it is an emergent property of nurses' interactions with technology. The thesis concludes by indicating that knowledge of how nurses understand, use and frame their identity in relation to technology can inform current research into technology adoption and diffusion in healthcare environments.

**Keywords:** Nurses' Technological, Health Technology, Technological Dependency

### **1.0 INTRODUCTION**

In this section I will explore those conditions of the ward environment which indicate that ICU nurses are, to some extent, determined by the technical necessities of the devices that they use. However, the theoretical ideas of technological determinism are perhaps too reductive in explaining the array of actions nurses perform around medical technology in the ICU. Instead I will focus on exploring nurses' dependency on technology. Nurses and medical staff are indeed dependent on numerous high-tech devices in order to carry out their duties and I wish to demonstrate that by adopting the term dependency, which to my mind has more to say about real social relationality, I can reveal the actual layered and nuanced interaction between nurses and machines. Interactions which are revealed to be never wholly absolutely determined and occasionally carried through with forms of subtle technological resistance on the part of nurses. Forms of technological dependency can be discerned in numerous interactions between nurses and technology on the ICU. To begin with nurses will describe their duties as 'looking after organs', the implication being that the technology and its management forces nurses to look upon the patient as an assemblage of organs. This may lead to a certain splintering of nurses' image as holistic care providers. The second section will continue this theme as nurses talk about 'chasing numbers'. There are a number of ways in which this expression is used; however in each case its use suggests that nurses (in their interaction with technology) endeavour to balance numbers as a representation of the patients' physiological systems. In both themes, chasing numbers and looking after organs, the analysis shows that the technology directs the nurse's actions and understanding. It frames a set of discourses about the patient that not only gives a label to the illness, but also constructs a perspective which leads to *Interpellating* - in the Althusserian sense (see Althusser, 1970) - the embodied subjectivity of nurses in their contextual interaction with technology and the patient being cared for. It becomes a culture of normative expressions of talk and actions, not only about the patient in terms of their condition (related to physiology and anatomy) but also in interpreting the patient as actants in the nurse-patient (organ)-technology network.

In the third part the findings reveal how looking after organs and chasing numbers correspond to the idea of 'balancing technologies'. Effective treatment of ICU patients is summed up through a balancing of technological outputs (such as monitoring and blood-gas tests) and technology inputs (like ventilation, infusion and filtration). Therefore, notions of patient care emerge as an exercise in balancing the network of technologies that interact with the patient. The fourth section explores the notion of technology as a 'hermeneutic device' (Ihde, 1998). Whether the nurse's action is tied to technological interventions as inputs, in terms of ventilation or blood filtration, or monitoring outputs, as in nursing observations or blood-gas analysis, the technologies used in ICU play a distinctive role in nurses'

understanding of their patient. As Sandelowski (2000) has explored these technologies constitute hermeneutic relations - as an apparatus for gathering knowledge of patients' anatomical and biological features which hitherto are undisclosed to direct visual scrutiny of patient's condition, but which nonetheless imprints a new set of readings of human illness and technological interventions. I explore in detail how all this might be the case; about how nurses become dependent on forms of technology that allow them clinical 'observations' at the cellular level, and about how such knowledge informs the way nurses view their patients and the tasks they perform to carry out their care role.

## **2.0 LITERATURE REVIEW**

### **2.1 Looking after organs**

The expression 'looking after organs' has all the appearance of an analytical category or convenient metaphor to describe, and then theories on, the everyday perspective of nurses - it is however the direct and personal assessment of a nurse captured during an observation of her going about her duties in ICU. It is in this respect an ethno methodological standpoint adopted by the nurse, it is the way that she makes sense of her world of patients and technology. Whilst she utters this meaning to her actions she is going about the activity of recording the patients 'observations'; she is doing, as the ethno methodologist would say, recording technological outputs as indicators of organ status. It is not that the sense of the action is interpreted after the action by the nurse, but that the meaning and sense of the activity are in the action and its indexical context (Atkinson, 1988). The numbers she records are taken from the various machines set around the patient's bed, numeric values produced by the technology, which give the nurse an indication of the particular organ status. When pressed on this self-representation of her nursing practice as 'looking after organs', the nurse explained:

*Interviewer: "You mentioned when I was talking to you earlier that you looked after organs. And I thought that's an interesting way of looking at things...kind of technology and organ."*

*Fn07, female nurse: "Well we've got technology for each organ. We've got technology for your kidneys if you've got renal failure, have you seen our new dialysis machine? You've got technology for your heart monitoring, your blood pressure and all of that. What else have we got? Technology for a head injury, your monitoring for that and your invasive line that you stick in. Yes it is organ orientated."*

*Interviewer: "Therefore, the technology gives you an outlook on the patient as being... I might be wrong and come back at me, but it's like the patient as an assembly of organs that the technology determines the way that you look at them in order to ensure the balance of these particular organs."*

*Fn07, female nurse: "Yes."*

Necessary to the purpose and function of the technology, where each machine has the specific task of maintaining or monitoring the function of a particular organ, the technical aspect of setting up the device and its ongoing maintenance directs the nurse to apprehend patients as a series of technological balances. As a perspective on the role of ICU nurses, I was interested in discovering if other nurses shared this interpretation. *Fn13, female nurse: "I think for some people it's easier to imagine that you are just tinkering with machines, that you are just helping fix different parts of somebody. Because it's easier to think that than to think this is someone's mum or dad or brother. It can be quite difficult if you know that you're fighting against the tide to save somebody, and you're thinking this could be my brother or my dad, it's quite a difficult thing."* In the quote above the nurse shares the sense of ICU nursing being about looking after something that is categorically detached from the notion of a patient. Through sedation the patient is framed as something other than 'social'. As the interviewee points out '...we don't meet the person', but how is this possible when the person, the patient, is directly in front of them? In effect the patient's social identity is subsumed within the network of technology and organs. It is by this configuration, where medical devices relay information from the different organ systems, that nurses take their cue. The following comment comes from a nurse when asked to sum up her nursing role. The notion of the 'person' as patient is configured in network of organs and technology: *Fn19 female nurse: "We try to get that person back to health by supporting different organ systems. And generally as a nurse within that, running the day to day tasks of the infusions; keeping the ventilator settings stable, taking the blood gases..."*

In these moments, a technological determinism shapes the interpretation of the patient and indeed the totality of the ICU nurse's role. There is a direct dependency on medical devices to reveal evidence of the root cause of the patient's illness, evidence which is not present in observation of the body surface (although of course skin pallor as well as the touch and feel of the skin can be observed). This direct technological, visual observation reveals information of underlying pathology and it is here that the technology within ICU comes into its own; such is its sophistication in revealing the anatomical condition. A stronger argument would be that due to the patient's condition nurses are directed in a profoundly meaningful way towards understanding the patient illness by means of the technology.

*Fn13, female nurse:* "...It's sometimes easier to detach yourself by thinking of the person as something you need to fix like, with the machines that you've got try to work out how to fix them." In subsequent interviews I used the notion of looking after organs to surmise nurses' view of technology and the way that it might direct their perspective on patients. When nurses considered this idea there was a consensus that they may indeed be being directed by the technology to perceive the patient as an array of fixable organs. The following quotes from different nurses exemplify this point: *Interviewer:* "One of your colleagues said 'what I do is look after organs'. What do you think of that idea?" *Fn05, female nurse:* "Yes I suppose that's a good way of putting it really because one machine takes over one organ and they all need to be working together in order for the patient to survive so yes that's a good way of putting it." *Interviewer:* "There seems to be machines for hearts, for lung systems, for kidneys. All these devices in a sense let you know about the patient?" *Fn14, female nurse:* "Yeah that's true. But it's not just technology like that though. We have people who come in to do echo cardiograms or chest x-rays. And that gives you an even bigger picture of their physiological anatomy. That adds to the technology, not just the technology we look after, but technology that comes in to the unit. That helps look after their organs in another way." The latter extract [from Fn14] has all the qualities of an actor-network. Mention is made of further actants extending out in to other departments in the hospital. Each one is recruited onto the network: radiographers, x-ray machines, heart specialists, medical engineers, nurses, patients, and hearts. This actor-network of machines and humans, it is supposed, work towards the treatment and cure of the patient as a focus of their expertise and specialism. However, the patient in the network is no longer a whole and autonomous agent but rather disassembled as a further network array of organs and tissues. Each component of the patient network is co-opted into the wider socio-technical network made up of specialists with their technological devices.

## 2.2 Chasing Numbers

*Fn, female nurse:* "So we are chasing whatever numbers and you can spend a whole day chasing numbers and trying to just find the little thing that gets these numbers right." During periods of observing nurses I noticed that an important component of the care routine involved documenting readings from the various devices connected to the patient (collected on a patient observation sheet). As one nurse pointed out in conversation, "ICU is monitoring intensive, probably more than any other department in the hospital". Undoubtedly due to the critical medical condition of the patients nurses require a constant stream of information to inform them of the status of their patient. If 'looking after organs' through the network of medical technology is the nurses' self-reported focus, then 'numbers' are vital actants in the network link between organs, monitoring technology, and care intervention. *Fn13, female nurse:* "...the numbers that we have on the monitors, because we do a lot of watching numbers and you do think how did I get by without having these in front of me before." Numbers flow through the network, they are output artefacts in the form of filtration fluid levels, heart rates, temperatures, blood-oxygen test results, Ph. levels, to name a few. As inputs, by way of treatment they can be a syringe driver, drug amounts, ventilation delivery in cubic amounts of oxygen, fluid giving in millilitres.

These numeric actants flow through techno-networks. The technology-patient nexus is the site of their construction where devices turn anatomic and physical actants: hearts, lungs, blood, into numeric values, which are delivered to nurses through electro-digital transformation into further interfaces in the network, such as monitors. Here nurses 'read' numbers on computer screens in papers readouts. At this point nurses are at work interpreting numbers in order to input other numbers into yet more devices for the purpose of delivering treatments to patients, such as oxygen levels through ventilation machines, or bolas drug prescriptions by way of automated syringe drivers. This description of the patient-technology-nurse network in which numbers play a vital role is evident in the way nurses interact with the technological systems within ICU. The following extract from my field-notes typify this, as a nurse observed taking blood describes the task of 'reading' technology, documenting values and interpreting those results as 'chasing numbers':

*Field note entry date 17/10/10: The nurse stands next the patient and is taking a blood sample from a tube with a valve situated on the back of the patient's wrist. She immediately takes the sample along with paperwork to the room off the ward where the blood/gas analyser is situated. In the room, I observe that she first presses a button near the screen. This action brings the machine out of standby. The nurse swipes her ID card and then inputs details from the patient's records then she prepares the sample by placing it within an opening port on the analyser. I ask how often she does this, 'Oh, quite a lot overall on this ward, but it depends on the patient'. She says the test takes about 30 seconds and we wait about for the results. I say, 'this looks a pretty sophisticated piece of kit?' 'Yeah, it's really important. It's one of the machines that we rely on a lot'. The device makes a mechanical sound from within that suggests it is carrying out automated steps. In the allotted time or so, the results are delivered in paper from a slot. The nurse carries out I suspect the usual routine of disposing of the sample. Back at the patient's bed bay, she is looking at the paper results, which has all the appearance of a till receipt, after some moments of deliberation she*

*claims' yes' and punches the air with a clenched fist. As I approach to ask her why she might be exhilarated she announces that she had been chasing numbers all morning.*

In the world of ICU nursing numbers are all important. They are, in effect, an interpretive device which nurses use to discern the condition of the patient which may determine additional actions from other nurses and other machines. The implication is that in the network machines have the powers to co-opt and recruit other devices into action, and, not least, they might configure the nurse's management of the patient. In the following extract from an interview the nurse recognises the meaning of 'chasing numbers', she describes the emerging implications for care that might come about as a response to numbers.

*Fn05, female nurse: "So yes when you're tweaking...obviously one of the things we look at all the time is blood gases to see if the ventilator's doing what it should do. Do oxygen in the blood to get rid of the carbon dioxide to get the Ph. normal. Because that's what you need to do, you need to get your Ph. normal. And it's the same with the filter as well. That's another couple of numbers you're looking at on this blood gas. Or you could be giving blood, that's another...Hb. is on your blood gas, you could be chasing that. These are all numbers that you're trying to normalise in order to get the patient better. So yes, if you've been working all day to do different things, to give them different blood products, different drugs. They're filtering so you're filtering all the rubbish out of their blood, and yes if you've just done a bronchoscope to clear out their chest and you'll put a chest rail in to get them to raise their oxygen levels up."*

Forms of dependency on the technology within ICU were apparent in nurses' interview accounts. For instance, in order to deliver appropriate care nurses considered the interpretation of the observations from machines to be essential. In this context, where interventions of intensive care are delivered through the application of technology, nurses view the notion of nursing intuition to be redundant. What is all-important in terms of nurse's perspective is that numbers are part of the quantification of illness; even qualitative presentation of the illness experience, such as indications of pain and its management, require numerical assessment using, for example, sedation scores. What is clear from the next extract is that the nurse respondent has chosen not to rely on direct observation, for, in their view, the complexity of intensive care treatment requires greater accuracy than nurse judgment. In light of the compelling precision of technology in providing up to the minute numeric reports and results of the patients' condition, the 'looking-on' of nurses is reduced to guesswork. *Mn17, male nurse: "Obviously you can tell when someone is sick and you can make some ball park guesses as to why, but you still couldn't, on this unit, on ICU you couldn't make any quantitative judgments about it. You have to quantify things, how people are getting sick in order to know how to make them better."*

My analysis suggests that through the pre-occupation with 'number chasing' (and 'looking after organs' or in the next section 'balancing technologies') ICU nurses develop an understanding that leads to a shared meaning that patient's inner anatomy and related pathologies is occluded from nurses' (as humans) embodied senses (Sandelowski, 2000). In the high technology environment of scanners and x-rays, nurses' observations based on their visual, olfactory and touch senses appear limited in comparison. They are, as the previous extract implies, a mere 'ball-park' assessment, a superficial understanding, of the presented illness which are somewhat disengaged from deep anatomical features of bodies with illness. Because the pathologies that nurse meet are obscured from direct observation the ability of ICU technology to penetrate patients' anatomy, even to the cellular level in the case of blood-gas analysis, ensures that the technologies co-opt, or in other words enroll, nurses into the necessary application of medical devices to patient care. The enrolment of nurses into the technological-nurse network results in a number of per formative and sense-making features adopted by nurses. The interactions of nurses and machines can be analysed, with regard to Law's (1999) notion of actants (human and non-human), as heterogeneous engineering. All networks, according to Law's theory, are held together in a set of stable interactions by the work of ascendant elements in the network - with the heterogeneity given in the diversity of the types of actants in the network at any given time.

Actants in this scenario will include machines, protocols, nurses, numbers, organ systems (networks systems themselves), tubing and electronic-digital flows - indeed the difficulty lies in finding and naming all actants that are inside the network. However, it can be presumed that at any moment when a component is in ascendancy in its efforts to form stability through heterogeneous engineering then other actants enrolled at that moment will have 'proximity' to the 'engineer'. Of course, proximity in ANT is not viewed in terms of spatial proximity and the role of classic Euclidian space, of near-ness or far-ness, is exposed in ANT (Law, 1999) as an inadequate explanation of object relationality. For example, within the context of nursing-technology proximity of actants in a network is about influence: a micro-bacteriological test carried out in some other part of the hospital and presented as a series of numbers on a piece of paper can be an influential actant in the stability of the network of objects that operate at the patient's bedside. Networks are able to fold space, bringing the proximity of influence of particular heterogeneous elements closer to the node point of nurse patient interaction, while other actants close-by remain in the 'background distance' as intermediaries with little or no network influence in terms of their transformative relationality to other

actants. Latour (1990a) describes this influence of actants at a distance as an absence-presence. In the present space of the patient's bedside, technology and humans are working with each other: "*feeling, hearing and touching each other, but they are now talking with many absent things presented all at once. This absence-presence is possible through the two-way connection established by these many contrivances*" (p.7)

In this instance the contrivance is the test report, carried out at a distance but conveyed to the bedside by means of numeric verification displayed on paper. I will say more on the influence of these objects, such as paper reports, monitor graphs, and patients' records, later when I examine their importance as forms of text to be read by nurses. A further important aspect of network enrolment is the way that actants who are co-opted may not necessarily engage wholly with the specific purpose of the network. According to ANT the obligation to participate in heterogeneous networks, placed on human and non-human actants alike, is of course a node of power in the network. In enrolment to the network and the empirical node of action nurses may act, in Latourian terms, as either intermediary or mediator (Latour, 2005). The function of the nurse in the network as an 'intermediary' is to operate as a fixed 'black-box' where the nurses neither add to nor diminish the effects of the technology. In this sense the nurse then cannot be taken that nurses are the absolute and sole agents of patient care within the network. By taking up the ideas and implications of ANT it is equally important to consider who are the actual mediators of care activity; in the microbiology example presented earlier the test carried out at some distance might be taken as an important mediator of care, whereas the nurse present at the site of care activity may only act as intermediary. The sense of nurse as intermediary is evident in the following extracts where a certain reliance upon the technology is demonstrated; a dependency that suggests a diminishment of mediator power.

*Fn1, female nurse: "Well as you're going on, you forget about the physical box, that's what we're talking about, the information within the technology. So yes you do use that information and the technology in your nursing care because it does in some degree, what's the word? What information you've got from it will determine how you're going to look actually, not from a clinical medical point of view but from a nursing point of view, how you are going to care for that patient."*

*Fn14, female nurse: "I'm very reliant [on the technology]. I'll tell you why. After I had trained in Birmingham, I worked in a cardiac ICU in Birmingham, and then I went to Australia for a year and did ICU nursing as an agency nurse. But one shift I did in A&E, I had a bay of patients. None of them even had a sats probe. They didn't have the oxygen monitor probe. And I was freaking out [laughs loud]... because I didn't know what was going on with the patient. I think I'm very dependent on the technology. because we're so use to them, patients, being hooked up to a monitor that we can...not ignore them in a way, but if anything starts to go wrong, the machines will tell us a lot of the time. It will start to trigger something. Now, that is a bad way of being, because you're supposed to...we're always told not to necessarily rely on technology. You should look at the patient first. You should look at the patient and see how they are; whereas, I already found out in that situation that I'm very reliant on the technology to give me a warning sign."*

On one level the nurses' accounts demonstrate the determining power of technology on the thoughts and actions of human caregivers, the machines will "start to trigger something". The assumption is that it prompts nurses towards care activities. In the second extract, the nurse states that she "didn't know what was going on with the patient", there is a self-implied notion that whatever knowledge they could bring to bear would not be adequate to deal with the clinical situation. As intermediaries nurses are left consciously divested of activity and meaning: "... the machines will tell us a lot of the time". I would argue that this set of discursive strategies and summations used by nurses in relation to technology is in fact the effects of mediators upon intermediaries within the network. The technology does determine the actions of nurses: it makes them do things, it makes them say things. But the determinacy is an effect of the network, the coming together of all actants makes the alliances and effects within the network contingent and emergent. It perhaps is understood that in their day-to-day role nurses rely on the stabilisation of networks: that organs are responding, as expected, to drug inputs, filtration or ventilation, and the number chasing has settled to a stable reading of the patient's status.

*Fn13 female Nurse: "I suppose for us the most important thing is that we are initially keeping these patients as stable as we can keep them. For us to be able to do that we have to have accurate monitoring and all the machines have to be working properly for us to be able to do that. So it's just ensuring that all that is going right as well." This nurse's statement is in effect the optimal balancing of patient's vital signs with the devices are working correctly and the network of technology providing 'accurate' monitoring. At this point 'number chasing', as an effect of the technology-organ balancing act, takes a back seat. In this equilibrium, where organs and technology are performing to expectation, nurses perceive the technology as a neutral force in their nursing role. Indeed, it could be suggested that the technology merges into the background of nurses' activities. At the same time the stability of techno-human network becomes naturalised. That is to say, the whole network acts as a series of empirical facts: numbers become a 'true' un-mediated measure of patients' organs. To borrow a concept from Ihde (1998) 'visual hermeneutics' and the*

task of interpreting observations is displaced by direct inductive knowledge. Acting upon repeated observations and test results informs the inductive ideal of nursing practice, the following extract exemplifies this forceful ICU nursing epistemology when carrying out blood-gases analysis: *Fn14, female nurse: "So I did another one [blood/gas analysis] and I did it on the other machine and that showed me results more consistent to our previous results... I should have done a best out of three...[S]o I did it again and it was a consistent reading."*

However ideal this space of network stabilisation is for nurses it is, as ANT suggests, very much prone to displacement and interruption (Law, 2008). For just when dependency on the technology-patient nexus allows settlement, what Callon (Callon, 1986b) describes as *domestication*, the obduracy of certain network actants creates a vertiginous moment for nurses. In the next extract, reproduced here at length, the description has all the appearance of a network breakdown. When the heterogeneous engineering efforts of the nurse to draw together actants: numbers, devices, consultants etc., produces the effect of network stability, the summation of the technological monitoring by the consultant throws the nurse's practical world into doubt. All that was factual and accurate (for the nurse 'real' enough to promote particular practices towards care) are now cast into dramatic disarray as the nurse struggles to re-establish the hitherto stable world created by the network.

*Fn05, female nurse: .So sometimes you feel like you are chasing numbers and things and you think what's the point because one person is saying, "Yes this is really accurate, we need to be looking at this". Then the doctors that are here all the time are saying, "Well, actually it's not really that accurate so can you switch it off." Interviewer: "So will you think, 'Why are we chasing the numbers?' What are your thoughts on that?" Fn05: "I think sometimes every doctor has a different preference about what they want and everyone's got a different idea of what we should do next...And sometimes you're a bit clueless. Sometimes you're a bit like, 'well this is a bit frustrating because what I am I supposed to be doing here?' When one person is saying one thing and one's saying another this number here is raised so you want to do something about it ...[S]o that can be a little bit frustrating and you're kind of unsure of what you're trying to achieve here because you're not really listening to what [the technology] is supposed to be telling you in the first place. Why is it there? [the technology] It's another thing to look at. If it's not even real then why? It's another thing that we have to concentrate on when we could be doing other things. Do you see what I mean?" Interviewer: "I do, yes." Fn05: "So it probably does hinder your patient care sometimes because you're thinking, 'Well, is it real?'"*

The uncertainty cast on nurses' technological monitoring and observations by consultants places further doubt on the efficacy of their interventions. At the same time this collision of interpretive purpose of nurses and consultants highlights the strong dependency which nurses place on the empirical loop of technology-human feedback. As the extract demonstrates, on those occasions when the exigencies of other actants are important the network effects might produce a different 'reading': a changed semiotic relationality between machines and nurses, which produces network effects quite different from any notion of technological determinism. This explanation of nurse's material and semiotic relation towards the technology needs further analysis and clarification. I shall say more about this affair at the end of the chapter when I have presented more findings. However, in the meantime, I wish to move onto explore further effects of the network, which might be construed as technology determining ICU nursing practice.

### 2.3 Balancing the Patient Through Technology

The task of looking after organs and chasing numbers comes down to one important aspect of ICU nursing which nurses shared as a locally produced metaphor - they are in the business of balancing the patient through the correct control of inputs and out puts. Gathering observations, monitoring patient's vital organs, creating numbers, looking after organs, upping prescriptions, reducing ventilations are all actions that are directed towards 'balancing' the patient with the technology. *Fn07, female nurse: "Well, quite often we do a lot of struggling with patients' ventilation or numbers that are on those reading. So whether it's something that's on there that's not right, it can feel like you've spent all day trying to fix it and you've adjusted one thing and it doesn't work and then you adjust something else and it doesn't work, so when you eventually find the trick to make it work then it is really satisfying." Interviewer: "What does that mean, 'making it work'?" Fn07, female nurse: "Well, to get the numbers into a sort of normal range that you are happy with, that's best for the patient to be in, we are usually aiming for things that keep the patients as stable as possible."* ICU nurses' interaction with technology 'chasing numbers' and 'looking after organs' become metonymies for patient care. These turns of phrase are in fact ways of understanding the critically ill patient subsumed under the semiotic weight of the network of technological actants. It is in this instance of comprehending the network that the devices - monitors, ventilators gas/oxygen analysis become mediators - force a particular semiotic 'reading' of the patients as these metonymic entities. In fact, it really depends on where and at what time the network is perceived. The notion is, following ANT, that all networks are understood by their local effects.

I am suggesting further that the network and its assemblage of actants configure varied readings of the ICU, and that any reading does depend on the position of other elements in the network - including nurses and devices.

From the perspective of the nurse the understanding of the patients is therefore fluid. The nurse concentrates on one particular aspect of their care practice and through doing this alights on a particular instance of the network, which produces a particular reading. Another way of viewing this is to understand the performative nature of socio-technological systems. When the nurse undertakes a particular activity he/she and the devices (and the patient) are engaged in performing that routine, bringing it into being by reproducing relations. *Performancy*, as a strategy, ensures that actant network connections are reinvigorated, but performance is also a strategy for new effects and dynamic change.

Balancing the patient becomes in other words the effort to set equilibrium between the inputs and outputs. The technology, by its sheer epistemological force (it has more knowledge of the patient than the nurse) profoundly directs the nurse's perception and interpretation of patient care as a task of organ stabilization. The technology reveals to the nurse the physical and biological sciences of tissue function and in doing so the devices foreground how the patient is to be read by the nurse. The next extract demonstrates how nurses' pursue this balancing of patients through specific procedural use of outputs (via monitoring) and inputs in terms of drugs.

*Mn03, male nurse: "going back to talking about the LIDCO and the SWAN GANZ [heart monitoring devices], if my patients is venal dilated, because my LIDCO tells me so. I give more noradrenalin. If my patient has got compromised heart contractility I give more adrenalin to drive the heart more. I need to know the deficiencies so I can tailor my therapy. Now, unless you've done some specific monitoring, you wouldn't be able to give those drugs safely. And that is why we monitor our patients more closely so we can give these drugs more safely."* This explanation from the nurse concerning balancing the patient is in effect the stabilising of a particular organ - the heart. In actual fact, as the nurse later explained, it is not really feasible to concentrate on one particular body system, in this case the circulatory function. These components, or actants, of the biological network (hearts, lungs, and livers etc.) have real implications for the wider nurse/ machine network. For example, a damaged heart has as much ontological force as a heterogeneous engineer or anything else described in the network. Its requirement for medical attention ensures the enrolment and enactment of a number of other actants in the network. How so? Well, the heart's output interfaces with monitoring devices and scanners. The technology in turn translates the biological function into numeric values which are read and interpreted by the nurse; who responds by performing drug infusion as a response to the chase of information.

Of course, the story of this network does not stop there; for there are a multitude of other actants that have an absent importance to the stability of this local process of monitoring and treatment. Among those present-absent actants might include pharmacists, medical engineers, pistons, protocols, technical training packs and consultants. This is the nature, as it were, of networks in that they comprise a whole series of heterogeneous agents, human and non-human. In the main most of these actants will have been black-boxed. That is to say, their input to the network would be taken as stable and assured; seldom is the authority of consultants taken to task. This authority over decision-making held by consultants is itself the effect of other networks, demarcated by professional bodies, educational status and social approbation. Returning to the case of the nurses' description of balancing the patient, in this example technological actants are engaging with other technologies in a network which includes humans as further actants. The decision over what actant is acting as mediator or intermediary is decided on the localised performance of the interaction and its effects. The inclination towards technological determination of nurses' actions lies in the tracing of events to the durable effects of the network. In this instance the nurse's reliance on monitoring becomes an effect of the actor-network. Monitor technology is therefore both a mediator and heterogeneous engineer. It brings information of the patient's heart function and shapes it into numeric patterns which condition the nurse to respond as an intermediary. The network enrolled nurse as conduit engages with inputting technology (infusion pumps delivering adrenalin or noradrenalin) to balance out the specifics of the patient's heart function.

Nurses use the notion of balancing the patient; they also talk about 'normalising the numbers'. Balancing and normalising are of course two sides on the same coin. To use the ideas of 'balancing' indicates that the patient's physiological status is mediated between input and output technologies. To talk of normalising numbers indicates a prevailing notion of what 'normal' is. 'Normal' is a further effect of the network. It is powerful enough as a 'good' care outcome that networks of humans and non-humans, technology and nurses (and clinical judgment, and monitors and pumps etc.) become engaged in achieving this result. The network will hold together remaining relatively stable for as long as this outcome is obtainable. *Fn05, female nurse: "So it's all different things that you're doing all day and what you want is all these numbers to be normalised. That's what you're aiming for at the end of the day. And it is satisfying but it's also disheartening if you're trying to do all these things for this patient and they're not getting any better."* This is the semiotic force, the representational power that pervades nurses' interpretation of the patient: realising the patient as an assembly of organs managed through numeric readouts on the one hand, and interpreting the patient's condition as the balancing and normalising of those numbers on the other. The indication is that the routinisation of technological vigilance, in an environment where the necessity to adopt these highly sophisticated

devices is a matter of life and death, frames the meanings nurses adopt in their understanding of patients and care provision. Put another way, the technological knowledge becomes the prevailing knowledge system used in ICU nursing. At the patient-technology-nurse nexus where the effects of that network produces a corresponding network of ‘semiotic relationality’ (Law, 2009) i.e. ‘balancing’ ‘chasing numbers’ ‘normalising’ and ‘looking after organs’- all semiotic effects of the network inform the discourse of ICU nursing. Consequently they also determine actions towards caring for the patient.

In ANT terms, the shaping of nurses (and of course all other actants) comes about through *translation*, and *enrolment*, which, if successful, shapes the nurse as they enter the network assemblage. *Translation* and *enrolment* in terms of Callon and Law’s (Callon & Law, 1982) perspective are doing the same thing; on entering the network there is a configuring of the actant in line with the purpose of the network, suggesting that the symbolic and material identification of a nurse becomes mutable, changed. If the symbolic notion of a nurse is understood as a relational-effect of potentially multiple networks they happen to be part of then this re-configuration through translation will present a semiological reading of an ICU nurse as carer whose idea of nursing practice is conveyed through technological rationality. Interestingly although the ICU nurses interviewed remained ambivalent as to what nursing care can be, they believe that other nurses who work in the classic Nightingale Style (i.e. hands-on, ‘holistic’ and empathetic) hold them in some suspicion as to their nursing motives and practice around technology. *Fn09, female nurse:* “*There’s a lot of misconception about ICU nurses; that at the end of the day they’ve got a nice big chart, they drink lots of tea and just watch the screens and write down numbers all day.*”

The perceptions of ‘ward nurses’ (in the language of the ICU) is that the ICU is populated by technophiles with little regards for humanist notions of care is countenanced by one interviewee’s account of a patient delivered to the ICU. Interpretation would indicate that the ICU nurse is constructing a ‘moral tale’ (Allen, 2001). The rhetorical device works in their account to set a boundary between perceived inadequate care on the general wards and the technologically driven high care standards on the ICU: *Mn20, male nurse:* “*...ward nurses bring patients onto the unit. And they want to hand the patient over to one of us. They do seem uncomfortable; out of their comfort zone. On a lot of occasions I do know nurses on here who are to some extent rude to ward staff because when they are handing them over it can be quite apparent sometimes that the care hasn’t been particularly good. And there can be bit of an atmosphere between ICU nurses and ward nurse. And I don’t think that that can do our reputation any good.*”

Ensuring translation of all heterogeneous actants is important for the network if it is to remain durable in its effects. Network engineers have strategies which ensure durability over time, not least in ICU nursing where embedding of routinised practice manifest in technological objects ensure the continuity of network relationality (Callon & Latour, 1992). However, keeping networks together is a struggle; they are by and large fragile entities that rely heavily on their continued enactment or performance. It is these enactments from network-actors that both brings the network into existence and reproduce the effects. As Law (2009) indicates, “they hold themselves together but they do so precariously. All it takes is for one translation to fail and the whole web of reality unravels” (p.145).

If, as I am arguing, ICU nursing practices are relational effects of non-human objects (medical devices, technological discourses, nursing values) and human interaction, and that these effects remain durable through continued enactment, but also that they remain delicate entities liable to breaking down, then analysis should bring up the possibility of network crisis. The data does reveal examples where the translation efforts of network-engineers have been unable to stabilise particular actants causing other network-actors to withdraw support for the network. Usually, when this occurs, the effect results in nurses’ diminished reliance on the information the medical device is giving about the patient’s status. The following description from a nurse is perhaps a dramatic example of where a network of nurse and technology relations dissipates.

*Fn13, female nurse:* “*You can see that they [patients] don’t quite look as comfortable as they did before, or their pattern of breathing is not quite the same as it was and you can’t put your finger on anything wrong with any of the numbers but you can see that there’s something not quite right.*” Interviewer: “*Can you give me an example about that, a story where that might have happened?*” *Fn13, female nurse:* “*Well, I had a patient fairly recently...all his numbers were fine. The blood pressure was fine; everything looked okay. But he had a strange breathing pattern. So he was taking very big breaths, and we couldn’t work out why. To look at all the numbers, all the numbers were fine. So we weren’t looking and thinking well he’s not sedated well enough or he’s in pain. There wasn’t any indication of those sorts of things, so we sort of tried increasing sedation and tried different settings on the ventilator to try and find what was causing it. And eventually the doctors decided to give a paralysing drug and when they gave this paralysing drug this patient’s carbon-dioxide levels shot up because he was controlling his CO<sub>2</sub> levels to help reduce this pressure in his head. He was self-regulating. It wasn’t until we did that that we realised there was something else going on. The patient went back for another scan of their head, where they found that it was worse than it had been before. It was one of those things where you just knew there was something that wasn’t quite right.*”

In this extended extract the nurse's account reveals that dependency on medical devices to produce an indicator of patient's condition may have a detrimental outcome. Earlier in the chapter I pointed to the fact that 'numbers' as actors in the technology-human network of ICU nursing have persuasive power as mediators of nurses' actions. This, I suggested, was because the only way that nurses are able to understand the patient's illness condition is through micro-biological evidence delivered by technology. Clearly human senses are unable to detect pathology at this level. Thus, nurses, and clinicians, rely on medical technology to offer a window onto the patient's condition. As such, the authoritative power invested in technology becomes a determining feature of ICU nursing - to some extent at least. That is to say, care is mediated by machines in nurses' vigilance over numbers as representation of illness. Returning to the extract above, here somehow that web of relations between machines, number production, and nurse interpretation of those numbers has broken down, and the technology has given a false presentation of the patient's state. As the nurse mentions "*all his numbers were fine*" but the patient was not. I consider situations like this, and there are others in the data, to be vertiginous moment for nurses.

ANT points out that an effect is produced when actants are in accord with the aims of the network. I suggest here that in instances where networks break down, creating vertiginous spaces, effects are also produced from that fracturing. It is as if the nurse has to manage the situation by incorporating new actants, or indeed re-aligning the network with the inclusion of older, more sediment nursing strategies. I am talking about direct patient observation: "*But he had a strange breathing pattern. So he was taking very big breaths*". With the use of direct interaction with the patient-nursing observation, clinical management took a new direction, which as a final resort required the patient being sent for scan.

## **2.5 Hermeneutic Devices and Nurses' Understanding of Patients**

I have talked at length on how technology might direct the way nurses understand patients' conditions. I have said that certain features of patient's illness are such that the only way nurses are able to understand the condition is through medical technology's ability to penetrate and reveal the microscopic level of pathology. That, through the necessity of technology, discursive habits have emerged that not only form the meanings that nurse use to represent patients, but also that this world-view (inculcated by technological actants) frames the material relationality between nurses and patients in nurses' practical action. I wish to conclude this chapter by exploring how this effect (the framing of relations and the construction of discourse of the nurse-technology network) might come about.

The sophisticated forms of care provided in ICU necessitate that nurses enter into epistemic arrangements with the technology they use. By epistemic arrangements I am indicating that the medical technologies used by nurses reveal knowledge of patients' pathology which would be otherwise occluded from the perceptual affordances of the embodied nurses (Sandelowski, 2000). It is not, however, the case that all illness conditions are beyond nurse and clinician detection. In fact nurses mention that to some extent they may rely on direct nursing observation as a tool for deducing the patient's illness status. Nevertheless, such is the nature of illness conditions that nurses meet in the ICU environment that there is a heavy reliance on technology outputs of figures and graphs to detect and monitor the micro levels of presenting pathology. In the next interview extract the nurse makes that connection between 'seeing' and technology; that the epistemic lens of the medical devices enables a more accurate and less assumptive appraisal of the patient's physiology.

*Mn17, male nurse: "The technology actually makes you understand the physiology better. So by having the technology there, you can equate what you are seeing in a patient better to your knowledge of how the patient is, and I think that without that [technology] there is a danger of making a lot of assumptions when you are looking at a patient about what is going on inside..."* The 'inside' of the patient is thus obscured from nurses' normal senses; only by means of the technology can nurses talk about what they are 'seeing in a patient'. But this 'seeing' is of a secondary order, it is knowledge to be sure, however it is mediated by the monitoring technology. In this moment of contemplating the patient technology operates as a 'hermeneutic device' (Sandelowski, 2000; Ihde, 1998). The concept of technology as a hermeneutic device draws attention to the fact that seeing patients through technology is an interpretive exercise. By this account the device presents a numeric or graphical representation which is taken as a text. But, being a text representation it is never the 'real' phenomena and it therefore has to be 'read' hermeneutically by nurses, and translated into yet other text forms by way of patient records. Reading the patient through technological texts is accomplished within a network of knowledge and understanding - of training and education, of tacit knowledge (Collins, 2001; Polanyi, 1962) gathered from nurse colleagues, senior clinicians and of course from company reps selling medical devices. As a hermeneutic accomplishment the action of reading and interpretation is of course achieved within a techno-human environment that offers a reservoir of textual resources, which is to say, the fact that reading technological texts is achievable, has as much to do with the diffuse technological environment itself. Classic hermeneutics comes to mind when one is directed to the conclusion that we can understand the singular part by

examination of the whole; and that the whole (i.e. ICU environment) is understood in relation to the singular hermeneutic accomplishment (i.e. reading/interpreting the technology as text) enacted by the ICU nurse.

Though I am indicating that nurses are in a creative act of interpreting text, I suggest that this interpretation is very much framed by what would be accepted as a meaningful and realistic ‘reading’. What is realistic is indeed framed in part by the ICU context and the exigencies of other forms of technology in the network environment. For in order to maintain the circuit of information from output monitors to input devices such as syringe drivers or ventilation machines, all information that flows has, by necessity, to be meaningful to all actants in the network, both technology and human alike. By this I mean that any attempts to input a 1-litre dose into a 100ml syringe driver is in this sense meaningless to the machine’s technological affordances. The ICU environment: nurses, patients, monitors, ventilators, patients’ records, beds, domestic staff, and everything else that belongs, make up a circuit of meaningful texts and objects. ANT describes this as material semiotics (Law, 2009) where each component in the ICU network gains its meaning in relation to every other element. On occasion, however, these circuits of meaning can break down. In the following a nurse talks a blood-gases analysis carried out by a supervised student nurse; the nurse reveals that the results were not as expected. *Fn14, female nurse: “Recently I was looking after a patient and I had a student nurse with me. She took the blood to put it in the machine, and all the readings were completely awful, which was a big change from the one I had done before, and I didn’t believe it...[And] we generally go with trends as well.”*

In the account above the circuit of meaning between machine and nurse has somehow been disrupted and the readings from the blood analysis machine are, in the nurse’s own words, ‘not to be believed or trusted’. The nurse takes her queue as to the veracity of the machine’s test output comparing the result against previous results and a follow-up test on another machine. Due to the constant need to monitor patients’ blood-gas balance as a crucial aspect of ongoing patient care the ICU has two blood-gas analysers, placed in rooms at either end of the ward. In this instance the nurse runs a further test on the second machine believing that the first results are meaningless, and she manages the rupture in the circuit of meaning by seeking the ‘trends’ in other elements of the ICU network. It is interesting to note that in order to get to the ‘truth’ of the patient’s blood analysis she then relies on the exact same technology, as the now dysfunctional machine. This is perhaps a rather mundane feature of ICU nursing to point out; nurses would of course be expected to re-test if one machine was not functioning properly. However, what is interesting is that the nurse is striving to maintain trends, to bring back normalcy to the technological network. In this endeavour by nurses as heterogeneous engineers, the term ‘normal’ becomes a stabilising discourse. Normal is a metonymy, a way of talking about machine outputs as a representation of both the patient’s condition and network stability; an understood shorthand for technology and biological components in balance.

*Fn08, female nurse: “You know your ventilator’s working and you know it’s working because the patient’s ventilating; the patient’s breathing. You’ve got rise and fall of the chest; or the numbers that you’re concerned with, are what they should be: the normal values- in inverted commas.”* This quote exemplifies one of many micro instances of how nurses encapsulate normal states of technology-patient interaction. All components, ventilators, chests, numbers are performing as a stable network. The nurse knows the ventilator is working because the patient is breathing; the patient is breathing because the ventilator is causing a rise and fall of the chest; and the numbers are normal because of the appropriate ventilation. One wonders however, if the experienced nurse perceives it as a set of interrelated moments or whether in everyday practice such clinical situations are apprehended, not as separate instances but, as a picture, as a total representation. This notion might be summed up in the next extract where the nurse talks about the use of technology as second nature: *Mn20, male nurse: “You get used to all the technology you don’t really even think about using it. It’s almost like second nature, knowing how to use it.”*

In relation to the idea of *second nature*, it suggests that nurses (for the most part) comprehend the ICU environment and their embodied actions within it as a totalising effect. To emphasise this point, later in the conversation the same nurse was asked about taking shortcuts with the technology or working around any problems with the ICU devices. Again, the nurse agrees that they will inevitably take shortcuts, but those instances just meld into the ‘goings on in the world’ of ICU nursing.

*Mn20, male nurse: “I probably take them that often I don’t realize them. Without analysing my day completely I couldn’t say anything of the short cuts I take.”* Thus, the ICU environment consists of networks of heterogeneous elements; each one taking its meaning, understanding and representation from its relationality to all other elements. This is experienced by nurses in any given moment as a localised totality, a gestalt configuration in other words, largely in congress with nurses’ ‘interpretations’ of situations as they manifest from moment to moment. Within the context of nurse-technological interactions, it might be analytically possible to say that the emergence of ICU nurses as accomplished readers of technology and texts is an outcome effect of the techno-human network.

The ability to ‘read’ patients’ physiology through the prism of technology, as I will discuss in the next chapter, is used by nurses to negotiate social interaction with both medical staff and patients’ relatives. However, to close this section I want to finish with the idea that although nurses are competent interpreters of technologically derived

information, they are also highly dependent on technology as a hermeneutic device in order to carry out their nursing care role. In this way, the machine's position becomes clear as an obligatory point of passage (Callon, 1986b). Thus, the critically ill patient needs the treatment deliverable through the ICU technology. Nurses (and of course medical staff) require the technologically mediated observations and test results to deliver that treatment. Nurses' direct observations of the patient have limited scope; and it is through this ontological limitation that nurses' observations come to depend on the technology as an obligatory passage point through which to understand and respond to the patient's illness condition.

As ANT shows, using a Foucauldian discourse perspective (Law, 2009), the language use does more than name these nursing activities. There is a materiality to language which shapes nurses and their care practices: technology determines the 'world-view' of nurses both in language and action. Through obligatory dependency on technology nurses enter, in determined ways, into interpreting patients specifically through the illness condition. This is seen in the quote below when the nurse describes her patient in ways that foreground the objective pathology (tackled through technological means) and not the subjective human patient. Interviewer: "*Does technology determine the way you look at them [patients] in order to ensure the balance of these particular organs. What's your thoughts on that?*" Fn07, female nurse: "*But, looking back, we do refer to things like that: renal failure, things like that. We'll say, 'What's wrong with head injury?' or 'heart failure'. You don't say their name but you do tend to talk the condition, yes.*" Similarly, in the next extract, the nurse's notion of "knowing" her patient is not about the patient as a social being, but about trends, numbers, and mercury levels. Fn09, female nurse: "*All these numbers have to be interpreted...It's knowing the patient. The trends of your patient I think. So you know your patient, you're rock steady with your blood pressure of 120 over 55-ish, give or take a few millilitres of mercury.*"

The two previous quotes highlight that ICU nurses looking after organs and balancing numbers appear to have a perspective on patients, a world-view, which is enframed by the technological necessity of ICU nursing. I have mentioned earlier, that ICU nurses hold ambivalence towards the role of technology in nursing care. Technological interventions in nursing are not seen as a diminishment of the ideals of what nursing care is. As one nurse rightfully indicated, "*it depends on how you define what nursing is*" [Fn12, female nurse]. Indeed, if technology helps the nurse in their care practice, then ultimately this is viewed as the best possible nursing care on offer. In the next section of the findings I will present and discuss material that indicates that nurses use technology to shape their intersection with other professionals and patients relative. In those scenarios the technology becomes amenable to social shaping, where nurses use its potential social affordances to bolster both their professional identity and caring credentials.

### **3.0 CONCLUSION**

In the review of the literature, I presented some theories of technological understanding. I wrote about determinism as an explanation of technology, but concluded that determinism presented too reductive an approach to the place of technology in society. By contrast, a social shaping perspective on technology considered that devices, machines and indeed innovations come about, and are shaped through social actors either working in consort, as in relative interest groups sharing the same concerns regarding the development of particular technological objects, or groups and individuals in conflict over certain technological developments (Akrich, 1992). The constructionist or social shaping model of technological development insists that new technology has to be understood within the wider context of social, economic, and moral worlds. This particular cluster of theories insists that no technology arrives on the scene as some finished object ready to influence social interaction. Instead, technology is shifted, shaped, and made compliant to the social context of its application.

I presented the findings in four chapters. In each chapter, I wanted to cluster the findings around themes that developed from the analysis. Chapter 5 explored dependency and suggested that nurses' actions were to some extent determined by the technology. Chapter 6 explored how nurses might shape the technology for social purposes beyond the given designed use of the technology. In chapter 7 I presented evidence that indicated how nurses, in mediation with technology, formed representations of patients.

While this structure might have suggested recourse to the determinist/essentialist dichotomy outlined by Timmermans and Berg (2003), my purpose in using this vocabulary was to explore how ANT may explain particular nursing interactions around technology which exhibit qualities of both determinism and social constructivism. ANT would not deny that actants could be at one moment determined by technology; however, this is not absolute. At one moment, nurses appeared to be calling the shots, building heterogeneous elements together to promote a particular outcome. A moment later, technology as an obligatory point of passage (Callon, 1986b) required nurses to perform and interact at the behest of the machine. Here, it might be said that the machine is the heterogeneous engineer, consolidating disparate objects such as patients, blood tests, and nursing protocols. The thrust of my argument was that networks produce effects that seem to reflect classic modalities of talking about technology.

Similarly, when ANT talks about ‘intermediaries’ and ‘mediators’ (Latour, 2005, p.37-46), there is both a discernable deterministic and shaping quality, respectively, placed upon actants’ action. Whereas *mediators* shape the configuration of the network and the objects therein; *intermediaries*, in Latour’s words, “...are *made* to act by many other” (2005, p.46, Latour’s italics), therefore, having a determined quality to them. The difficulty is in knowing what the actant’s role is in the network at any given moment. ANT revealed the dynamic nature of nurses’ understanding and interaction with technology in the empirical world of the ICU, though when dealing with the world through the lens of ANT; when ANT recommends that the researcher ‘follow the actors’, one has to be prepared to shift sociological certainties (Latour, 1987, 2005). Invariably, nurses’ accounts (as with all actors) present a discursive tangle of actions of reciprocity, values, empowerment, and submissions and so on. In the discussion that follows, I will demonstrate how ANT has explained how nurses interact with the technology within the context of the ICU.

### **3.1 Nurses as dependent actants in networks**

In chapter 5 I explored how nurses, as an effect of the network configuration, come to be dependent on the technology they work with in their care practices. The reason for this lies with the critical nature of the illness presented to ICU staff. Illness, injury, and disease that require medical interventions at the micro physiological level also rely on the input of sophisticated technology that can observe and report on the progress of illness. Because nurses become dependent on the technology to perform effective treatment regimes, nurses enter into network arrangements where the devices present as obligatory points of passage (Callon, 1986b). It is not that nurses are enrolled into networks unwillingly, as I highlighted in the findings, there is something to be gained for nurses in terms of role status by taking on the complex tasks surrounding technologically imbued care. To achieve this, nurses become locked into the network where the task in hand is to ‘look after organs’, ‘chase numbers’ or ‘balance patients’. As I indicated when reporting the findings, these metaphors for nursing care are constituted by the functionality of the technology. The necessary dependency on the technology for nurses to provide critical care involves framing the patient’s illness in line with the operational purpose of the technology. Where separate devices are designed to maintain each organ system (ventilators for lungs, dialysis machines for blood etc.), nurses’ understanding of the patient’s illness and the care processes involved is directed towards ‘looking after organs’.

This thesis has demonstrated that ICU nurses have to work within the medical technology network if they are to care for patients. Moreover, whatever technology the patient’s condition calls for, the device operates as an obligatory passage point. It claims the attention of the nurses, and shapes the conditions of interaction, even to the point where the patient is enrolled and configured in line with the technological discourse. Thus, nurses talked about chasing and balancing numbers as a stand-in for patient stability. Numbers are important in the ICU technology network; they are forms of text or inscriptions. Inscriptions work as rhetorical devices, carrying within them, in the context of the ICU, persuasive power to alter and direct care interventions. Their purpose is to carry the modalities of medical science and technology to other locations to act as social objects of persuasion. Thus, the results from a routine blood-gases analysis entered onto a paper chart not only engages nurses’ interests in continued involvement in the network aim- i.e. patient recovery, but also supplies evidence to maintain the *interessement* of other specialists in the ICU environment. Interestingly, in this example of activity surrounding the blood analysis technology, the nurse maintains their enrolment in the network through their dependency on the results to initiate further treatment (which might include the operation of the dialysis machine). It is in her/his interest to comply with the results and carry out subsequent treatment decisions. I suggest this is not only for the patient’s sake, but also for the nurse to demonstrate that ‘being a competent ICU nurse’ requires performative interaction with an array of technological devices. The latter point directs attention to the fact that what an ICU nurse is- an issue of ontology- depends on nodes of action that bring together heterogeneous elements. John Law (1992) puts the argument for human and non-human constituency this way: “*Analytically, what counts as a person is an effect generated by a network of heterogeneous, interacting, materials. This is much the same argument as the one that I have already made about both scientific knowledge and the social world as a whole. But converted into a claim about humans it says that people are who they are because they are a patterned network of heterogeneous materials.*” (p.383)

I would further add that ICU nurses’ understanding of their professional status and nursing identity is intrinsically linked to their network activities around technology. It is also pivotal to who they are as ‘individuals’. This is to say, they have a psycho-social interest in maintaining ‘subjectivity’. I feel this is the same point made by May and Fleming (1997) in that they raise the valid assertion that the content of nurses’ empirical practice assigns their identity. However, I would further agree with Miettinen (1999), who insists that the “world of artefacts is a precondition for human subjectivity” (p.190). This point is just as true for the subjective experience of nursing identity in the technological environment of the ICU. It might appear that when talking about nurses’ dependency on technology, the machines have ascendancy, enrolling nurses towards specific channels of interaction framed by the exigencies of the medical devices. In the example of blood-gases analysis, the outputs inscription from the machine

directs nurses' actions towards further technological involvement in the network. However, demonstrating the dynamism in network configurations, nurses may also operate as heterogeneous engineers, using these inscription devices to enrol further actants, including other medical devices and professionals, onto the network. In their efforts to secure recovery for patients, nurses deploy blood analysis results as text evidence to translate the interests and concerns of medical specialists- and their technologies- to get involved in the patient's case. The point I am trying to make here is that ANT helps untangle the network pathways; letting the researcher explore contingent alliances and the types of objects/subjects they produce e.g. the dependent nurse, the determining machine. By tracing the actions and intentions of actants, human and non-human, analysis can ascertain the flow of influence at specific moments in the network, and the contingent worlds they make.

On the contrary, if analysis remains chained to forms of technological determinism, the structural propensity towards determinist explanations would necessarily dismiss the analytical potential of viewing nurses, even within technologically pervasive circumstances, as network builders and shapers of socio-technical interaction. ANT leaves the unfolding scene of actant interaction open to indeterminacy and change, moment by moment. According to Singleton and Michael (1993), the indeterminacy and ambivalence of elements within networks should not be looked upon as an issue of analytical fuzzy-ness. On the contrary, indeterminacy is about actants taking up or being allocated roles within the network, which are at one moment intrinsic to the configuration of the network, and at the next marginal to the centre of action. Nurses' role in network associations is encapsulated in the ideas of centrality and marginality. Take the next two quotes from the findings as examples. In the first, the nurse's account describes their dependency on the technology as a way to understand the patient's condition. The nurse waits for information to determine her actions towards caring for the patient. At this node in the technology-patient-nurse network, the monitoring device effectively determines the input of other actants - namely nurses. The nurse, for her part, remains marginal to the technology-patient interaction, only responding, as her account indicates, when the technology delivers information on the course of care. *Fn01, female nurse: "What information you've got from it [monitor] will determine how you're going to look actually, not from a clinical medical point of view but from a nursing point of view, how you are going to care for that patient."*

In the extract, the nurse appears to position herself in a line of command where she perceived her nursing role as being able to respond adequately to the signs from the medical technology. This role position could be taken as identity-in-practice work, where the individual sees ICU nursing as the ability to respond to the technology. On the other hand, it could be viewed as the technology translating the nurse, ensuring that the nurse understands her requirements as an effective ICU nurse, able to handle and respond to the monitoring outputs. There is a feeling of ambivalence in this arrangement, where technological dependency also offers nurses a form of identity management, "*from a nursing point of view*". Fundamentally, ANT allows the researcher to think in these terms, that technological objects have agency to shape the understanding that nurses bring to their identity. If the marginality of nurses suggests a position outside the core action of network associations, then the notion of centrality puts the nurse-actant at the centre of network building strategies. The second quote below illustrates how nurses were able to take control of the construction of alliances, which were shaped by them to achieve the best possible care for their patients. *Fn09 female nurse: "I think we are quite autonomous in our practice for that one patient for a 12-hour shift or a seven-hour shift or whatever we are working. And we can initiate therapies, obviously working with the doctors; they are very receptive to our ideas. If we think something needs doing, they'll agree 'let's go ahead with it'. We're advocates of the patient as well."*

In this quote, ICU nursing was now at the centre of action. The language use was authoritative, and indicates the kind of network building that had been accomplished in order for the nurse to practice with autonomy. For example, the statement that doctors "*are very receptive to our ideas*" suggested that the nurse assumes a stabilised set of responses from the doctor. If doctors are also the effect of network stability, then the nurse not only relies on the stabilisation on the doctor-network, but also works to maintain it. This might be through, as the nurse indicates, further network strategies such as black boxing 'patient advocacy' as a role particular to nurses. The authoritative assertion inherent in the discourse around patient advocacy is enough to stabilise the nurse - doctor interaction, leaving nurses to practice their autonomy over initiating patient therapies, invariably involving medical devices. In terms of the nurse's account above, there is a marked difference in the command chain from the previous quote [Fn01], now it runs- nurse → doctor → initiated technologically derived therapy. To achieve this, the nurse has had to work at securing alliances, persuading doctors to acquiesce to the fact that through her long bedside vigil, which is another manoeuvre for network ascendancy, the nurse knows best for the patient. Constructing the nurse in this way, as central to network build efforts, throws up issues that need further explaining.

Firstly, are nurses, as autonomous agents, free to cluster other heterogeneous elements towards their own empire building goals? Secondly, what does this say about how nurses achieve an identity as ICU nurses? These questions, in fact, are interconnected. ANT addresses these issues by saying that although it may look like some actors

present themselves as autonomous tacticians, with the wit and nerve to draw together and command the services of other elements in their networking aims, the truth of the matter is these same actors are dependent on the existing enrolment and stabilisation of surrounding elements to enable the power to build. Thus the concept of power in ANT is associated with forces of alliances within the network and not with individual actants (Law, 1999; Latour, 1996). In the same way, nursing identity building should not be looked upon as established through some internal subjective voluntarism. On the contrary, identity formation is similarly dependent on the inter-relationality of actant elements circulating in networks.

Therefore, in both quotes above, there are two forms of nursing identity defined in interaction with the technology. The first [fn01] sees ICU nursing as being able to respond and make sense of technological monitoring, converting machine knowledge into care interventions. The second nurse's [Fn09] identity is configured as an autonomous agent able to act independently of the medical staff when instigating therapies for patients. In each case however, nurses' understanding of who they are as nurses only appears in the world as the effect of relationality to other actant elements. This suggests that identities, rather than being fixed, are in fact mutable in relation to the other shifting elements operating within the network.

The last point returns me to the findings presented in chapter 5. In this discussion it might be appropriate to reconsider the technological dependency of nurses as in fact a relationality of co-dependency between nurses and all actants in the network. Thus, a technological problem, e.g. a clotted line during patient dialysis, becomes a nursing problem translated into a setback in the patient's recovery. Similarly, when confronted with the problem of patient dialysis nurses are compelled to comply with the requirements of blood filtration technology, including maintaining its functionality. In this respect, the machine, like many of the sophisticated medical technologies in the ICU, commands nurses' attention as an obligatory point of passage in the patient's treatment. However, this scenario, on closer inspection indicates a co-dependency between nurses and the technology they interact with. On the one hand the nurse requires the technology for patient care, and is thus obligated to perform their nursing tasks through it. On the other hand, the machine requires the co-opting of nurses, along with a host of other network components, technicians, consultants, tubes, patient blood, in order to carry on as a viable technology. Crucially, these states of network alliances are indeterminate and precarious, liable to be reconfigured at other points and in other contexts within the ICU networks.

In the same way, nurses' understanding of the situation is partial. From the perspective of any one of the actors involved in this interaction, the role of the nurse could look quite different (Singleton & Michael, 1993). However, this is what emerges in analysis when one follows the actors. It is the partial perspectives of all the heterogeneous elements that result in indeterminacy in networks and indeed leads to failure when attempting to secure analytical closure. The researcher could trace all the actants in the network to resolve the matter, however this would be a formidable task due to the rhizomatic form networks take; ever expanding into new territories of actant engagement (Dolwick, 2009). By following other actors, we find that at different temporal nodes in the network, others are trying to re-open black boxes and resist enrolment, which are all factors that lead to occasional network instability. A case in point from the findings in chapter 6 was when nurses disclosed that in their efforts to work with certain technology; doctors will undo efforts by asserting that particular devices were "random number generators." *Fn11, female nurse:* "Quite a lot of our consultants have lost faith in the information the machine gives them. We're actually using different machines now... So we very rarely use these machines anymore, because we've lost trust in the information they give us."

Consultants happen to be important components in the ICU network. Therefore, their disengagement signals a sizeable rupture in the efforts to stabilise routine use of the technology in cardiac care interventions. The LIDCO heart monitor, as a once stable technology used by ICU staff, has become untrustworthy. This fall from grace for this particular device has come about through subsequent innovations in cardiac monitoring. The interesting thing about the LIDCO's history is that, according to interviewed nurses, as a technology it has always been untrustworthy. The nurses who were interviewed report that setting it up involves a series of invasive convolutions. When operating, it required regular re-calibration, and for all the effort on the part of ICU staff, it returned dubious monitoring results. Nonetheless, back in the day when its innovative features were viewed as the best in cardiac monitoring, it was able to draw together heterogeneous elements within the ICU towards ensuring its functionality. New devices and techniques in cardiac monitoring have caused the LIDCO black-box to be opened. The result is that alliances which held it together have now become unstable. However, the LIDCO remains the monitoring tool of choice in particular care scenarios, where some consultants favour it while others refute its merits. In science and technology studies this situation is the stuff of technological controversy (Collins & Pinch, 1998; Pickering, 1992).

ANT enables us to understand this situation as the inherent instability of actant enrolment. Indeed, characterising the LIDCO monitor as a 'random number generator' is now an effect (or outcome) of the precarious network built around the device. In addition, if we consider the LIDCO in terms of its immutability- its ability to

remain constant in form and purpose across the network- then its shifting inscription from cardiac monitor to *random number generator* suggest that time and innovation has very much made this technology mutable. It has, semiotically speaking, changed shape, and taken on a new identity through its technological lifetime in the ICU.

But where does this leave nurses' understanding of the device, with regard to their identity-in-practice? Interestingly, the nurses somehow stand between intersections of network influence. On the one hand they are led to operate the monitor by particular consultants, while on the other hand other senior staff refute the usefulness of the machine. This results in nurses demonstrating ambivalence to their identity (as a network effect) in relation to their practice with this particular technology. As the quote above indicates, the nurse shares the reluctance of consultants to rely on the machine. It might be considered that this stance marks their refusal to remain enrolled in this particular machine network. If the alliances that surround the LIDCO have broken, it is due, I suggest, in some way, to nurses working to protect their role and standing as technologically astute actors: "*we very rarely use these machines anymore, because we've lost trust in the information they give us*". There are new alliances to be made with other devices. The problems of the old machines are now not the nurse's problem. Their interests lie with the capabilities of other technology to support their patient's care.

### **3.2 Nurses' Social use of Technology**

I explored how nurses might use technologies in their interaction with other actors in the ICU environment. Here I was interested in the social affordances of medical technology beyond their actual technological function in the care of patients. For example, although nurses employ an array of monitoring devices to gather physiological information, the findings indicated nurses also used the technological information to mediate their status in relation to senior medical ICU staff. In addition, when nurses dealt with the death of patients, they again 'shaped' the semiotic qualities of technology in relation to patients relatives' expectations of bearing witness to the moment of death.

According to Law (2009), ANT recognises that technological objects can own layers of meaning which are open to appropriation by 'human' actants in their network building strategies. This is to say, the sign system in which nurses (and other ICU personnel) take their understanding from is one that is *necessarily* shared by all participants in the intensive care environment. I use the term *necessarily* to indicate that the world of ICU exists as a totality of meaningful practices, where the community participates in the collective circulation of meaning. Referring to this manifold of meaning, Suther (2006) describes it as the production of "intersubjective epistemologies" (p.318). Accordingly, meaning is created jointly in the interactions of group actors, but also actors can 'use' the shared meaning to mediate forms of interaction. Thus, the material 'reality' of the ICU is informed by the meaning-making practices of all who share the network environment. The technologies of the ICU are part of the semiotic or symbolic field in which nurses, consultants, patients and their relatives participate. As John Law (2009) states: "*We've seen that material-semiotics explores the enactment of realities, the ontological. We've also seen that it describes the making of knowledge, the epistemological.*" (p.154). Put another way, nurses are able to shape the symbolic meanings of technology to effect particular social interactions. When I presented the social affordances (Hutchby, 2001) that ICU technology offered, I was directing attention to the semiological qualities inherent in machines. In other words the machinery becomes a form of text or sign to be read. I would argue that nurses work to shape the technology as text to produce social effects. As Hutchby (2001) emphasises, "users ... may seek to produce readings of the technology-text that best suit the purposes they have in mind for the artefact" (p.445). So in the findings when the nurse talked about removing the technology from the dying patient, I indicated that the nurse was in effect mobilising a textual 'reading'. Wherein the removal of the technology signified to the patient's loved ones that the passage to death was perhaps imminent, and that they should bear witness to the actuality of the dying patient and not to any signs of death displayed in the technology. These insights from nurses' social practices surrounding death in the ICU have resonance with Timmermans' exploration of death in the emergency department (Timmermans, 1998). Timmermans also records that far from technological involvement effectively dehumanizing the social aspect of death (Moller, 1990), in enacted resuscitation efforts, technological devices can mediate the transition of death, by affording space for relatives to come to terms with the death of the patient.

As the previous extract from the findings demonstrates, machines in the ICU environment are used not wholly in terms of their technological affordances. That is to say, social affordances move the uses of technological devices beyond the direct purpose built into them as part of their designated technological role. Those who design and manufacture technology work to secure a particular use of the technology: how it should be operated, who should operate it, and in what context. It is not that ICU nurses use technology incorrectly, but they might employ it to achieve other ends, which creatively extend the textual qualities of devices. In doing this, nurses open up a space, which engages the technology in the social contingencies of the world. Of course the idea of social affordances does not suggest that anything goes in terms of using the social element of technology, the logic of local practices in which the technology is placed in some way defines the limits of the social affordances of the technology (Hutchby, 2001). I am

seeking, with this example to bring attention to how nurses as heterogeneous engineers are able to enrol machines into alliances in order to shape interactions with human and non-human actants. In some respects, the activities involved in network building amount to persuading and enrolling other actants on to networks. I reported in the findings that this is most notably achieved when nurses situate themselves as an obligatory point of passage, ensuring that other actants, namely doctors, have to engage with nurses to understand the patients' condition. *Mn03 Male nurse: "I'm not saying that I know better than the doctors, but I do think because I'm spending more time with the patient I am the best person to relay changes in their status condition... because I monitor them closely."*

The power/knowledge relationship, enacted through technology, gives nurses a level of status enhancement in the ICU. Thus, in the findings in chapter 6 where I discussed nurse-doctor interaction, nurses were able to challenge the treatment decisions of doctors, through their intimate knowledge of the patient's condition, provided through intensive monitoring. Once more, I would argue, nurses are appropriating the textual quality of machines beyond their technological affordances. This is to say, they use their position as knowledge providers in terms of the patient's condition, to mediate their social-professional status in relation to medical staff. For their part, doctors, consultants, and surgeons, as participants in the epistemological community, 'recognise' and indeed acquiesce the symbolic knowledge/power held by nurses, through their tacit acknowledgement of nurses' expertise. This interaction, as well as operating through the materiality of the ICU technology, also operates at the semiotic level, where signs, symbols, and texts flow in the circuit of meaning that makes up the ICU world. This analysis is similar to Carmel's (2006a) examination of the doctor-nurse relations in his study of the ICU. I agree with Carmel on the notion of a shared project of the ICU. However, my analysis suggests that nurses' use of technology-in-practice reveals, as with other examples presented in the findings, that the doctor-nurse relationship is mediated around the social, symbolic and crucially the material qualities of ICU technology. For example, ownership of the knowledge and information that the technology provides very much structures the status relationship of the two professions.

All this raises an interesting point in ANT analysis. The point I have been making throughout this thesis is that ANT usually assigns outcomes or effects to stable networks. Thus, it might be considered that an ICU nurse or a LIDCO machine materialises as an effect of a stabilised network of heterogeneous elements: designers, manufacturers, trainers, codes of conduct, technicians, power supplies etc. But what happens to the nurse as a network effect when a particular network untangles, when elements remove their enrolment or the dimensions of alliances shift? The answer is that nurses don't disappear. Instead, I would argue that the breakdown of networks produces further effects at other points in the web of association. Indeed, the suspension of particular network alliances instigates actants to reassemble elements, find new associations, and begin the work of stabilising new networks. So, the nurse's suggestion that the old filtration machines are "dying" can be taken as an effect of the destabilised network of elements that once surrounded it. Having observed the efforts involved in introducing the new technology to nursing practice, I can testify to the trials that nurses undergo in assimilating new forms of knowledge and expertise into their practice. For a while, the network elements- amongst which are company representatives, training sessions, product manuals, and nursing protocols- will remain visible. However, in time, nurses will shape their understanding of the technology, and socialise the technology as an extension of their nursing practice and identity; whilst the stabilised heterogeneous elements will vanish into the background. The network, according to Law (1992): "*[W]ill be replaced by the action itself and the seemingly simple author of that action. At the same time, the way in which the effect is generated is also effaced: So... that something much simpler... comes, for a time, to mask the networks that produce it.*" (p.5)

The simplicity that is arrived at in the normalising of nursing practice around technology, frames the technology as a neutral component in their endeavours to care for patients. Although nurses are involved in the minutia of network activities, the complexities of the network arrangements are never wholly disclosed to them, through their actions. Furthermore, nurses in their everyday work do not recognise their network building strategies, or in fact, that they may be influenced by heterogeneous engineering strategies of a host of other actants, including technologies, pushing them this way and that way, enrolling them through unspoken interests. The findings disclose that nurses do operate strategically, using their own power and influence to configure representations of patients. When looking through the lens of ANT, the network world of the ICU and nurses' understanding of it comes to the fore. Networks can be traced, to some degree, to enlighten nursing practice around technology in the ICU. Within Chapter 2 I examined various sources of science and technology and nursing literature, and agreed with May and Fleming (1997), and Carmel's (2013) argument that standard nursing theory may not serve its purpose. What nurses should do by way of prescribed theories of practice does not capture fully the boundary of ICU nursing in context. Where I differ with Carmel is in the mode of analysis of these fundamental socio-technical relations. My focus, although it touches upon many of the themes raised by Carmel, has been to find explanation for the changing practices of ICU nurses in the complexity of socio-technical arrangements. Carmel appears not to consider the radical consequences of technology upon nurses' social interactions with other actors in the ICU. Although he recognises the materiality of technology in

the ICU, he eschews the nonhuman charisma (Lorimer, 2007) of technology to hold the same ontological forces as human actors (Carmel, 2003).

I, on the other hand, understand the force of technology in the ICU to mediate care interventions along with nurses. The ICU is a complex world; and to explore how nurses understand it, requires unravelling the complexity that involves both technological and social interaction. Not all nursing interactions around caring for patients on the ICU are technological, although they may appear as such on the surface. Likewise, analysis of supposed direct social (and political, economic) exchanges must admit the importance of technology as a mediator in those interactions. Returning to Timmermans and Berg's (2003) analysis of technology-in-practice, I have demonstrated the complexity of technological involvement in the ICU, and demonstrated that nurses' understanding and use of technology configures a great deal of the practice that goes on within the ICU. Moreover, nurses, in their interaction with the ICU technology nurses, are able to articulate the symbolic qualities of the technology. Through this articulation nurses subtly reconfigure both their own and patient identities. These identities are not static, but dynamic and mobile. Hence, I showed in the findings in chapter 7 that patients' identities are transfigured in socio-technical networks, as they move through the ICU care regime. They move from 'technological bodies' to 'social bodies' as an effect of the changing representations of patients constructed by nurses. This transfiguration comes about as a necessary component of both nurses and patients' reliance on network alliances with the life-saving technology; making it possible for the former to practice and the latter to survive.

### **3.3 Future Research Using Technology-in-Practice**

Timmermans and Berg (2003) ask that future research of technology and medicine is alive to the creative interplay of actors and technology and the social context of interaction. In the last decade or so, the technology-in-practice model has informed the diffusion of technology in healthcare environments (Ulucanlar et al., 2013; Peiris et al., 2011; Harrison et al., 2007; Poland et al., 2005). These studies have looked at how technology has been adopted across a range of healthcare settings, ranging from hospitals to GP practices. At the same time, the UK health service, through the institutions of Health Technology Assessment and NICE (National Institute for Health and Clinical Excellence), has attempted, through protocol and guideline processes, to ensure the stable transition of new innovations into health practice. However, the guidelines given for diffusion have often been criticised for using the assumptions inherent in probabilistic science, and efforts towards the routinisation of practice around new technologies (Chalkidou et al., 2007). The message from technology-in-practice has been that technological adoption must be understood as presenting a complex interplay of social processes; technology innovation does not simply transfer from design to manufacture to practice in a straightforward linear progression.

In a recent study undertaken by Ulucanlar et al., (2013) the authors set out to inform the introduction of technology by placing diffusion efforts within the empirical world where the social context informs the adoption of technology. The important message from this work is that to understand the successful adoption of new technologies, the researcher must undertake a sociological analysis of how technology is taken up in the world of health care. Ulucanlar et al., concurring with my theoretical perspective, use ANT as a lens to provide a framework which includes investigating the social identity of both technology and humans as a valuable indicator into technological adoption by healthcare organisations. Ulucanlar et al., (2013) have identified that the: "*Adoption processes are strongly socially mediated by technology identities: a set of composite and contestable attributes that give each technology a distinctive, if contingent, character. Identities reflect actors' social orientation and the cognitive necessity to define and imbue with meaning other actors, including... the nature of the technology itself and its material properties.*" (p. 103)

In conclusion, I recommend that research and policy guidelines reflect the complex and contingent nature of socio-technical network arrangements. Any prior assumption about how technology will interact with individuals and organisations should be laid aside. Emphasis in policy guidelines should be on understanding the co-configuration of human and technological identities. Ulucanlar et al., (2013) have developed a useful framework which articulates the uptake of machines beyond their technological usefulness, as devices that enable identities of use. However, what is not clearly understood in the findings presented by Ulucanlar et al. is the possibility of reciprocity of identity construction in the interactions between professionals and machines. In my study, however, there is a thread throughout that alludes to the ideas that through their understanding of technology, nurses adopt and play out forms of identity in relation to socio-technical networks. In relation to my thesis, future research on ICU nursing and technology adoption might consider the possibility of socio-technical interactions to configure positive nursing identities as a strategy for technological adoption in the ICU.

### **3.4 Conclusion**

This thesis set out to explore ICU nurses' understanding of technology, and sought to answer the questions: In what way does nurses' understanding of technology in the ICU mediate their use of this technology? Do technology

and technological regimes shape nurses' ideas and representations of patients, and the forms of care they provide? In order to investigate these questions I used an ethnographic approach, informed by ANT. Using this theoretical approach my aim was to investigate technology-in-practice, to pick up on the nuanced socio-technical interactions between nurses and technology. I found that by taking this approach I was able to gain a picture of how at one moment nurses' understanding of technology revealed their dependency on the technological arrangements in the ICU in order to care for patients; whilst at other points, nurses used the technology to mediate social interactions with others to achieve socially significant outcomes. However, when analysing these interaction moments it was important to understand that nurses' dependency upon, and social shaping of technology were a dynamic feature of the socio-technical interactions of a whole array of heterogeneous elements operating in the ICU network.

A further message from this study was that nurses' interactions with technology provided an opportunity for nurses to construct a number of metaphorical identities: as 'mini doctors', 'scientists', and 'technicians'. These identities, I argued, were an outcome effect of the socio-technical networks that make up the ICU. A technology-in-practice approach, such as ANT, with its interpretive flexibility allowed the dynamism of real world interactions to emerge from the data. I have argued that ANT provides an important means to make sense of the data, and have suggested future research using an ANT as a technology-in-practice perspective might focus on how nurses' identities in particular might be shaped by technology. Also, how in turn, nursing identities constructed in socio-technical network interactions, might inform the adoption of new technologies in the ICU.

In closing, I believe the findings presented in this thesis add to an understanding of the complexity of technology diffusion and implementation in nursing practice in the ICU. My sociological account casts light on some of the complex interplay between nurses and technology. Modestly, I hope that these insights can help to address the issues faced by nurses and by extension, patients, their relatives and designers of medical technology.

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