The ghost of anatomies past

Simulating the one-sex body in modern medical training

Feminist Theory

SAGE Publications
(London,
Thousand Oaks, CA
and New Delhi)
vol. 6(2): 141–159.
1464–7001
DOI: 10.1177/1464700105053691
www.sagepublications.com

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Abstract An examination of the use of medical simulators shows that they contain traces of the one-sex body model found in pre-Enlightenment anatomies. The simulators present the male body as 'male including female' rather than 'male, not female'. Only when female sex organs are relevant to a practice, as in gynaecology, does a simulator need to become 'female, not male'. The widely held modernist understanding of sex and gender as binary categories is actually masking local practices which allow varied sex and gender paradigms to coexist in simulator use. This analysis applies the discussions of Laqueur, Schiebinger and Faulkner to simulator practice. The consequences of recognizing the presence of the one-sex body are two-fold. Firstly, seeing that the reification of medical knowledge can still be haunted by conceptual paradigms of the past forces a more nuanced understanding of the variety that localized medical practices contain. Secondly, observing the ease with which the reified knowledge of a one-sex body is embraced by subjects who also exist in a world of binary gender points to the complexity our subjectivities can embrace and forces the researcher to acknowledge the implications of the simulations' context.

keywords *anaesthesiology, anatomies, binary sex, gynaecology, medical practice, MIS, one-sex body, simulators*

This paper has grown out of a study of the use of simulators in medical education, during which I observed the ways in which medical students and instructors approached, used and discussed simulators, both as tools for teaching medicine and as stand-ins for patients. The research was based on analysis of video taped simulator sessions, interviews with instructors and students, and observations conducted while shadowing students on the wards as they trained on real patients and in a simulator centre. The research made visible methods employed by users to create medical practice out of simulator practice.

During the course of my research I have encountered a number of different simulators, three of which I am going to discuss in this paper. These three simulators, a virtual reality surgical simulator (Figure 1), a digital full patient mannequin for anaesthesiology training (Figure 2), and

Figure 1 *Virtual reality surgical simulator. © Huddinge Media Department.*

a female pelvic exam simulator (Figures 3 and 4), were and are being used in teaching hospitals by medical students while they concurrently took traditional courses in the fields for which the simulators have been designed.

The surgical simulator uses haptically enabled virtual reality to imitate the instruments used in Minimally Invasive Surgery (MIS) and allows students to practise manipulating the visual optics needed for seeing inside the body and the surgical instruments used to perform simple procedures. The body of the MIS simulator is modelled in part on data taken from the male body of the visible human project.

The anaesthesiology simulator (a computerized full body mannequin)

Figure 2 *Full patient mannequin, anaesthesiology simulator. © Huddinge Media Department.*

simulates a patient's physiological responses to anaesthesiology practices and pharmaceuticals, both in a healthy state and during unexpected complications such as heart attacks or strokes. It is generally used by groups of three to four students and an instructor. In these groups the students take on the various roles of medical professionals in the operating room, and practise the work done by the anaesthesiologist as well as by the anaesthesiology nurse and operating room nurse. Students train in both the technical practices of anaesthesiology as well as the communication which occurs between the actors involved in an operation. The mannequin of the anaesthesiology simulator is modelled on a large, adult male body, though there is a replaceable insert which can be used to change the genital region from the male to female sex organs.

The pelvic simulator is a physical model of the female reproductive organs encased in a body-like sheath that represents the front of the lower abdomen and the upper thighs. The internal organs (uterus, cervix and ovaries) are equipped with sensors that display on a computer screen if the person examining the simulator has felt the correct organs with sufficient pressure. The sensors also indicate if the examiner has pushed too hard on the organs and thus caused the patient pain.

Using the simulators allows students to try medical procedures at a much earlier stage in their training without risking the health or comfort of a patient, and without the need to maintain the professional mask in front of the patient. Managing the professional mask and performance in front of patients and other professionals is a common theme in the

Figure 3 *Pelvic simulator, for gynaecological exams, exterior. © The New Visualization and Simulator Technologies Group, Linköping University.*

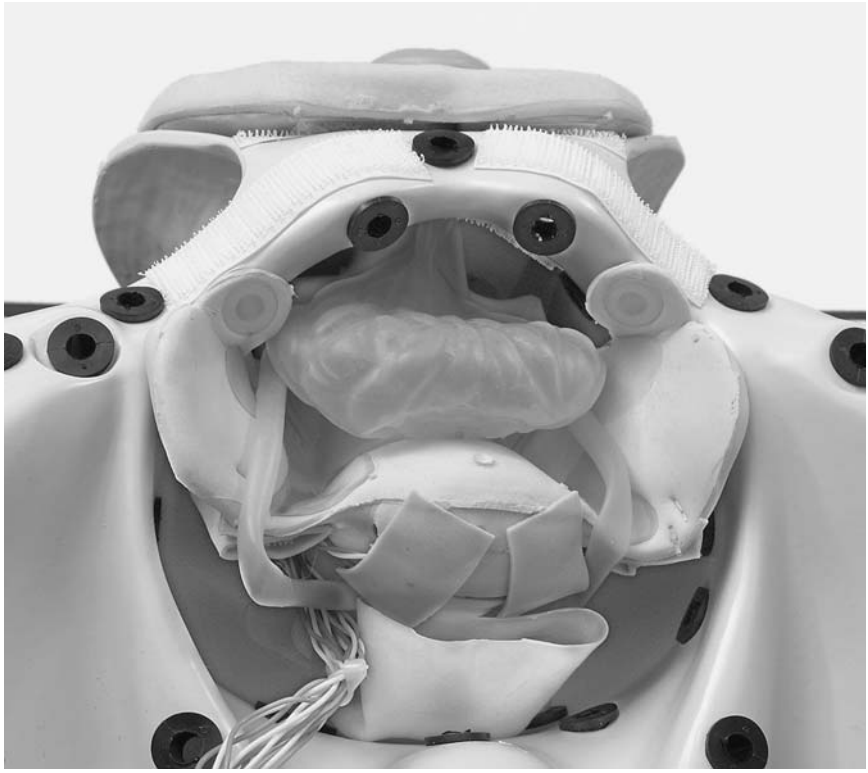

Figure 4 *Pelvic simulator, for gynaecological exams, interior. © The New Visualization and Simulator Technologies Group, Linköping University.*

sociology of medicine (see Haas and Shaffir, 1987; Thelander, 2001), as is the display and standardization of medical knowledge. Traditionally, students learn how to conduct themselves as doctors in front of patients and their peers through clinical practice, while the teaching of theoretical knowledge of the body's anatomy and physiology has generally relied on various representational technologies, such as plaster, plastic or wax models, illustrated anatomy textbooks, or even dissected cadavers (see Starr, 1982). Crossing the bridge between theoretical knowledge and the practical ability to apply medical techniques is not always easy. It is in bridging the gap between theoretical and practical teaching that medical simulators are being used as a substitute for the unsuspecting 'patient-guinea pig'.

While the use of simulators in medical training is, according to medical and computer science literature, a recent development, representing the human body in sketches, etchings and plaster models for medical educational purposes is nothing new. And like other methods for representing the body, modern simulators, too, have gendered understandings of the body built into them. Research in cultural studies and the history of medical visualization technologies has discussed this when analysing medical images from the Enlightenment – sensual female images

with round and attractive bodies reclining on settees and draped in alluring poses, similar to 18th-century portraits of nudes except that in these sketches the abdominal skin is slit and pealed back to reveal the underlying muscle structures, intestines, or organs. Historical work on even earlier anatomical sketches of the male and female genitals has presented the understandings necessary for medieval artists to render a pair of ovaries inside an abdomen as nearly identical to the male testes hanging outside between the legs. Analysis of these time capsules of past medical concepts has shown how western medicine has represented and taught the body differently through time (see Laqueur, 1990; Schiebinger, 1993; Jordanova, 1999). Medical simulators carry on this tradition of representing the body to medical students and professionals, while adding the possibility for students to feel and recreate practices upon the technology. Simulators join modern and historical anatomical sketches and models in revealing the medical understandings of the body held by those who create and use them.

Parallels between the simulators and the more established use of anatomical sketches can be drawn on several levels. The most obvious is that both traditions rely on an often stated claim to represent the actual, living body and a desire to be as truthfully realistic (*valid* in the medical simulator literature) as possible. In anatomical sketches, the visual was the raison d'etre (Jordanova, 1999: 183). In current simulators the visual combines with the tactile, so that advances in computer graphics are integrated into technical systems that also rely on physical mannequins or virtual reality models 'felt' through haptic feedback technologies. To achieve a validity in relation to the living body, some of the models used for the creation of both simulators and traditional anatomical schema have been dead bodies. Jordanova details 18th-century processes, such as the use of wax filled veins to prepare cadavers for dissection and artistic reproduction, and drawing decaying tissue as if it were still wet and glistening (Jordanova, 1999: 189). Today's high-tech version of the hospital basement cadaver is the visible human project, a set of bodies that have been frozen, sliced, scanned and digitally rendered into computer models of the human body. This project first modelled the body of a white, middle aged male, then a post-menopausal white woman, then eventually another woman still in her reproductive years (see Waldby, 2000; Cartwright, 1998a).

A second parallel between anatomical sketches and medical simulators is that they are both being used to turn the knowledge and practices of the medical profession into material representations, and thereby legitimate anatomical understandings (for example, the pre-Enlightenment sketches presented the idea that the female reproductive system mirrors the male, just inside out) and medical practices (as the surgical simulator introduces and propagates MIS techniques). Jordanova acknowledges that the use of visual display once played a stronger legitimating role than it does now, since medical schools, teaching hospitals, and licensing boards today have taken over much of the validation of training and professionalization for the medical community (Jordanova, 1998: 215–16). A century ago, anatomical sketches represented facts about the body, more for the medical

community than for patients (Jordanova, 1998: 209). Today simulators are taking on this role of creating and representing medical knowledge for the medical community. Simulators can be interpreted as an attempt to articulate and reinforce, through visual and tangible proof, the knowledge and local practices of a particular community as truths.

As teaching tools, the simulators serve to standardize the practices being taught on them. For example, while students may not be aware of this, simulators like the minimally invasive surgical simulator work as missionaries for an innovation in surgical procedures which is relatively new, as well as to introduce specific surgical tools into the technical repertoire of a new generation of medical professionals. These simulators are also used to spread knowledge about the benefits of keyhole surgery to older practitioners by working as a demonstration tool in the hospital. And, potentially, they can be used as a testing tool to ensure a certain standard of practice by surgeons employed at the hospital, legitimating the individual surgeon's practice for both the peer group and the potential clients.

A third parallel that can be drawn to anatomical sketches is that, as assertions of 'reality' or 'fact', both anatomical drawings and simulators stand open to an analysis of the underlying values and understandings they simultaneously represent and reproduce. Even though the medical discourse of validity attempts to underline their realism, the simulators are still conceptual representations of the body, just as earlier anatomical representations. In discussing her work with images, Jordanova makes the point that, 'once it can be agreed that naturalism and realism must be analysed and not taken for granted, as too many works dealing with medical images still do, then attention can be turned to cultural motifs and historically-specific themes' (Jordanova, 1999: 201). Turning my attention to the 'cultural motifs and historically-specific themes' in the modern medical simulators has uncovered some very historical, un-modern ideas behind their construction, and their use is an example of the modern subject's ability to integrate multiple understandings of the human in practice.

Patient-bodies, simulators and senses

There are a number of levels on which an analysis of the medical practices and understandings embodied in the simulators can focus. One of the more obvious starting points is the way the medical patient and practitioner are constructed by the machine, and how, thereby, the simulators reflect the different bodily senses which are more or less important in various medical fields.

In the surgical simulator there is an attempt to make the computer graphics displaying the body realistic to the point of unrealistic realism. The simulator's images are clearer and the organs more differentiated than those appearing on the video monitor during an actual operation. At the same time, the simulator presents visuals that force the student to translate from two-dimensional images to three-dimensional space. Even though the 'space' created by the machine underneath the surgical cloth is

three dimensional, and the probes and pinchers are manoeuvred through this three-dimensional space, the images on the screen which the student looks at are two dimensional, replicating the two-dimensional images surgeons receive on the video screen during MIS procedures. Validity is also enhanced in the surgical simulator through a series of small, computerized motors which create varying resistance on the handles in order to simulate what it feels like to bump up against the squishy stomach or collide with the significantly firmer liver. Using the simulator means learning how to make steady, co-ordinated movements and to manoeuvre instruments in a crowded space. It also means learning how to manipulate the optics inside the 'body' to create the right visual on the screen, and then translate that visual into a workable understanding of an anatomical space. The tactile 'seeing with one's hands' as well as seeing three-dimensional out of two-dimensional images have been built into the simulator (see Johnson, 2004). The result of this is that the 'patient-body' in the surgical simulator is the interior of a knee, shoulder or abdomen, and the internal configuration of bones, tissues and organs which need to be worked upon, avoided or approached with the instruments. The worked-upon body also includes the video screen (computer monitor) and the instrument handles that stick up out of the green surgical cloth covering the haptic motors. The patient's head, his temperature or heart rate, or the pallor of his skin is not part of the simulation since it is not part of the patient-body necessary for minimally invasive surgery, at least as defined by the MIS surgeon who helped in the development of the simulator.

The full patient mannequin is used to train anaesthesiology students and emergency response teams. Anaesthesiology practice relies on interpreting the patient's physical condition through both the physical body as well as the read-outs of an electrocardiogram (ECG) machine connected to the body. The simulator allows students to do both of these by using the mannequin and the ECG machine it is attached to. It has a heart rate which can be read from a screen, felt in the pulse points and heard through the stethoscope. The patient's pupils can shrink and dilate in response to medications administered during a procedure. The patient's muscle reflexes can be tested through an electric shock applied to the thumb, just like with a real patient, and the intubation procedure can be carried out, which means the students can really shove (with difficulty, as they also encounter in real patients) the tracheal guide and tube down the trachea and into the stomach (accidentally) or into the lung passages (correctly). The 'anaesthesiologist' can also use the respirator and hand pump to 'breathe' for the patient when the muscle reflexes have been numbed and the patient is anaesthetized. The breathing can be 'heard' from the surface of the patient's chest with a stethoscope, and the user can also listen for the sound of air bubbles if the tube has ended up in the stomach region or, alternatively, breath in the lungs if the tube is correctly inserted. But the interior of the patient is not anatomically correct. Rather, it is designed to give the correct external signals on the patient's body and on the machine read-outs so that the anaesthesiology team can interpret their actions and

the body's responses correctly. This interpretation relies on the medical student's ability to observe the patient through sight and sound, as well as their ability to interact with the body and interpret its responses, both directly and through the mediating ECG machine. In this manner the simulator creates a body that can communicate through the same channels a real body would, but that does not have the underlying anatomy of a real body. The technology of the full patient mannequin creates a certain type of body: the anaesthesiology patient-body.

An 'anatomically correct' interior is more important for the female pelvic region simulator. The outside of the 'body' doesn't really look like a human patient, and a replication of patient responses or the physiological body functions of the interior organs represented are not included. This is because the simulator is designed to teach students how to conduct a manual gynaecological exam which, they are taught by the simulator, occurs inside the female body, not with the patient's exterior, and not with the patient herself. Instead, the size, shape and position of the uterus and the ovaries have been represented, and these have been fitted with sensors to signal if the student touches the correct spots during the exam. The ability to sense shapes and surface structures with the fingers is what the simulator is trying to convey. There are no knees for the medical student to touch reassuringly with the right hand before entering the vagina with a gloved and lubricated left hand. And there is no face for the medical student to make or avoid eye contact with during more or less 'embarrassing' procedures (see Heath, 1986). Rather, the simulator represents the part of the body and the elements in it which are examined by the specialist's hands, which says as much about the understanding of what a gynaecological exam is as it does about the simulator. Reading the gynaecology patient-body from the simulator shows that, for practices like pelvic exams, the patient-body is the pelvic region with active, internal reproductive organs, but not the sexual organs located on the outside of the body (for an analysis of the medical relationship to the oft disappearing clitoris in anatomies, see Moore and Clarke, 1995). And like the surgical simulator that facilitates practices localized in specific body parts, the rest of the body is not represented with the gynaecology simulator either.

Examining the simulators for the medical patient-bodies they represent can be a tool to bring the specific concepts of the patient-body into sharper focus, both for the medical practitioners using the simulator and for others, like myself, who are analysing it. Seeing, for example, the idea of the gynaecology body so clearly represented in the technology used for teaching medical practices exposes the conceptual understandings of the body that have led to the development of other medical reproductive technologies and techniques criticized for reducing the female patient to the visual images of her internal reproductive organs. This underlying concept of the body is found in the use of ultrasound to extract and recreate on a monitor the 'body' quite separate from the woman lying on the examination table during pre-natal exams and egg harvesting (see Cartwright, 1998b; Cussins, 1998a). It is also found in the way practices of reproductive technologies can be understood to have dissolved the unity of foetus

and mother, involving instead discrete elements such as eggs, fertilized or not, embryos, wombs, and petri dishes (Martin, 1992: 19–20; Cussins, 1998b). When we see the concept of the gynaecological patient-body reified in a pelvic exam simulator, the situations described in many of the critiques of reproductive medicine practices become more understandable – not less disturbing, but a little more contextualized in the understandings of the patient held by the field.

A simulator can be a tool to materialize, or reify, elements of medical practice, including concepts of the patient. In the use of the surgical simulator and the pelvic simulator, the patient is reduced to a non-interactive body part, which can also be seen as a commentary on the role the patient is allocated within those fields. The objectification of the surgical patient-body has been dealt with in other work (Fox, 1992) but the way the simulators themselves contribute to this detached and objectified view of the patient is highlighted by the contrast between training gynaecological exams on the pelvic simulator and training on a professional patient. This could be the result of an instrumentalist approach in western medicine that eschews the embodied self. In the case of the pelvic simulator, it serves the gynaecological community both as a venue to practise pelvic exams and to define 'their' area of activity for students. But this is also perhaps a result of the technology itself. I have had the chance to observe students learning to perform a gynaecology exam on professional patients, women who volunteer to be examined by students learning the procedure. In these teaching situations the women make a point of including their whole person as part of the exam. Students are taught how and when to make eye contact with the patient, are reminded by the women about the pressure their non-examining hand exerts on the patient's knee, and told how their hand movements inside the pelvis feel for the patient during the exam. In this type of learning situation, with real women working as both patient and teacher, the area of activity for a pelvic exam is expanded beyond the interior of the pelvis. Yet in the simulator, which is being adopted and used, the pelvic exam is defined as occurring within the pelvic region and the exterior of the vagina. According to an interview with the simulator's designer, this was done for practical reasons, so it could be easily transported from room to room in a hospital. Yet that 'convenient' design also tells a significantly different story of the patient than the pelvic exam conducted on a real patient.

The pelvic simulator marginalizes the 'person' from the medical procedure conducted on the 'female body' (understood as the reproductive organs), in a way that the full patient anaesthesiology simulator does not, suggesting that the gynaecology community's understanding of the patient-body differs from that of the anaesthesiology community. Interestingly, during use of the full patient simulator with students, the simulator was 'animated' through a ventriloquist style attempt on the part of the teacher, who was trying to make the students verbally interact with the patient as they would before and after an operation, which helps them interpret the patient's status during anaesthesiology. Thus it would appear as if the patient-body which is reified in each of these three simulators reflects a

specific understanding of the patient in the respective fields, and that the patient-body varies between them. In doing so, the simulators then function as a visible and touchable tool to teach new doctors these discipline-specific understandings.

The sexed simulator

It is easy to see which parts of the human body are of interest to the fields of minimally invasive surgery, anaesthesiology and gynaecology from examining the simulators and thereby gain insight into the varying understandings of the patient-body which exist in different medical fields. However, one can also examine the simulators for the biologically sexed patient-bodies they represent, in much the same way earlier work (Laqueur, 1990; Schiebinger, 1993; Moore and Clarke, 1995; Jordanova, 1999) has examined older anatomies in textbooks and folios for what they say about how a body's sex is conceived.

On the surface, the sex of the simulators seems fairly straightforward. The anatomical volumes presented in the surgical simulator have been modelled from data derived from the male carcass in the virtual human project. The full patient mannequin is modelled on a generic, full-grown male body, and the pelvic simulator simulates elements of the female pelvic region. The simulators represent two male bodies and one female body. One could assert that the first two simulators (as has been said about many modern anatomy textbooks) are based on the universal male body, and see the third as an anomaly. But I am not sure it is that easy. The ideas for this paper started developing while I was conducting ethnographic fieldwork at a medical simulator centre with professionals whom I generally found to be politically correct, gender sensitive, and pedagogically concerned with integrating female students into their practices. I had a hard time reconciling this image of the instructors with the blasé answer I received when I asked if there was a female simulator for the anaesthesiology students to work on as well. ('The abdomen is removable and there is a female replacement part, but it doesn't really matter. It's not important for what we are simulating'.) At the time I had been reflecting on why there had never been any mention of the fact that the two primary simulators in the centre were modelled on male bodies[1] by any of the doctors or nurses I encountered there, even though they talked about other aspects of gender and medicine and even though half of the staff, including two of the surgeons in leadership positions, were female. Of course, none of these details would have to mean that they must be concerned about which sex the bodies of the simulators represented, but I still thought it was a little odd that it would be treated as such a non-issue when I brought it up. That the simulators simulated the male body merely seemed to be the natural state of things, and not something problematic. I wanted to explain to myself how this could be a non-issue. I had no reason to doubt what the instructor had said to me, that it was not important for what they were simulating. For the instructors and the students, it obviously did not matter, at least not enough to reflect over. But I wondered about *why* it wasn't important.

One thought could be that this was a result of the objectified body of medicine which is reduced to mechanical functioning. But even a mechanical view of the body leaves room for male and female mechanics. Instead, I started to consider the possibility that there was an understanding of sex at work behind the simulators (and the libraries full of anatomies) that differed from my own admittedly binary conception. I started to suspect that, just as understandings of the patient-body could differ between specialities, so could the understandings of sex employed in medicine vary between fields and between differently situated practices. And I started to suspect that, in the simulator centre where I had been conducting my fieldwork, I was encountering the remains of a much older, one-sex body reincarnated in a modern simulator, like a ghost of anatomies past.

It has been fifteen years since Laqueur (1990) came out with his history of the one-sex body and medicine's transition to the two-sex model during the Enlightenment. Laqueur explains the one-sex model as an understanding of the female as a lesser developed version of the male. He documents its presence in anatomical descriptions stretching back to the Greeks and forward until the late 17th century (Laqueur, 1990: 114, 157–8). In the one-sex model the under-development of the female is embodied in the genital construction. Because the female body has less 'heat' her genitals are never pushed outside of the body, so the organs that would have become the male genitals are still inverted and inside. The potential penis and the scrotum are upside down and inside out, hanging in the abdomen disguised as (to use our two-sex model terminology) a vagina and a uterus.

Underneath this medical explanation lies a theoretical understanding of the one-sex body; the female body is the same kind of body as the male body, only with a different anatomical mapping of the genitals. Despite the differences in appearance – or location, or topology – the one-sex model of the body states just that: there is but one sex to the human body. The dissolution of difference between the two sexes is not an ombudsman for equality; the model is hierarchical through positioning the female 'below' or as a less developed version of the male. The theory posits that the human body in its most perfect form takes the physical appearance of the male body. But therein lies a linguistic consequence of the one-sex model: calling the ideal type body 'male' becomes a misnomer when we use 'male' to denote one of the two sexes in the binary relationship we today use to understand sex, and for that matter gender.[2] The body of the one-sex theory is physically the same as the universal male, but in the practices of anatomical representation, the one-sex model's 'male' also includes, describes and represents the female body. Differences between the male and female bodies are differences in degree, not differences in kind.

Laqueur discusses the demise of the one-sex model, attributing it at least in part to changes in society which required that the sexes be made irreversibly distinct. Women became a different *thing* than men, rather than being underdeveloped men. He claims that this eventually caused a change in the way medical images and medical understandings represented the male and female. 'Gradually the genitals whose position had marked a

body's place on a teleologically male ladder came to be rendered so as to display incommensurable difference' (Laqueur, 1990: 158).

While the timeline for this change has been debated (see Stolberg, 2003; Laqueur, 2003), one of Laqueur's points is that social understandings of the gendered body influenced the interpretation of biological sex and medical facts, even by the medical practitioners themselves. He shows that discoveries in the field of hormonal and reproduction processes during the early 20th century were not used to challenge the then dominant ideology of sexual dimorphism, even though they could potentially have done so. Instead, science and medicine paid homage to the two-sex model, because, as he puts it, 'two incommensurable sexes were, and are, as much the products of culture as was, and is, the one-sex model' (Laqueur, 1990: 153). In other words, how we understand sex determines how we see it around us. As Oudshoorn has also shown, even when the essence of sex moved from the gonads to the hormones with the development of the field of endocrinology, the difference between male and female was still seen as one of type rather than degree (Oudshoorn, 1994: 145f.).

Laqueur's history of the one-sex and two-sex models shows clearly that, and to a lesser extent how, the two-sex model has become dominant in North American and European societies. Laqueur focuses his attention on medical anatomies, but the understanding of biological sex, of male and female as grounded in the sexual difference of the human body, has influenced other fields of science as well. Schiebinger (1993), for example, traces it in 18th-century botany and biology. With time, the idea of sexual difference became a binary, differing from the one-sex model in a very important way: the male and the female were posited to be mutually exclusive, and this is applicable to gender as well as biological sex. Faulkner claims this can be traced to the hegemony of heterosexuality in cultures that see male and female as complementary opposites necessary for the unity of marriage. 'The need to define masculinity as not femininity, and the fear of the feminine in men, are recurring themes in the masculinity literature, explained in terms of normative heterosexuality' (Faulkner, 2000: 781–2). This tendency to define masculinity as that which is not feminine, and create tangible distinctions between the two, does appear to be just about everywhere once one starts to see it. It shows up in child rearing and the 'acceptable' toy choices given to girls and boys such as Barbie dolls and computer games (Cassell and Jenkins, 1998). It shows up in labour disputes over the introduction of new technologies and subsequent 'feminization' of industries (Cockburn, 1983), and in the displays of masculine behaviour by female engineers who want to succeed in engineering (Kvande, 1999). It is even built into the English language: masculinity and femininity are constitutive categories in themselves (Butler, 1990).

Within the field of sociology of medicine and technology, the two-sex construct has been the conceptual framework against which researchers have revealed the male norm in much of the medical research and practice conducted in Europe and North America. Fausto-Sterling (2001) has shown how researchers working with a (binary based) view of male as presence

and female as absence produced research results which explained the appearance of male testes in foetuses but entirely avoided the question of female ovarian development. The conceptual mutual exclusivity of male and female patient-bodies has created a tendency to focus work on reproduction at the locus of women's bodies. The predominance of female birth control technologies and the general lack of male contraceptives stems from a view of child bearing as female and the reproductive process as something that happens in the female body instead of in conjunction with the male. This view has enabled medical research to focus on how the female reproductive organs function and naturally provides a female working platform for the development of contraceptive methods and technologies (Oudshoorn, 2000: 131–2). Likewise, there has been a critique (and defence) of the selection of male test subjects for clinical drug trials instead of male and female subjects (Meinert, 2001: 306), a criticism that also starts from a binary understanding of sex.

One field in which the male/not-female[3] binary model has recently been radically challenged is the treatment of intersex individuals, babies who are born with indistinct or multiple gender. In this area the empirical data demand a re-evaluation of the two-sex paradigm. While traditional practice has rested upon the surgical and hormonal creation of binary sex from multiple options in intersex babies, this 'creation' simultaneously acknowledges that alternatives can exist, even if the medical practice has traditionally tried to deny this through surgery and hormone treatments. 'The belief that gender consists of two exclusive types is maintained and perpetuated by the medical community in the face of incontrovertible physical evidence that this is not mandated by biology' (Kessler, 1994: 232). The biological challenge to the binary sex paradigm that intersex children present, as well as the theoretical discussion about sex versus gender, have opened up a space for a discussion of alternative sex and gender options. A bit tongue in cheek, historian of science Fausto-Sterling suggested that perhaps our view of gender needs to be expanded to include five biological sexes (male, female, and three variations on combinations in between), at the same time that she reflects upon anthropological rumours of cultures which recognize three genders instead of two and a chromatic system of gender presented by Rothblatt which produces 343 shades of gender (Fausto-Sterling, 2000: 108–9; see also Schiebinger, 2003). One question these alternatives to binary sex and gender force to the surface is whether different and differing sex and gender paradigms already exist with us in our daily practices. Can a complexity of ways to understand sex and gender silently be floating around in the unarticulated foundations of the material objects which inhabit our world? To take my observations from the simulator centre as a concrete example, I suggest that the two-sex, binary based understanding of sex, that female is not equal to male in kind, has not entirely succeeded in replacing the one-sex model. I suggest that there are traces of the one-sex model left in more places than we realize.

Take, for example, the whipping boy of much (deserved) criticism for using the male body as a stand-in for the female body: Gray's *Anatomy*,

one of the canonical texts of American medical schools. As Laqueur notes, in it:

> All the surface anatomy is demonstrated by male, though curiously unmuscular, subjects and thereby belies whatever objective claim one might want to make for the advantages of the male body in illustrating surface articulations. . . . The female body is presented only to show how it differs from the male. (Laqueur, 1990: 167)

The same pattern of representation can be seen in the simulators I have described. The male body is used as the norm and the female body represented only when it differs from the male, and then only in the 'parts' which are 'importantly' different: the genital insert on the full patient mannequin and the primary reproductive organs in the pelvic simulator. But the fact that this was unproblematic for the medical professionals I was working with, as is Gray's *Anatomy* for many anatomy courses, makes me suspect that the one-sex model is still being used (un-stated, unexplored, unarticulated, and therefore uncontested) as the basis for design and interpretation of anatomical teaching tools, be they visual anatomies or physical simulators.

What this could mean is that the simulators (and the anatomies) are still being materialized out of the one-sex model, which allows for deviations in the female reproductive organs but not the whole body. The pelvic simulator, viewed against the full body mannequin and surgical simulator, can be read as a material assertion that the practices of anatomy still see female as a subset of the human body, a subset with different genitals. In this paradigm the female is different in degree, not in type. Using the one-sex theory of the body, the normal body of which the female is a subset could be called the universal human (not the universal male) because the female is understood to be the same as the universal, though with slight variation in the appearance of genitals. It is this variation which dictates that the female genitals be represented on their own, in their own simulator, but without the rest of the body. It would appear as if, even in modern anatomies and medical simulators, the one-sex body is haunting the medical understanding of the human body, still presenting an image of the variation between male and female as a difference in degree rather than a difference in kind.

Discussion

Medical simulators can be examined for the clues they hold about medical practices on many levels. They can be read for the information they contain on the patient-body significant to various practices. Just as this patient-body is constructed differently between the various medical practices, so the patient-body is represented differently by the simulators, and reconstituted by the people using the simulators (Johnson, 2004). The sex of the patient-bodies in the simulations can be read in modern simulators in much the same way as it has been read in historical anatomies.

Examination of the sex of the patient-body presented in the simulators,

and the way medical professionals accept it as an uncontested standard, indicates that the simulators and the medical understandings of what they represent still contain traces of the one-sex body model found in pre-Enlightenment anatomies, rather than relying on a strict adherence to the modern binary understanding of sex. It has been asserted that the universal subject's body is the same as the male body. It is no surprise, then, that the simulators designed to teach upon and about that body are also male, something not seen as problematic by the medical practitioners using them. But, given what we know about how this universal has resulted in skewed medical practices, the question becomes, how the medical community cannot see this as problematic (see Moore and Clarke, 1995: 261). I argue that it is because the people who are using the simulators do not see the male body of the simulator as 'male, not female' but rather 'male including female'. Only when female reproductive organs are interesting to a practice (as in gynaecology) does the simulator need to become 'female, not male'. When this happens, the 'female' simulator consists of the female primary sex organs but not the rest of the body. Even in the case of the full body mannequin, the elements of the mannequin which can potentially be changed to make it female are not the broad shoulders, the thick neck or the muscular thighs; they are the primary reproductive organs. Once the penis is switched to a vagina, the mannequin can be interpreted as a female body. It seems as if the one-sex model is haunting these simulators, with the result that analysing them through the prism of binary sex is not useful. Instead, the simulators seem to be built upon an understanding of sex in which female is a subset of male. That is to say, the universal body also represents the female except for a few specific sex organs.

This may be because of the tendency in certain branches of western medicine to view the body as a system of discrete elements rather than a holistic and social person. Including the 'person' in the understanding of the patient would encourage the medical community to see the gender of the patient. Yet the practice of reconstituting the patient in the anaesthesiology simulations actually involves enacting the patient with responses to questions about *his* health and activities. Nonetheless the simulator's body is male except for the interchangeable penis/vagina. And while both reproductive systems have been used in teaching practice at the simulator centre, the students and instructors seem to have no problems with the fact that the rest of the body stays the same.[4] That the anaesthesiology simulator also appears to use the one-sex model would indicate that its existence is not a result of medical practices which ignore the whole patient, as anaesthesiology does not employ the objectification of body parts associated with, for example, surgery. Instead, this remnant of the one-sex body could be a left-over in the anatomy practices representing the body that has not been thoroughly exorcized by the modern binary sex paradigm.

Within a feminist analysis, the one-sex model of the body is still problematic and the consequences it has on women's healthcare and research are just as treacherous as prioritizing the male in a binary paradigm. Regardless of the paradigm, both understandings encourage a disinterest in the female body that results in a medical corps more adept at promoting

health and recognizing and curing disease in the male population than the female. Both paradigms grant the female body legitimacy only in relation to the male; in which ways the female is similar to or different from the male. Both paradigms present the male body as the unmarked category. And both paradigms tend to define the female through her reproductive functions and how they differentiate her from and complement the male, ignoring the rest of her body.

However, recognizing the difference between the exclusion of the female in a binary paradigm and the inclusion of the female in a one-sex paradigm is important for understanding medical practice. It could be the one-sex model in the minds of medical professionals that allows them to use the male-including-female model in their practice without seeing the negative implications it can have on their gendered medical practices, since to them they are practising medicine on 'female' bodies just as much as on 'male'.

Importantly, observing these remnants of the one-sex model in modern medical simulators, and seeing them appropriated into medical training uncontested, leads me to suspect that different conceptions of sex and gender can concurrently exist within the same subject. The medical student who unquestionably practises intubating only on a male mannequin at the simulator centre can simultaneously interact with his or her classmates in the gender-appropriate way. One can discern different sex and gender paradigms simultaneously coexisting for professional and personal practice, just as one can see other unstable paradigms between medical practices: the understanding of what constitutes a patient-body or the role tactile or visual inputs play in diagnosis, etc. This suggests that perhaps variations exist in how we can understand the sex and gender of the human body in other spheres of practice, too. Perhaps the apparent dominance of a binary gender system is actually hiding varied, localized practices based on non-binary understandings of gender and sex in many other contexts as well.

The consequences of seeing this are two-fold. Firstly, while discovering that the reification of medical knowledge can still be haunted by conceptual paradigms of the past should not come as a surprise, it nonetheless took me a while to recognize it because I was so blinded by my own understanding of sex and gender as binary relationship. This begs the question of why we are so rigid in our understanding of sex and gender as binary. The division between a more social gender and a more biological (or naked) sex has been tussled back and forth (see Kraus, 2000) yet much of this work stops short of questioning the existence of two sexes or two genders. However, as the work of Laqueur, Oudshoorn, Faulkner and Fausto-Sterling points out, the binary sex paradigm is as much a result of our time as the one-sex model was of the pre-Enlightenment era. And as my observations in the simulator centre suggest, it may not be as dominant and water-tight as we assume it to be. By being confronted with other paradigms, other conceptual frameworks than the one I was used to working within, I have been forced to create a more nuanced view of medical practices, a view that again underlines the importance of looking closely at localized practices and paying attention to the variety they can contain.

Secondly, and perhaps more importantly, seeing the remnants of past anatomical models in modern simulators and observing the ease with which their reified knowledge is embraced by subjects who also exist in a world of binary sex points to the complexity our subjectivities can embrace. That we (or at least medical students and professionals) can so easily and unremarkably integrate conflicting understandings of sex into more or less seamless medical, pedagogical and social practices belies my attempts as an outsider to tell a simple story of medical simulators and instead forces me to acknowledge the complexity of contexts (geographical, disciplinary, cultural and historical, to name a few) within which the simulators are reconstituted into simulations. This makes the job of understanding simulator practice harder, but it will make the resulting analysis much richer.

Notes

The author would like to thank Ulf Mellström, Nina Lykke, Stellan Wellin, Anders Persson, Wendy Faulkner, Finn Olesen, and the anonymous reviewers for their helpful suggestions on this article. Thanks are also extended to the Huddinge Media Department for permission to use Figures 1 and 2.

1. The gynaecological simulator was located in another hospital, in a women's health research centre, not in a centre devoted to simulators as such.
2. The relationship between anatomical sex and gender is problematic. I have, in this paper, tried to use *gender* as a denominator for the socially enacted male and female and *sex* for the more physical, biological and anatomical sexual differences. I do this out of respect for convention, but I am uncomfortable with this division, one which implies a nature/culture opposition that seems arbitrary and fragile, both for feminists critiquing science and medicine, and for scientists and medical practitioners themselves, as Kraus (2000) points out in her analysis of scientific practices and the concept of a 'naked sex'. I concur with the idea that sex and gender are both made relevant in their practice, their enactment, and that the distinction between them then starts to become untenable. It is because both sex and gender are enacted that it is possible to observe the different paradigms played out simultaneously by students interacting with each other in gendered ways while training with the unproblematic one-sex simulators. The distinction between sex and gender becomes even more problematic when its relationship to culturally specific understandings of the English words is considered, as happened during the debate within Swedish gender studies about the introduction into Swedish of the terms *genus* and *gender* as a complement to *kön* (sex) during the late 1990s (see Åsberg, 1998).
3. I am aware that this is usually written as male/not-male, with the not-male understood to imply the female. However, I want to point out that in this paradigm the 'not-male' option is not always the female. Sometimes it is an unspecified sex, ungendered or both, as in the cases of intersex individuals. And sometimes the counterpart to male is the immature human body. The not-male of the binary is not necessarily female. In

addition, by writing male/not-female, I remind the reader of the understanding of female as absence (see Fausto-Sterling, 2001).

4. Correspondence with Dr Carl-Johan Wallin, 1 July 2004.

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