Determining the Compatibility between Power Exerted by Closed-Loop Medical Systems and Foucauldian Biopower

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Abstract

Closed-loop medical systems (CLMSs) autonomously perform medical actions on the bodies of patients. By constantly exerting power over the physiology of the body, they provide more effective regularization of health compared to when these actions are manually performed. Furthermore, the role of the body is diminished when it comes to regulating its health. This is because CLMSs only consider an abstraction of the body when determining what actions to perform. Essentially, CLMSs have power over both these abstractions and the corresponding bodies. Power over these abstractions cannot be adequately described by Foucauldian biopower. To solve this, I propose that the concept of biopower is updated with a new interpretation of the body in the context of CLMSs.

Introduction

In his analysis of how power operates in western societies, Foucault notes the emergence of a new power that replaces the old power that used to be prevalent (Foucault 2013a, 42). Foucault coined the concept of biopower to refer to this new power (Foucault 2013b, 67). Foucault sees biopower as the counterpart to the old power of the sovereign (Foucault 2013a, 42). The sovereign took hold of life by deciding over life and death (Foucault 2013a, 41-42). This power over life and death resulted in the sovereign being able to order the death of his subjects when they challenged him (Foucault 2013a, 41-42). He could also choose to expose his subjects to death when there was a war that threatened him (Foucault 2013a, 41-42). In this way, the sovereign essentially had the power to directly take the life of his subjects, or letting them be so they could live (Foucault 2013a, 42). This power to take life is essentially a power of deduction (Foucault 2013a, 42). Biopower refers to power that treats life in the opposite way where deduction is no longer the main element (Foucault 2013a, 42). Rather than having a sovereign power of deduction that takes lives, we now have a power that "exerts a positive influence on life, that endeavors to administer, optimize, and multiply it" (Foucault 2013a, 42). In this way, biopower is a power that fosters life rather than takes from it (Foucault 2013a, 43).

The concept of biopower has been used to bring into focus and analyze rational attempts that affect human health (Rabinow and Rose 2006, 196-197). For this reason, biopower is used in many different fields and discussions where power that affects human life is the object of analysis. For example, Apatinga analyzed the rationale behind anti-migration policies using this concept (Apatinga 2017, 38). He noted that anti-migration policies could be interpreted as potentially protecting the health of the population of a country from the potential threat that other humans could pose (Apatinga 2017, 41-42). In this way, anti-migration policies could be described in terms of biopower due to them protecting the health of a population. Another example is the analysis of the discussion surrounding the adoption of the HPV vaccine (Engels 2016, 299-300). Engels suggested that the action of mandating HPV vaccination could result in a positive effect on the health of people as it plays a part in eradicating the HPV disease (Engels 2016, 300-301). She also identified various power relations that occurred between people relating to the adoption of the vaccine (Engels 2016, 307). For example, she identified the expectation that people vaccinate themselves for the sake of others (Engels 2016, 307). In this case, we can see power relations between individuals who expect certain behavior and those who display this behavior.

Society has become more technologically advanced since Foucault wrote about biopower. Slowly, society is transforming into what is known as "society 5.0" (Beniiche, Rostami, and Maier 2022, 160). In this society, technology is primarily there to support people (Beniiche, Rostami, and Maier 2022, 160).With the introduction of advanced technology that supports, and therefore affects, human life, we can no longer blindly assume that Foucauldian biopower can be used to fully analyze power that affects life. We can clearly see the transformative effects of supportive technology in the medical sector. In this sector, we can identify a category of systems known as "physiological closed-loop control systems" (Khodaei et al. 2020, 23965). These can be defined as "systems that apply concepts from feedback control to attain automatic regulation of physiological variables – such as blood pressure, depth of anesthesia, blood glucose concentrations, and others" (Khodaei et al. 2020, 23965). Throughout this thesis, I will refer to these systems as CLMSs (closed-loop medical systems). I do this to emphasize that I consider such physiological closed-loop control systems purely in a medical setting. An example of such a CLMS is that of the artificial pancreas (Trevitt, Simpson, and Wood 2016, 714). Such a system continuously measures the glucose of patients, determines specific doses of hormones to regulate the blood levels, and injects these doses to achieve this regulation (Trevitt, Simpson, and Wood 2016, 714-718).

Before I explain why technologies such as CLMSs can undermine the analytical utility of biopower, it is important to realize that CLMSs regulate bodily health by ensuring its physiological stability (Khodaei et al. 2020, 23965). By this I mean that physiological values are kept in a desired range (Khodaei et al. 2020, 23966). CLMSs do this by interacting with a digital model of the patient (Khodaei et al. 2020, 23966-23967). I refer to these models as digital representations. Digital representations can be seen as simplified abstractions of the body (Khodaei et al. 2020, 23967). They contain variables that represent the physical state of the body (Khodaei et al. 2020, 23966-23967). Consider again the artificial pancreas. In this case, the digital representation refers to the quantification of the blood glucose of the patient (Trevitt, Simpson, and Wood 2016, 715). This representation is required for the system to determine the health of the body to which it is attached (Trevitt, Simpson, and Wood 2016, 715). This is the case because the system will determine what action to perform on this body based on the values contained within this digital representation (Khodaei et al. 2020, 23965-23966). In the case of the artificial pancreas, the value of the variable that represents the glucose variable will determine how the pancreas acts (Trevitt, Simpson, and Wood 2016, 715). In section two and three, I will elaborate in more detail on how these digital representations are essential in how CLMSs regulate bodily health.

We will see that, in considering digital representations, CLMSs can be seen as treating the human body in a reductionist manner. This becomes clear when we consider the process by which CLMSs regulate the health of clinicians and patients. In this process, there are two types of power that are relevant. The first type of power is described in terms of the positive effects that CLMSs have over human life. In the context of this thesis, human life refers to clinicians and patients. The second type of power enables this first type of power. This second type can be described as power that CLMSs exert over digital representations of patients. The aim of this power is to change the state of these representations. Based on the variables that are stored in these representations, CLMSs decide whether to perform a medical action on the patient in the attempt to get these variables in a desired range (Avital et al. 2022, 2). This results in a changed state of these representations. The relation between these two types of power will be illustrated in more detail in section three. In this section, we will also see in what way we should interpret the human body from the perspective of CLMSs. It will become clear that, from the perspective of CLMSs, it is more accurate to interpret digital representations as being part of the body.

The practical importance of being able to describe such power over digital representations in terms of biopower becomes clear when we consider the analytical utility of biopower. Scientists and philosophers who want to analyze these power relations, must be assured of the analytical completeness of Foucauldian biopower. This is especially true if they want to analyze situations in which power over life is exerted through autonomous systems such as CLMSs. If the concept turns out to be inadequate to help in analyzing these power relations, then any analyses using this concept will be incomplete. This hampers the accuracy and relevance of these analyses. In such cases, the specific power that is exerted over digital representations would not be included in this analysis. However, if the objective of this analysis would be to identify power relations that have a positive effect on human life, then this relation would clearly be relevant. As such, to have a clear overview of the power dynamics that result in regulative effects on life, power exerted on this digital level should be included in the concept of biopower. This is the case even if a digital representation is not human. Throughout section two and three, it will be investigated whether Foucauldian biopower has problems in analyzing power that results in a positive effect on life when CLMSs are involved.

In addition to analytical completeness, there is also another reason why it might be the case that power over digital representations would be more accurate to be described in terms of biopower. This reason has to do with how we should view the human body in the context of CLMSs. The conventional interpretation of the body as an organic mass that is closed and inaccessible is contested (Lemke 2011a, 94). A big reason why this interpretation is contested is due to the rise of technologies such as biotechnology and biomedicine (Lemke 2011a, 94). In many areas of the life sciences, a new way of thinking is emerging (Rose 2013, 19). This style sees the body not simply as a system that is "enclosed by the boundary of skin" (Rose 2013, 19). Instead, it sees it as a system that is in constant connection with everything around it, as well as with the components that constitute it (Rose 2013, 19). Essentially, bodies can be seen as systems that are a "symbiosis of multiple entities from bacterial flora in the gut, to the proliferation of neurons in the brain, each in multiple connections with milieux, internal and external, inorganic, organic, vital, historical, cultural, human" (Rose 2013, 19-20). As such, a body exists in an environment that is shaped by it (Rose 2013, 20). This environment, in turn, shapes the body and its capabilities (Rose 2013, 20).

This emergent way of thinking is quite different from the reductionist way of thinking (Rose 2013, 5). As will become clear, CLMSs treat the body in a reductionist manner. Consider the reductionist view of the human body that became popular due to the emergence of a molecular way of viewing biological beings (Rose 2013, 5). According to this view, all the life-related processes in the body can be analyzed by viewing them in light of their cellular components (Rose 2013, 5). The implications of such a view are tremendous for how the body can be interpreted. For example, the human body is increasingly seen as something that can be optimized (Rose 2013, 5). Its life is subject to "reverse engineering and reconfiguration at this molecular level" (Rose 2013, 5). A good example of this can be seen when we consider the promises of genomic medicine. Genomic medicine is set to "identify the key processes that control the manufacture of proteins and, in doing so, open these to precise intervention" (Rabinow and Rose 2006, 15). These precise interventions can result in medicine that targets processes at the molecular level (Rabinow and Rose 2006, 214). An example of this are the new generations of medicine that treat depression (Rabinow and Rose 2006, 214). These anti-depressants target specific neuronal mechanisms (Rabinow and Rose 2006, 214). Besides targeted medicine, genomics also allow for personalized medicine (Rabinow and Rose 2006, 214). For example, through genetic testing of an individual, this person can receive uniquely tailored medicine that maximizes the positive effects of the medicine (Rabinow and Rose 2006, 214-215).

These changing views on how the body should be interpreted, brings our attention to the discussion on how the body should be interpreted in the context of CLMSs. Should we see the body as Foucault did as being “closed and delimited” (Lemke 2011a, 94) and therefore not being fundamentally dependent on its corresponding digital representation? Or should we look at the body as something to which we can gain access on a digital level while it, at the same time, is fundamentally intertwined with its digital environment?

At this point, you might think that the interpretation of the body and the analytical completeness of biopower is not really a problem. After all, if biopower affects human life, then CLMSs can simply be seen as systems that can be described in terms of Foucauldian biopower. If this manifests itself through an indirect effect of power that is exerted over digital representations, then this does not matter. This is, however, not entirely accurate. As we will see, CLMSs operate autonomously, and their algorithms only have the goal of regulating digital representation. Essentially, they interpret the body in a reductionist way as a digital representation. Just now, it was noted that Foucault saw the body as delimited. It was also noted that new scientific developments change the way how the body can be interpreted. This makes it questionable whether, in the context of CLMSs, the body can still be seen as being delimited. Or that the body is fundamentally intertwined with its environment which, in the context of CLMSs, can be seen as the digital representation. If it is the case that we need to view the body as not being delimited, then power that is exerted at this digital level over digital representations can be viewed as power that is exerted over this new interpretation of the body. At this point, the way in how the body is seen from the perspective of CLMSs, must be included in the concept of biopower. This is, of course, different from the delimited view of the body that Foucault had. It would therefore result in an update of the concept of biopower that it should not only be able to describe power over delimited bodies. In this case, power relations involving digital representations that are fundamentally intertwined with the body would be describable, and therefore analyzable, in terms of biopower due to them being explicitly seen as power over life. Crucial to understand here is that the focus has shifted. It is no longer the question of whether indirect power is a problem. The relevant question is now if the delimited view that Foucault had regarding the body is compatible with how CLMSs exert power over life.

Specifically choosing to investigate the compatibility of CLMSs with Foucauldian biopower is not arbitrary. The use of this technology is quickly rising (Avital et al. 2022, 1). At the same time, it has the potential to vastly enhance the effectiveness of healthcare due to being able to perform medical actions better than conventional equipment (Khodaei et al. 2020, 23966). Another reason is related to their autonomy. Unlike other new systems that are rising in popularity, we will see that CLMSs are able to act largely autonomously. As we will see, it is exactly this autonomy, which is enabled by the reliance on digital representations, that allows CLMSs to differentiate itself from other technological tools. These tools, such as wearables like the FitBit, are far more reliant on human action (Ajana 2017, 2-3). A final reason is that gaining insight into the status of CLMSs regarding them being describable in terms of Foucauldian biopower, can contribute to future research. This would be research that investigates similar systems that are likely to be increasingly used in the future. With similar systems, I refer to systems that also rely on digital representations to autonomously exert a positive influence over human life. An example of such technologies would be autonomous robots that support people in their daily lives.

CLMSs have not yet been researched from the perspective of Foucauldian biopower. As such, scientific literature does not provide clarification whether the power that CLMSs exert over digital representations can be described in terms of Foucauldian biopower. The same is true when it comes to the power that CLMSs have over clinicians and patients. For this reason, I will analyze both types of power and investigate whether these are describable in terms of Foucauldian biopower. Additionally, I will investigate whether the concept of CLMSs is compatible with interpretations of contemporary biopower. In investigating this compatibility, I will be considering the three aspects of contemporary biopolitics that Rose described (Rose 2001, 1). This is done to relate CLMSs more explicitly to the philosophical field of biopower and provide philosophical context. The first of these aspects is what Rose sees as risk politics (Rose 2001, 1). The second aspect relates to biopolitics being molecular politics (Rose 2001, 1). The third aspect is biopolitics as ethopolitics (Rose 2001, 2). In section one, I will describe what these forms of biopolitics entail.

These three aspects can be interpreted in a broader sense by relating them to the three elements of contemporary biopower that Rabinow and Rose described (Rabinow and Rose 2006, 197). The first of these three elements is that there is a view about what the vital characteristics of human beings are, and that there is an authority that is eligible to determine this (Rabinow and Rose 2006, 197). The second element relates to the idea that interventions are possible to promote health for certain groups (Rabinow and Rose 2006, 197). The third element states that people are working on their own health under the supervision of a certain authority (Rabinow and Rose 2006, 197). These elements are "at stake in any transformation" (Rabinow and Rose 2006, 215). For this reason, it is important to consider the roles of these elements in the context of CLMSs. This provides further philosophical context. As I will illustrate in section two, these elements are closely related to the previously discussed aspects of contemporary biopolitics.

The research that is closest to this topic comes from Btihaj Ajana. Btihaj Ajana explored the Quantified Self movement in which the use of wearables is promoted (Ajana 2017, 1-2). These wearables measure and display vital, biometric and health indicators (Ajana 2017, 1-2). Using this information, the wearers of such devices attempt to improve themselves (Ajana 2017, 6). For example, different fitness tracking wearables such as the FitBit and Apple watch are described (Ajana 2017, 2). They measure a variety of health related data such as the hours slept and the amount of calories consumed (Ajana 2017, 2). Feedback to the user is then given by means of illustrations or graphs (Ajana 2017, 2).

The analysis in this thesis differentiates itself from the work of Ajana in two fundamental ways. The first is that it focusses on CLMSs. These are different from the category of non-medical wearables that are used for self-improvement.

For example, wearables such as the FitBit and Apple watch have the potential to facilitate the health of users by providing insight into their daily habits (Ajana 2017, 2). However, the context in which these sorts of wearables facilitate improved health is not necessarily medical. The CLMSs that I analyze, are exclusively meant to be used in a medical context under the supervision of clinicians (Khodaei et al. 2020, 23965-23966). As such, they generally aid in treating serious medical problems such as regulating blood glucose levels and blood pressure (Khodaei et al. 2020, 23965). This makes the context in which CLMSs are applied very different from where wearables that facilitate self-management are used.

The second difference is that closed-loop systems try to reduce the human element through automation (Lee and Sokolsky 2010, 745). For example, the closed-loop artificial pancreas reduces the need for users to manually enter meals into the system (Daly et al. 2023, 204). This is different from wearables that try to actively involve users in the process of self-improvement (Ajana 2017, 9). Interpreting and applying the feedback from the measured data requires users to actively engage with their wearables (Ajana 2017, 2-3). After the data has been interpreted, users need to optimize their lifestyle accordingly (Ajana 2017, 2-3). For example, the FitBit and Apple watch can confront the user with bad habits (Ajana 2017, 2). Users can then consider these habits and try to enhance their health using this information (Ajana 2017, 2).

As might be clear by now, there are two major issues at stake. The first is whether Foucauldian biopower is accurate enough to be used as an analytical concept to analyze power relations in scenarios that involve CLMSs, or if it needs to be revised for it to be able to do so. Section three will show that the need for such revisions, as well as what needs to be revised, are related to the second issue which relates to the interpretation of the body in the context of CLMSs. To analyze these matters, this thesis is structured to answer the following research question: ‘To what degree is the process through which closed-loop medical systems regulate the health of clinicians and patients describable in terms of

Foucauldian biopower? How should Foucauldian biopower be modified if this process cannot be described?'

To answer this question, I will be performing a conceptual analysis. This will be done by discussing the relevant components of Foucauldian biopower and how they relate to medical treatment that involves CLMSs. This should provide insight into their compatibility. For this reason, two Foucauldian works will be central to my analysis. The first is "Right of Death and Power over Life" in which Foucault (2013a) gives an elaborate description of his concept of biopower. The second work that I will be using is "Society Must Be Defended" in which Foucault (2013b) describes the concept of biopower more extensively. Additionally, the article called "The Politics of Life Itself" written by Rose (2001) will be used as the primary article that helps to contextualize the biopolitical status of CLMSs. Of course, I will also be discussing the fundamental aspects that make up the concept of CLMSs. To do this, I will describe the basic building blocks of CLMSs and illustrate concrete instantiations of CLMSs. This will be done by using a wide variety of scientific literature related to CLMSs.

The structure of the thesis is the following. In the first section, I will be laying the groundwork for the analysis. Here, I will be discussing the Foucauldian concept of biopower and its contemporary interpretations in more detail. I will also illustrate how biopower can manifest in current society. Then, the concept of CLMSs will be introduced in more detail. In the second section, four CLMSs will be discussed. These will be analyzed to illustrate the way in which they have a regulative effect on the health of clinicians and patients. Their connection to contemporary interpretations of biopolitics and biopower will also be illustrated. In the third section, I will analyze the displacement of patients and clinicians. I will show that, when it comes to performing medical actions on the bodies of patients, clinicians are displaced by CLMSs. I will also show that patients are displaced by CLMSs in a similar way. Additionally, I will show that the bodies of patients are displaced by their corresponding digital representations. This will be shown as being a result of how CLMSs exert power over digital representations to regulate the physiological variables that are contained within it. Following this, I will discuss why this displacement is a problem for Foucauldian biopower and the delimited interpretation of the body that Foucault had. I will then suggest how the concept should be modified. Finally, I will end by answering the research question in the conclusion.

Section 1: Introducing Foucauldian Biopower and Closed-Loop Medical Systems

I will start this section by illustrating the philosophical concept known as Foucauldian biopower. This is done so that the two previously discussed types of power that are fundamental for how CLMSs work can be analyzed from the perspective of biopower. This analysis will happen in section two and three. After this description, I will illustrate the concept of CLMSs in more detail. This will be done by illustrating the fundamental components that underlie this concept. Afterwards, I will elaborate on contemporary interpretations of biopolitics. Then, I will consider how CLMSs relate to the way how traditional medicine is performed. This will be done so that, in section two, it becomes clearer how CLMSs are able to automate many tasks that used to be performed by clinicians and patients.

The first fundamental aspect that underlies the analysis in this thesis is Foucauldian biopower. Foucault noted the emergence of a new power (Foucault 2013b, 63). This new power was known as biopower (Foucault 2013b, 67). Foucault described biopower as a power that could "“make” live and “let” die” (Foucault 2013b, 62). Characteristic for this power is that it exerts a positive influence over life (Foucault 2013a, 44). This life is defined as human life (Lemke 2011a, 95). Important here, is to realize is that Foucault sees individuals as delimited bodies (Lemke 2011a, 94). Biopower was contrasted against the old power of the sovereign that is characterized by the power to “take life or let live” (Foucault 2013b, 62). This old power is described as “the power of the sword” (Foucault 2013b, 62). This power of the sword essentially means that the sovereign can exercise his right over the lives of his subjects by killing them (Foucault 2013b, 62).

Biopower is not a power that suddenly emerged (Foucault 2013b, 62). It can have its origins traced back to the seventeenth and eighteenth century

(Foucault 2013b, 63). During this time, disciplinary techniques of power that were aimed at individual bodies emerged (Foucault 2013b, 63). Foucault describes this disciplinary power as a power that “produces individualizing effects, and manipulates the body as a source of forces that have to be rendered both useful and docile” (Foucault 2013b, 69). Since biopower affects human life, disciplinary power can manifest throughout all of society. What characterizes disciplinary power is that it manipulates individual bodies in a positive way (Foucault 2013b, 63). Examples of locations where disciplinary power can manifest are in “schools, hospitals, barracks” (Foucault 2013b, 70) and “workshops” (Foucault 2013b, 70). For example, students can learn skills such as nursery or communication in educational institutions. Mastering such skills allows them to participate in society more effectively. The nursery skill allows them to work in an efficient manner in a hospital. This is advantageous for both the students and society. The communication skill allows them to better communicate with other members of society. This also contributes to letting them function optimally. These skills that the students have learned are the result of disciplinary power. This is the case since these skills have a positive effect on the ability of individual students to effectively participate in society. Each individual student has essentially been manipulated to be more useful.

When we consider hospitals, we can see a similar individualizing effect taking place. In this case, people might receive medical treatments and be taught how to live after receiving this treatment. For example, a person might need a new heart and consequently receives a heart transplant. After the operation, the patient is taught how to live with this new heart. An individualizing effect has been achieved by teaching this person how to live properly after the operation. This person is therefore able to keep participating in society effectively. Both the individual students and patients have essentially been the object of a positive power that empowers them. This power resulted in them being taught useful knowledge. Of course, not all students and patients are the same. Each will have trouble with learning different aspects of what is being taught. For example, one person can learn slower than someone else. This emphasizes that disciplinary power is essentially aimed at individuals even though groups of people can be taught at the same time in class. In this way, disciplinary power is fundamentally different from the power that I am about to explain in more detail. Disciplinary power can essentially be described as power that takes control over people on an individual level (Foucault 2013b, 69).

There was another power that emerged a bit later than disciplinary power (Foucault 2013b, 63). This power emerged around the second half of the eighteenth century (Foucault 2013b, 63). It is not the case that this new power replaced disciplinary power (Foucault 2013b, 63). Instead, it operated alongside it (Foucault 2013b, 63). Where disciplinary power was focused specifically on exerting power over individual bodies by disciplining them, this new power was "centered not upon the body but upon life" (Foucault 2013b, 69). This means that it concerned itself with the population that consists of multiple bodies (Foucault 2013b, 66). Foucault referred to this second power as "biopolitics" (Foucault 2013b, 64).

At its core, biopolitics is a power that deals "with the population, with the population as political problem, as a problem that is at once scientific and political, as a biological problem and as power's problem" (Foucault 2013b, 66). It concerns itself with the general biological processes that affect these populations (Foucault 2013b, 64). Characteristic for these processes is that they are primarily related to the ratio of life-related processes (Foucault 2013b, 64). For example, biopolitics concerns itself with observing and controlling the ratio of deaths, reproduction, and fertility of a population (Foucault 2013b, 64). It does this by using various techniques of power to affect multiple elements that have their effects on these biological processes (Foucault 2013b, 64-67). Essentially, biopolitics regulates biological processes. The goal of this regulation is to achieve, and maintain, a homeostasis of these processes in a population (Foucault 2013b, 67-69). As such, these regulations are built around random variations in a population regarding these general processes (Foucault 2013b, 67). These randomly occurring variations can be seen as influences that can negatively affect the homeostasis of these processes (Foucault 2013b, 67). Regulation of these processes is therefore something that happens indefinitely (Foucault 2013b, 67). In short, Foucault described biopolitics as:

> a technology which brings together the mass effects characteristic of a population, which tries to control the series of random events that can occur in a living mass, a technology which tries to predict the probability of those events (by modifying it, if necessary), or at least to compensate for their effects. (Foucault 2013b, 69)

Several examples of where biopolitics might manifest are in "Health-insurance systems, old-age pensions; rules on hygiene that guarantee the optimal longevity of the population" (Foucault 2013b, 71). Consider how health insurance systems could help in regulating a population. The regularizing effects of biopolitics become clear here. Consider a population that suffers from bad health because people do not visit medical services and, consequently, die far too early. Power that aims to regularize this morbidity can be described as biopolitics. For example, this regulation can be achieved by changing the health insurance system. In this instance, the government could decide to make health insurance mandatory. The effect will be that more people are likely to be taking health insurance and, consequently, utilize it more. This should result in the morbidity rate being lowered. As becomes clear here, biopower manifested through biopolitics in that it has regularized the morbidity rate in this population. This was done by creating the circumstances that lead to people being more likely to visit health providers.

Now that I have discussed both disciplinary power and biopolitics, it is important to emphasize that both are "technologies of the body, but one is a technology in which the body is individualized as an organism endowed with capacities, while the other is a technology in which bodies are replaced by general biological processes" (Foucault 2013b, 69). So, where disciplinary power is aimed at enhancing individual bodies and interprets the body as something that can be optimized, biopolitics interprets the body in terms of more general processes and is aimed at regulating populations by manipulating general biological processes.

The interpretation that Foucault has of the body as being delimited, becomes clearer here. We saw that, through disciplinary power, Foucault interprets the human body as being somewhat self-contained. With this I mean that, as we saw in the examples and quotes, the body seems to be interpreted as being something that is malleable to a certain extend by being the object of a positive power. In the examples, this malleability became clear in the body being the target of a power that teaches it new skills. Essentially, the forces contained within this body along with its capacities were modified by power that treats the body as a largely self-contained individual. In the case of biopolitics, this delimited interpretation becomes apparent in the fact that the bodies are interpreted through these general biological processes. In the example, the levels of morbidity were taken as both representing human life in a population, and as being the object of regulation. Interpreting bodies in terms of general processes such as morbidity, shows this delimited character again. Information about morbidity or any other general processes such as sickness at the level of a population, can only be obtained by considering the overall status of the bodies within this population. These bodies must be interpreted as either alive, dead, sick or healthy. The body is, again, seen as a self-contained object further illustrating the delimited view of the body that Foucault had.

As was just illustrated, disciplinary power and biopolitical power are fundamentally different. However, at the same time, they are not mutually exclusive (Foucault 2013b, 63). Instead, they complement each other (Foucault 2013b, 63). These two powers combined can be described in a more general way as power that "has taken control of life in general" (Foucault 2013b, 73). This power aims to "improve life, prolong its duration, to improve its chances, to avoid accidents, and to compensate for failings" (Foucault 2013b, 73). Because of this, it would be accurate to say that biopower takes control of life through two poles (Foucault 2013a, 44). The first pole is the disciplinary pole and the second pole is the biopolitical pole (Foucault 2013a, 44). One important thing to realize is that it is not necessarily the case that there is always a strict demarcation between the two poles of biopower (Foucault 2013b, 72). For example, medicine has a unique position since it combines knowledge of processes relating to both individuals and the population (Foucault 2013b, 72). Medicine has “the authority to create statistical measures--norms against which all individuals could be judged” (Jen 1998, 23). For this reason, it can create the statistical measures which can be used to determine if bodies are conforming to them or not (Jen 1998, 23).

The knowledge of statistical measures help biopower in taking control over life since people are pressured to conform to those norms (Jen 1998, 23-24). They could also be disciplined if they fall outside it (Jen 1998, 23-24). Medicine can therefore be seen as an instantiation of what Foucault refers to as a norm (Foucault 2013b, 72). Foucault wrote about the norm as being an element that “will circulate between the body and population alike” (Foucault 2013b, 72). It can “be applied to both a body one wishes to discipline and a population one wishes to regularize” (Foucault 2013b, 72). Jen notes that this discipline to adhere to the norms is achieved by creating desire rather than coercion (Jen 1998, 24). This desire leads to people wanting to conform to the norm (Jen 1998, 24). By means of knowledge and desire, power creates the conditions for people to adhere to norms (Jen 1998, 24-25). The normalizing society is therefore “a society in which the norm of discipline and the norm of regulation intersect along an orthogonal articulation” (Foucault 2013b, 72). The effect of living in such a normalizing society is that it is not necessarily the law that solely decides what is good and bad anymore (Lemke 2011b, 39). This is displaced by the norm (Lemke 2011b, 39). This is not to say that the law does not function anymore (Lemke 2011b, 38-39). It still operates in the normalized society in service of preserving life (Lemke 2011b, 39).

To make it clear how the norm can operate in a normalized society, consider a scenario in which a virus threatens the health of its citizens. For example, if there were a pandemic, the government could decide to utilize hand gel dispensers that dispense gel that kills the virus. They know that people have the desire not to get sick. Acting on this desire, they could choose to discipline citizens by teaching them that the virus is dangerous, and that hand gel kills it. At the same time, they could place hand gel dispensers strategically in locations where the virus is spreading fast. The desire not to get sick, the knowledge that the virus is dangerous but can be killed, and placing hand gel dispensers strategically slows the spread of the virus. The reason for this is that, given these assumptions, people are likely to use the dispensers. This clearly shows that medicine has both regulating and disciplining effects at the same time. The disciplining effects are seen in that individual people are being taught why the virus is dangerous and how it can be stopped. At the same time, the desire not to get sick and stop the virus makes them likely to use the dispenser. The result of masses of people acting on this knowledge and desire has regulatory effects for the population. These regulatory effects can be seen in there being less sickness in the areas where these dispensers are placed.

The law can still be used if a threat presents itself and hinders the efforts of the government to reduce the negative impact of the virus. This becomes clear if we consider that people could willfully endanger others with reckless behavior. For example, people could destroy the gel dispensers which hinders the ability of the government to regulate the health of the population. Then, by using the law, the government could force people not to do this under the threat of being fined if they do not comply. Despite this threat, the norm that is established regarding the societal desire not to infect other people is the main force behind making people comply. After all, these people do not want to spread the virus or want others to look down on them for doing so. Consequently, they use the hand gel and comply with the norm.

In the introduction, I gave a concrete definition of closed-loop medical systems (CLMSs). I will now describe the fundamental components of such systems in more detail. This is done because future parts of this analysis refer to these components. Characteristic is that CLMSs can affect the physiology of the bodies of patients to which they are attached in both an automatic and precise manner (Brogi et al. 2017, 446). To achieve this manner of manipulation, several components must work together. The components, which make up a closed-loop system, are the following. First, there is a sensor that monitors the target variable and converts the state of this variable into a feedback signal (Brogi et al. 2017, 446). Second, there is a controller that receives this feedback signal from the sensor (Brogi et al. 2017, 446). The controller uses algorithms to produce an output (Brogi et al. 2017, 446). This output is based on the variable in the feedback signal as well as the ideal value that this variable should have (Brogi et al. 2017, 446). Third, there is the actuator (Brogi et al. 2017, 446). The actuator receives the digital output of the controller and performs physical actions on the body (Brogi et al. 2017, 446). An example of an actuator performing an action is the syringe pump that adjusts a certain dose (Brogi et al. 2017, 446).

At this point, I want to elaborate a bit on the levels at which power can be exerted. Power operates at many different levels (Foucault 2013a, 45-46). Consider biopolitics. We saw that this pole views human life in general biological processes of which averages relating to those processes are derived from members of a population. This pole can be seen as operating at more general levels compared to disciplinary power. For example, the government might want to regulate the morbidity that is due to complications that are caused by mismanaged diabetes. To achieve this, they might force insurers to reimburse the purchases of CLMSs that manages diabetes. Essentially, power can be seen as being exerted at the level of the state and institutions. Simultaneously, life is considered at the level of general biological processes of a population. After this, insurers include the reimbursement of CLMSs in their insurance policies. This, in turn, incentivizes patients to use such CLMSs. Clinicians, in turn, are also more likely to recommend such systems. In this case, we can see a power relation originating between both the general and individual levels of society. At the general level, we see insurers implementing the reimbursement of CLMSs in their policies. This, in turn, affects the decision making of clinicians and individuals. Here, power affects the bodies of specific members of society. Also, this power considers life at the individual level. This becomes clear since, in this case, clinicians and patients can be interpreted as being organisms that are malleable in their behavior. This power would be more in line with the power that the disciplinary pole of biopower describes. At the same time, we can see power relations between clinicians and patients on an individual level. This happens in the form of clinicians recommending patients purchasing CLMSs. Patients, in turn, are the object of this power. This is again power that manifests at the individual level and is more in line with the power that the disciplinary pole describes. In section two, we will see that these last sorts of power relations between individuals are essentially interpretable in terms of the Foucauldian norm. Furthermore, in section three, the digital level at which power is exerted will become more apparent.

Now that the concept of biopower has been illustrated in more detail, I will elaborate on interpretations of contemporary biopolitics. I quickly touched upon these in the introduction. The first of these notions was biopolitics as risk politics. Rose sees contemporary biopolitics as being a form of risk politics (Rose 2001, 1). This risk politics is characterized by thinking about health in such a way that, when considering certain risks regarding the development of future conditions, interventions can be performed in the present (Rose 2001, 7-8). In this way, this risk can be managed (Rose 2001, 7). From another perspective, Rose also considers contemporary biopolitics as being molecular politics (Rose 2001, 12). Molecular politics relates to life that opens itself up to be shaped at the molecular level (Rose 2001, 16). Rose states that, in the context of this molecular politics, life processes can be "'reverse engineered' and then reconstructed in the lab, and modified such that they unfold in different ways" (Rose 2001, 16). Finally, Rose interpreted contemporary biopolitics as ethopolitics (Rose 2001, 1). Ethopolitics refers to self-management practices that individuals perform to both judge and enhance themselves (Rose 2001, 18). The reasons for performing the relevant practices is guided by the beliefs of different members of society such as individuals and institutions (Rose 2001, 18). In section two, I will illustrate the connection between CLMSs and these three forms of contemporary biopolitics in more detail.

CLMSs affect the way in which conventional healthcare is performed. To analyze how CLMSs do this, we must consider the interactions which are present in cases where medical actions are performed on the patient. But first, I will clarify what I mean when I write about conventional healthcare. When writing about conventional healthcare, I refer to healthcare in which no CLMS is used to treat medical conditions. In this form of healthcare, we can see that there is a real-time interaction between clinicians and patients. To clarify what is meant with real-time interactions, we should take a look at when medical procedures are performed. During the execution of these procedures, clinicians must be near patients and focus their attention on the bodies of their patients. While performing these procedures, they have real-time relations with the bodies of their patients. A similar logic holds when patients perform medical actions on their own bodies. To illustrate this, we can consider the chronic condition diabetes. When patients suffer from diabetes, they will have to regularly perform painful fingerstick tests to measure their glucose levels (Jung and Lee 2016, 102). In this case, the patients must have a real-time relation with their own bodies to properly process the feedback of pointing the needle, pricking their body, and then measuring the glucose levels.

The conventional way of performing medicine, where there is also this real-time component, can actually be likened to what Foucault called a medical gaze (Foucault 1975, 89). A gaze is essentially a way of looking and filtering the perceived information in such a way, that only the relevant information is considered (Misselbrook 2013, 312). The medical gaze can therefore be seen as clinicians who interpret the story told by the patient (Misselbrook 2013, 312). This story is then filtered such that only its biomedical components remain (Misselbrook 2013, 312). With this medical gaze, clinicians focus specifically on small deviations and anomalies (Foucault 1975, 89). For this reason, it is a very calculating gaze through which clinicians consider risk (Foucault 1975, 89). It is important to realize that this gaze is not one that relies solely on the visual modality. Instead, it combines "The sight/touch/hearing trinity" (Foucault 1975, 164). In this way, the gaze can be seen as having a "plurisensorial structure" (Foucault 1975, 164). It is of course the clinician who has the medical gaze (Foucault 1975, 89). However, in the last paragraph, I described that patients have a real-time interaction with their bodies as well. This interaction can be seen when they perform medical actions on it. Of course, these interactions are not necessarily the same as having the Foucauldian medical gaze directed at their bodies. After all, patients are not clinicians. Nevertheless, when we consider the fingerstick test example, patients certainly interpret the results of their fingerstick tests. Based on these results, they will perform a certain action. For this reason, it is certainly accurate to state that they too have a gaze, albeit not a medical one.

CLMSs break the conventional way of performing medicine. This results in the requirement for real-time interaction between the one who performs medical actions, and the body that is the object of these actions to be no longer necessary. In section two it will become clear that many of the manual tasks that were previously performed by clinicians or patients, are now performed by these CLMSs. Not only that, new tasks that did not exist before are also taken on by the CLMSs. For example, consider the case of a CLMS that affects the heart rhythm of its wearer. The CLMS will stimulate the heart, and therefore affect the rate at which it beats (Touil, Bahatti, and Elmagri 2022, 360). This is a medical task that clinicians and patients could previously not reasonable do themselves in a conscious way. This is due to them not being able to have constant access to the heart. This would require heart surgery that is constantly performed. However, the CLMS performs this task without any problem due to often being integrable with the body (Touil, Bahatti, and Elmagri 2022, 360). In this way, it can automate the regulation of the heartbeat (Touil, Bahatti, and Elmagri 2022, 360). Essentially, CLMSs perform many medical actions on the bodies of patients automatically. As a result, clinicians and patients do not have to do that manually anymore. For this reason, clinicians no longer have to maintain a real-time relationship with the bodies of their patients. They can simply configure the CLMS and let it perform the actual medical procedures automatically (Khodaei et al. 2020, 23966). The same is true for patients. Once the CLMS is installed, they no longer need to maintain a real-time relation with their body due to not having to perform the automated task anymore. Since CLMSs take on this real-time relation with the body that they perform medical actions on, it is accurate to state that these systems inherit the medical gaze from clinicians and the gaze from patients.

At this point, we can relate the three basic components of CLMSs to the conventional process of performing medical treatment. First, we have the sensors that measure the physiological values from the bodies of patients (Brogi et al. 2017, 446). These can be likened to clinicians that are investigating the physiological states of the bodies of patients. They can also be likened to patients that investigate the physiological state of their own bodies. Second, we have the actuators that manipulate the bodies of patients (Brogi et al. 2017, 446). These can be likened to clinicians who are performing medical actions on the bodies of patients to affect their physiology. These can also be likened to patients who are attempting to perform medical actions on their own bodies to affect their physiology. Third, we have the control algorithms (Brogi et al. 2017, 446). These can be likened to the conscious minds of clinicians and patients. This allows them to interpret the condition of the body, come to a conclusion regarding what action to take, and carefully perform this action on the body.

In this section, I have discussed relevant components of Foucauldian biopower and illustrated that it exerts control over life at different levels of generality through disciplinary power and biopolitics. Disciplinary power affects individual bodies. Biopolitics regulates populations. I also touched upon the Foucauldian concept of the norm. The concept of closed-loop medical systems (CLMSs) was also described in more detail. I noted that it reduced human involvement compared to conventional healthcare when it comes to treating medical conditions. In the next section, I will describe four CLMSs of varying complexity. I will then investigate in what way they take over roles from clinicians and patients in the context of performing medical actions. Additionally, I will also illustrate how taking over of these tasks results in more thorough biopolitical regulation of the populations of clinicians and patients. I will then show that CLMSs exert power over clinicians and patients that is describable in terms of Foucauldian biopower.

Section 2: Analyzing the Regulative Effects That Closed-Loop Medical Systems Have On Patients and Clinicians

In this section I will describe four CLMSs. The goal of doing this is to illustrate how the power that CLMSs exert have a regulative effect on clinicians and patients. With this I mean that I will illustrate that these systems, through automation, take over medical tasks that were previously performed by either clinicians or patients. It will become clear that this automation results in CLMSs being able to achieve biopolitical effects. I will also show that the close integration of CLMSs with the bodies of patients results in more effective regulation of the health of these patients. This is because of CLMSs being able to provide personalized medicine. I will explain that this can be interpreted as CLMSs exerting regulative power over clinicians and patients. For these reasons, I will argue that CLMSs can be seen as instruments that allow for the manifestation of biopolitical and disciplinary power. Finally, I will illustrate why CLMSs can be interpreted in terms of risk politics, molecular politics and ethopolitics and relate this to biopower.

The four CLMSs that I will illustrate in a moment, have been selected due to the varying complexity regarding the components that they consist of. In this selection, I have also considered the different physical aspects of the body that they affect. Based on my literature research, this selection provides a good overview of the different sorts of CLMSs that might be found.

A classic example of a CLMS is that of the implantable cardioverter defibrillator. This system is implanted in the body and concentrates on the heart (Touil, Bahatti, and Elmagri 2022, 360). When someone has a heart rhythm that is unhealthy, a closed-loop implantable cardioverter defibrillator (ICD) helps in maintaining a healthy rhythm (Touil, Bahatti, and Elmagri 2022, 360). The ICD combines the functions of pace making and defibrillation into one device (Touil, Bahatti, and Elmagri 2022, 360). The ICD exerts control over the heart by automatically delivering either electrical pulses when the heart rate is too low, or electrical shocks when the heart rate is too high (Touil, Bahatti, and Elmagri 2022, 360). To determine whether to administer a pulse or a shock, the ICD uses sensors to measure the heart rate (Touil, Bahatti, and Elmagri 2022, 360). Other variables such as the walking speed, breathing rate, and ECG signals are also measured and considered (Touil, Bahatti, and Elmagri 2022, 362-363).

The second CLMS is the brain stimulation system for people with Parkinson's disease. Parkinson's disease is characteristic in that patients have episodes in which they exhibit involuntary physical tremors (Camara et al. 2015, 2). By providing stimulation to the brain, the normal brain rhythm is maintained (Perlmutter and Mink 2006, 230). The brain stimulation system stimulates the brain of the patient on demand (Camara et al. 2015, 2). To detect when stimulation must be administered, two physiological signals are measured using electrodes (Camara et al. 2015, 2-3). Using these signals, the system tries to infer whether the patient is suffering from a tremor episode or not (Camara et al. 2015, 6). When the system concludes that an episode is happening, then the brain will be stimulated (Camara et al. 2015, 6). If no episode is detected, the system does nothing (Camara et al. 2015, 6). Of course, the algorithm that decides this can be tweaked such that it is also able to consider the situation of individual patients in determining when to stimulate or not (Camara et al. 2015, 7). This is important since, for some people, the system has an easier time to determine whether to stimulate or not (Camara et al. 2015, 9). When tweaking the algorithm uniquely for each person, the system becomes more sensitive to the unique physiology of that person (Camara et al. 2015, 9). This results in the system being able to more accurately detect tremors and stimulate accordingly (Camara et al. 2015, 9).

The previous two systems were quite local in the sense that they were implanted. The components of the artificial pancreas are more distributed physically (Inreda® Diabetic 2022, 5). Additionally, rather than affecting a specific organ, the artificial pancreas mimics the actual pancreas (Boughton and Hovorka 2019, 1). Modern closed-loop artificial pancreases are worn externally

(Trevitt, Simpson, and Wood 2016, 714). As a sensor, they use a CGM (continuous glucose monitor) that monitors the glucose levels of patients (Trevitt, Simpson, and Wood 2016, 714). For the actuator they use a pump that can administer hormones (Trevitt, Simpson, and Wood 2016, 714). And, like the other CLMSs, they have a digital controller (Trevitt, Simpson, and Wood 2016, 714). The CGM sends the feedback signal that contains the measured data to the digital controller (Trevitt, Simpson, and Wood 2016, 714). The digital controller then decides if anything needs to be changed regarding the injection of hormones (Trevitt, Simpson, and Wood 2016, 714). Once a decision has been made, it will be sent to the pump (Trevitt, Simpson, and Wood 2016, 714). By constantly measuring the blood, the artificial pancreas makes sure that the values will get not get too high or too low (Inreda® Diabetic 2022, 4).

The final and most distributed sort of CLMS that I will discuss is that of the PCA pump. A Patient-controlled analgesia (PCA) infusion pump is used to ease the pain that patients experience (Lee et al. 2012, 78). This pump is a distributed system that has many different components such as monitoring devices, a controller and delivery devices that, through a network, communicate with each other (Lee et al. 2012, 83). To control the pain, this system disperses pain medication (Lee et al. 2012, 78). The sensors of the system measure two physiological variables (Lee et al. 2012, 83). Based on these variables, the system automatically decides to stop the infusion if it detects that the patient is experiencing respiratory problems (Lee et al. 2012, 83). The PCA pump also allows for the tuning of the model depending on the patient to which the system is attached (Lee et al. 2012, 84). This allows the system to accurately determine the relationship between physiological variables and drug doses (Lee et al. 2012, 87). As a result, the PCA pump can produce accurate and individualized results that allow for optimal control over physical pain that the patient might experience.

The four CLMSs that have been introduced will now be analyzed regarding the positive effects that they have on clinicians and patients. During this analysis, it is good to remember that in the first section I described that biopower has control over human life through its disciplinary and biopolitical pole. I illustrated that the disciplinary pole describes power over individuals while the biopolitical pole describes power over populations. I also described that the norm has a disciplinary effect on individuals. This disciplinary effect gently pushes them towards behaving in a certain way. In the context of biopolitics, this intended behavior relates to actions that facilitate the health of the individual. Such actions are, for example, using a gel dispenser to kill viruses. This behavior results in biopolitical regulation of a population since the individuals that are part of this collective remain healthy.

As illustrated earlier, CLMSs can have a positive effect on individuals. In a short while, I will identify what these effects exactly are in more detail. I will also argue that these effects will result in clinicians and patients being more likely to use CLMSs. These positive effects originate from the two fundamental characteristics of CLMSs that I alluded to earlier. The first is the ability of CLMSs to automate tasks that were formerly performed by clinicians or patients. The second is the ability to provide personalized medicine due to CLMSs having immediate access to relevant parts of the bodies of patients. It is by looking at these key characteristics from the perspective of the Foucauldian norm that I can identify why clinicians and patients would desire the usage of these CLMSs. At the same time, this allows me to clearly illustrate in what way CLMSs have disciplinary effects on individuals that results in regulative effects on populations.

I will first consider the automation that CLMSs provide. For this reason, I will now consider what automation means in the context of medical tasks that clinicians perform on the bodies of patients. At this point it is important to realize that CLMSs are not meant to completely replace clinicians (Avital et al. 2022, 14). Instead, they provide relief from “burdens imposed by technical, distracting and wearisome tasks” (Avital et al. 2022, 14). The relief that this automation of clinical tasks can provide for clinicians is important. A big reason for this is that more than half of the physicians that work in the United States suffer from burnouts (Dzau, Kirch, and Nasca 2018, 312). The increasing adoption of CLMSs allow the clinicians to give some of their workload to these systems. Having fewer tasks should help in reducing the stress of clinicians.

All CLMSs can aid clinicians with automating their tasks. However, due to its distributed nature, the PCA pump is most suitable for aiding clinicians in hospitals. By using this pump, continuously monitoring the state of the body of the patient is no longer necessary (Lee et al. 2012, 83). Clinicians are only spurred into action when the physiological variables of the patient are deviating from the desired value ranges (Lee et al. 2012, 83). In this case, clinicians are alerted by the system (Lee et al. 2012, 83). Besides automation of specific tasks like monitoring the effects of drugs, more general tasks can also be automated. For example, clinicians can rely on the fact that CLMSs operate highly autonomously and will notify them when something is wrong. Because of this, clinicians do not have to spent as much time anymore on manually checking whether the physical health of their patients is in a good condition. To make this more concrete, we should consider the other CLMSs again. Clinicians can trust in ICDs to keep the heart beating healthily resulting in less medical interventions. The brain stimulation systems will make sure that patients can move their limbs properly. Finally, the artificial pancreases keep glucose levels at appropriate levels resulting in less complications due to diabetes.

When clinicians have their workload reduced, patients will also benefit from this. For example, clinicians will have more time to focus on tasks that are of a higher benefit to the patients (Lee et al. 2012, 83). Reducing the workload can also aid in reducing the chances of a burn-out. Preventing clinicians from burning out is of value to patients since burnt-out clinicians are more likely to make medical errors (Dzau, Kirch, and Nasca 2018, 312).

CLMSs also automate many tasks that were previously performed by patients. This results in patients, whose bodies are the objects to which these CLMSs are attached, remaining in optimal health. Consider again the artificial pancreas. It reduces the need for patients to perform fingerstick testing (Jung and Lee 2016, 102). These tests are painful which often results in patients not performing them even if they know that they are important (Jung and Lee 2016, 102). Automation in the sense of explicitly taking over tasks such as fingerstick tests from patients, is a bit different for the ICD and brain stimulation systems. The difference lies in the fact that these CLMSs take over actions that are performed subconsciously. Despite this, CLMSs could still automate such tasks. For example, we saw that the ICD takes over the regulation of the heartbeat from the body. The brain stimulation system partly does this for the coordination of proper motor function. Despite patients not consciously performing these fundamental actions, they are still actions that are otherwise taken care of by the body. In this sense, both types of systems do take over actions from patients in a similar way as the artificial pancreas does. Finally, the PCA pump is a bit of an outlier here. The duties of the patient are not automated. However, patients are given more control over their bodies since they are not as dependent on their state being continuously monitored by clinicians (Lee et al. 2012, 83). They could therefore satisfy their demand for getting pain medication much faster compared to when clinicians are continuously involved.

As a result from not having as many tasks, patients are less likely to go and visit their clinician for information on how to perform medical actions. Due to automating actions that were previously performed by clinicians or patients, a lot of knowledge intensive tasks disappear. For example, consider the ICD. Patients will not have to think so much about all the daily activities that they are performing when it comes to how it affects the heart. After all, the ICD automatically detects relevant variables such as walking speed and stimulates the heart accordingly (Touil, Bahatti, and Elmagri 2022, 362-363). As described earlier, the brain stimulation system allows patients to move in a smoother way due to reducing the tremors. The artificial pancreas reduces the need to explicitly take note of all calories ingested (Inreda® Diabetic 2022, 4). After all, these calories affect the glucose levels in the blood (Khodaei et al. 2020, 23969). The artificial pancreas automatically performs the relevant medical actions on the bodies of patients if this is necessary (Inreda® Diabetic 2022, 4). Finally, the PCA pump reduces the need to think about anything that is related to having pain medication administered. All that patients need to do is simply push a button (Lee and Sokolsky 2010, 744).

As was just illustrated, CLMSs automate tasks that were previously performed by patients and clinicians. This results in the regulation of both clinicians and patients. As illustrated in section one, power that regulates populations is described via the second pole of biopower called biopolitics. As such, since these populations are regulated through biopolitics, there is actually biopower that is affecting these populations. Regulation of populations takes place once its individual members are affected by power. In the context of CLMSs this means that a great number of clinicians and patients must use CLMSs. Only if enough of them use CLMSs, regulation of their respective populations can occur. Consider the population of clinicians. As is clear by this point, the health of clinicians is positively affected as a result of using CLMSs. As I described earlier, having a smaller workload likely reduces the stress levels and burn-out rates of clinicians. In this way, CLMSs preserve the health of individual clinicians. When you assume that many clinicians use CLMSs, then they regulate the health of the population of clinicians. It is important to recognize that this regulation of the health of the population of clinicians, immediately also regulates that of the population of patients. This is a result of the reduced risk of clinicians making medical errors due to burnouts. As such, the result will be that patients will likely receive better medical care. This preserves the health of the population of patients.

As illustrated, CLMSs can perform actions in place of the patient. This includes subconscious actions like regulating movement or keeping the heart beating in a healthy manner. As a result, patients can go about their daily lives while not being hindered as much by their conditions. Reducing the hinderance of their conditions allows them to operate more efficiently in daily life within society. As illustrated earlier, biopower describes power that aims to have a positive influence on life in general. Allowing people to participate more effectively in society is one way in which this aim can be achieved. By enabling patients to move about more freely in society, CLMSs have this positive effect on them. Once enough patients use CLMSs, these systems are able to regulate the health of the population of patients through this power.

CLMSs can do better than just automating tasks that were previously performed by humans. They have the potential to perform these tasks better. After all, because of their direct access to the bodies of patients using their sensors, these systems can deliver personal medicine. For example, the algorithms in CLMSs can help with administering the correct doses of medicine to patients at all times (Ilan 2022, 7-8). This helps with improving drug effectiveness (Ilan 2022, 7). All patients have unique bodies and, with them, unique physiologies. For this reason, not everyone always needs precisely the same amount of medication at all times for it to be effective (Ilan 2022, 5). For more optimal treatment, the algorithms in CLMSs can update the dosage of medicine in real-time for each patient as required (Ilan 2022, 8). The actuator can then administer this personalized dose to the body of the patient. Note that this is exactly the point where CLMSs intersect with the genomic medicine that was mentioned in the introduction. The promise of genomic medicine is “to identify the key processes that control the manufacture of proteins and, in doing so, open these to precise intervention in order to produce therapeutic effect” (Rabinow and Rose 2006, 212). As we have seen during the description of the CLMSs, we can see that CLMSs fulfill a similar function. CLMSs provide, by intervening in specific parts of the body, health and therefore therapeutic effects for the patients to whom they are attached.

To illustrate the ability of CLMSs to provide personalized medicine, the ICD can be considered. We can see the personalized aspect clearly when we consider that patients might be performing different physical activities at different times. For example, one person with such an ICD might be running while another person is walking. In cases like this, the target heart rates differ (Touil, Bahatti, and Elmagri 2022, 363-364). The ICD will then make sure that the appropriate pulses or shocks are administered at the correct times (Touil, Bahatti, and Elmagri 2022, 360-363). The brain stimulation system is similar. In some brains certain activity is harder to detect than in others (Camara et al. 2015, 9). In this case, the system requires personalized configurations to operate optimally for individual patients (Camara et al. 2015, 8-9). The artificial pancreas also dispenses uniquely tailored doses of insulin to account for factors that affect the glucose levels at different times such as meals (Daly et al. 2023, 204). Finally, the PCA pump also needs unique models for each patient to properly model the effectiveness of drugs (Lee et al. 2012, 84). Based on what we have seen so far, it is essentially the case that CLMSs can detect the relevant physiological variables of the body with their equipped sensors. With these variables, the algorithms can determine the appropriate target values to strive for. These targets are what the CLMS will then try to achieve using its actuators. In this way, the health of the patients to whose bodies CLMSs are attached, is optimally regulated. If many patients that use CLMSs are considered, then we can see that the population of patients is also regulated.

In order for CLMSs to perform these actions, they use simplified digital representations of the bodies to which they are attached. In the introduction, digital representations were described as being abstractions of the physical body. Such a digital representation should store, at least, a variable that represents the physiological state of the patient. Additionally, patient specific information that clinicians might have entered such as the weight of the patient can be stored (Touil, Bahatti, and Elmagri 2022, 362). The reason why CLMSs need such digital representations to be able to perform continuous actions, is because of the way in how they attempt to carry out their goal. This goal can clearly be understood from the perspective of the control algorithms that are incorporated in the CLMSs. Should at any point values deviate from a desired value range, then the algorithm can instruct the actuator to perform actions on the body (Brogi et al. 2017, 446). The goal for this algorithm is therefore to keep these values in the desired range. Now that I have discussed how CLMSs regulate populations of clinicians and patients, it is clear why its usage is increasing and therefore normalizing. As mentioned earlier, health is one of the central themes in current society. I also illustrated that CLMSs support health in more optimal ways compared to what conventional medical tools could possibly do. As discussed in section one, this is because of it having immediate access to the body. We have seen that, as a result of the many personalized actions that CLMSs perform, regulation of the population of patients takes place. We also saw that CLMSs regulate the population of clinicians. These effects of CLMSs are in line with the focus on health in current society. As a result, the norm of remaining healthy helps with increasing the usage of CLMSs. This, in turn, establishes and strengthens the norm of using CLMSs in medical healthcare.

Until now, I have often discussed how CLMSs and the biopolitical pole of biopower relate. It is time to turn our focus more explicitly on the disciplinary pole of biopower. Because health is one of the central themes in current society, both clinicians and patients are urged to remain healthy. This desire to remain healthy combined with the knowledge that CLMSs can help in preserving health, promote the adoption of CLMSs. Individuals from both the population of clinicians and the population of patients, are therefore increasingly likely to incorporate CLMSs to some degree in their treatments. This willingness to adopt CLMSs, results from these individuals being the objects of disciplinary power. As explained in section one, disciplinary power affects individuals of a population. In the context of CLMSs, this means that it subtly encourages clinicians and patients to use these CLMSs. This clearly strengthens the norm that encourages the adoption of CLMSs due to them facilitating health. In essence, the effects of the norm in using CLMSs can basically be seen as disciplinary power at play. After all, both the knowledge about how CLMSs can help in maintaining health and the desire to remain healthy, gently push individuals towards adopting CLMSs. The way in how disciplinary power operates in this case, is not much different from the example that was given in section one regarding education. In the case of CLMSs, people are taught how it can benefit health and how it can help them in attaining the desire of having good health. Essentially, it is accurate to state that the benefits that CLMSs provide when it comes to maintaining health, strengthen the norm that gently pushes people towards using them. In this way, their benefits result in disciplinary power affecting both clinicians and patients. Clinicians in the sense that they are taught that CLMSs make their job of keeping patients healthy easier. This gently pushes them towards incorporating CLMSs in their treatments. Patients in the sense that they are taught that CLMSs help them in attaining and keeping bodily health.

It is now clear that the effects that CLMSs have over patients and clinicians can be interpreted in terms of Foucauldian biopower. This is not a surprising result when we consider the contemporary interpretations of biopolitics that were described section one. More specifically, through CLMSs, biopolitics can manifest as risk politics. To a certain degree, it is also able to manifest as molecular politics and ethopolitics. Risk politics, molecular politics, and ethopolitics can, in turn, be related to the three more general elements of contemporary biopower that were discussed in the introduction. Showing these explicit links between these contemporary interpretations and CLMSs, places CLMSs in a broader philosophical context and illustrates that they can be seen as systems that are compatible with contemporary biopower.

First, I will consider biopolitics as risk politics. In section one it was described that this aspect of biopolitics relates to performing explicit interventions based on the risk of medical conditions that might develop in the future (Rose 2001, 7-8). In this way, the relevant risk might be managed (Rose 2001, 7). In this section, I have given four concrete illustrations of CLMSs. These can all be interpreted as providing these concrete interventions. Consider the ICD. It attempts to manage the risk that might occur due to having a heart that does not function properly. The brain stimulation system attempts to mitigate risks that comes with untreated Parkinson's disease. The artificial pancreas tries to control the risk of unmanaged glucose levels. Finally, the PCA pump attempts to manage the risk of administering wrong doses of pain-relieving drugs (Lee et al. 2012, 83). Considering how all these CLMSs manage risk, it is accurate to state that CLMSs can be seen as instruments that allow biopolitics to act as a form of risk politics. Risk politics, in turn, relates to one of the more general elements of contemporary biopower. This element relates to the idea that specific interventions can be performed to promote the health of people (Rabinow and Rose 2006, 197). These specific interventions become clear from the fact that CLMSs, through the logic of risk politics, intervene in the bodies of patients.

The second form of contemporary biopolitics was molecular politics (Rose 2001, 1). Biopolitics as molecular politics was interpreted as the ability to specifically target life-related processes at the molecular level (Rose 2001, 16). An concrete example of where this ability is exercised is through genomic medicine (Rabinow and Rose 2006, 212). As described in section one, genomic medicine attempts to control the manufacturing process of proteins (Rabinow and Rose 2006, 212). By doing this, genomic medicine aims to achieve health promoting effects (Rabinow and Rose 2006, 212). When we consider the previously discussed illustrations of CLMSs, we can see similarities between how these systems perform medicine and how genomic medicine operates. Like in genomic medicine, there is a reductionist element to how CLMSs perform medicine. In attempting to have a positive effect on life, CLMSs attempt to affect life-processes of the bodies of patients. The ICD achieved this effect by influencing processes that regulate the rhythm of the heart. The brain stimulation systems did this by affecting processes in the brain. The artificial pancreas aimed to influence the process of injecting hormones. The PCA pump changed the process of how pain is perceived. Considering the way in how all these processes are influenced, it is accurate to state that, at the core, CLMSs are very similar to genomic medicine in how medicine is performed on the body. From this perspective, CLMSs can be seen as being describable in terms of biopolitics as molecular politics. This is true despite CLMSs not necessarily affecting molecular processes. The overall logic is similar between the two. This molecular politics can, in turn, be related to another element of contemporary biopower. This element relates to the idea that there is a way of thinking about the vital character of a human being, and that there is an authority that can decide on what this is (Rabinow and Rose 2006, 197). Clearly, the way in which the body is viewed has changed. From the perspective of CLMSs, it can be seen as something that can be shaped by affecting specific physiological processes. Medical research, as well as research into these CLMSs, can in this context be seen as sources of authority that determine how to think about the vital characteristics of human beings. After all, it is this research that decides how CLMSs can aid in affecting human vitality. Considering this, CLMSs and the related research play a large role in reshaping how human bodies are approached.

The third form of contemporary biopolitics was ethopolitics. Ethopolitics refers to the way how individuals use self-management techniques to improve themselves (Rose 2001, 18). This behavior is guided by different elements such as the "sentiments, moral nature or guiding beliefs of persons, groups, or institutions" (Rose 2001, 18). In this section, I illustrated that an increased usage of CLMSs would be compatible with the overall focus of society on enhancing health. I linked this increased adoption to the Foucauldian concept of the norm. The biggest reason why the norm of using CLMSs continues to be strengthened, had to do with the fact that these systems bring numerous health benefits to both clinicians and patients. This increased adoption normalized the use of these systems. This is also explainable from the perspective of ethopolitics. Consider the fact that ethopolitics "concerns itself with the self-techniques by which human beings judge themselves and act upon themselves to make themselves better than they are" (Rose 2001, 18). Considering the focus on health in current society, as well as the benefits that CLMSs have on the health of both clinicians and patients, this increased usage can be seen as a consequence of ethopolitics. After all, clinicians and patients decide to use CLMSs for the health benefits that they can bring them. From this perspective, the increased use of CLMSs can be described in terms of biopolitics that is manifesting itself as ethopolitics. Ethopolitics can be related to the last element of contemporary biopower. This element was described as people that work on their health under supervision of an authority (Rabinow and Rose 2006, 197). When patients choose to have CLMSs incorporated into their treatments, they clearly do so because they think that it will enhance their health. Clinicians will then supervise the usage of such a system. In this way, the ethopolitics that CLMSs enable can related to this last element.

In this section, four explicit instantiations of CLMSs were discussed. These were the ICD (implantable cardioverter defibrillator), the brain stimulation system for Parkinson's disease, the artificial pancreas and the PCA (patient-controlled analgesia) pump. I described how such CLMSs can be seen as largely autonomous sources of biopower that regulate both individual clinicians and patients, as well as their corresponding populations. This is due to them automating tasks from both patients and clinicians while performing them more effectively and in a personalized manner. After this, I discussed how the increased adoption of CLMSs related to the Foucauldian idea of the norm. I then illustrated how this norm relates to disciplinary power. The norm that promotes the use of CLMSs gently pushes individual clinicians and patients towards using CLMSs. Finally, I described the relation between CLMSs and risk politics, molecular politics, ethopolitics and the three elements that are relevant in the interpretation of contemporary biopower.

At this point it looks like CLMSs can simply be seen as one of the many instruments that can be used in regulating populations. After all, CLMSs clearly have a positive impact on life. Additionally, since this positive power is fully interpretable in terms of biopolitics and disciplinary power, the delimited interpretation that Foucault has of the body does not seem to be a problem. As such, CLMSs seem to be fully describable in terms of Foucauldian biopower. It is important to realize that we discussed only one type of power in this section. This was the power that CLMSs exert over clinicians and patients. In the next section, I will illustrate why the other type of power poses a problem for Foucauldian biopower. This type of power describes power that is exerted over digital representations. For this reason, I will more explicitly illustrate that CLMSs fundamentally rely on digital representations. Finally, I will show that with a certain modification to Foucauldian biopower, this problem can be remedied.

Section 3: How Closed-Loop Medical Systems Displace Human Bodies

The previous section ended with the conclusion that, within the Foucauldian framework, CLMSs appear to be just another tool that regulates populations. This was because the first type of power that is relevant to CLMSs is describable in terms of Foucauldian biopower. This type of power was described as regulative power that CLMSs exert over clinicians and patients. In this section, I will show that the way in how CLMSs work, results in the displacement of the human body. This results in the second type of power being relevant. This type was described as power that is exerted over digital representations of patients. We will see that this power becomes visible at the digital level. I will elaborate on why this is a problem for Foucauldian biopower. Afterwards, I will show that the concept of Foucauldian biopower must be modified to properly be able to describe both types of power. After all, both play a fundamental role in achieving regulation of the population of patients and clinicians when CLMSs are involved.

There are two elements that are relevant to the displacement of human bodies. With the displacement of human bodies, I refer to the fact that human bodies are losing their importance to CLMSs and digital representations. With human bodies, I refer to the physical bodies of clinicians and patients. The first element relates to the person who actively performs medical treatment. This can either be the clinician or the patient. As I have illustrated, CLMSs take over the tasks of clinicians and patients. In this way, they are displaced by CLMSs. The second element relates exclusively to the patient. Their bodies are also displaced due to how CLMSs primarily consider the state of their digital representations to perform medical actions. This is true for both determining the appropriate medical action to perform, as well as the goal of CLMSs to regulate digital representations.

To investigate this first element regarding the displacement of human bodies, we should first consider where power originates from in the conventional treatment setting. As discussed earlier, it used to be clinicians who performed medical actions directly on the bodies of their patients. Patients would also perform medical actions on their bodies such as fingerstick tests. By performing these actions, clinicians and patients could themselves be seen as instruments that enable the regulation of bodily health. As such, in medical settings, patients and clinicians can be seen as sources of biopower since their actions enable the regulation of life.

As we have seen at various points throughout this thesis, CLMSs are often able to take over tasks that were previously performed by clinicians and patients. This was because of how CLMSs work at a fundamental level. Consider the observation that was just made about how clinicians and patients could be seen as sources of power. This was because they perform medical actions that preserve the health of patients. With the introduction of CLMSs, many of these actions are no longer performed by clinicians or patients. CLMSs have taken over those actions and, in this way, preserve the health of patients. Using their measuring sensors, CLMSs start chains of events that ultimately result in the use of actuators to regulate bodies. Taking all this into account, it can be stated that, in the context of providing medical care, clinicians and patients are displaced by CLMSs. Rather than saying that solely clinicians and patients are sources of biopower, CLMSs are now also sources of biopower due to them taking over medical tasks.

To illustrate this change in the source of biopower more clearly, consider the ICD that I have discussed in section two. The ICDs treat heart problems which used to require far more attention from clinicians in the past. By making sure that hearts keep beating properly, the ICDs performs many small actions continuously. In this way, ICDs can be seen as sources of biopower each time they perform actions that correct the heart based on new readings from the measuring sensors. Because of that, the health of individual human bodies is regulated. When the ICDs are used in big numbers, the health of the population of patients is also regulated. A similar reasoning holds true for the other CLMSs that were discussed in section two. The brain stimulation system is a source of biopower since it takes over actions that allow bodies to effectively continue to participate in society without muscle tremors. And the artificial pancreas becomes a source of biopower since it automatically takes over actions that result in injecting hormones that keep bodies healthy. Clinicians and patients do not have to manually manage medical conditions anymore. This results in them losing relevance as a source of biopower. Finally, the PCA pump system is a source of biopower since it automatically determines and injects correct dosages of pain medication resulting in a body that can regain health quicker. After all, patients will not be hindered in their recovery process due to suffering from unnecessary pain. Clinicians do not have to manually administer the medication anymore resulting in them losing relevance as a source of biopower. Due to CLMSs gaining relevance as a source of biopower, these systems displace the bodies of clinicians and patients when it comes to performing medical actions on the body.

It is not just the source of biopower that has changed, the object of this power has also changed. With the introduction of modern CLMSs, we can also observe a displacement of the bodies of patients by digital representations. With this displacement, I mean that the importance of the bodies of patients in the context of medical treatment is waning. As illustrated earlier, CLMSs use digital representations of bodies of patients to determine what actions to perform on this body. Remember that digital representations are simplified representations of the body of the patient. It contains all the information that is required for CLMSs to properly operate and calculate what action to perform on the body. This obviously does not mean that the body of the patient becomes irrelevant. The body is still required for the CLMSs as it must update the values in this digital representation based on physiological readings from it. For this reason, it can be said that the body is displaced by its digital representation. This is not to say that the digital representation will eventually completely replace the human body. Rather, the digital representation is simply necessary for CLMSs to function and, therefore, to exert power over patients. This means that both digital representations and the human body are necessary for CLMSs to exert power over its users.

Based on what I have illustrated when it comes to how CLMSs work, I can now demonstrate the fundamental importance of digital representations in more detail. The following part of the analysis follows from the descriptions of CLMSs that I have given so far. This relates to how these digital representations enable these CLMSs to work. The algorithms in CLMSs only consider this digital representation of the body. With this I mean that they only consider the measured physiological and general person-specific data that is stored in this digital representation. Likewise, their goal is to get this stored data, that represent physiological variables, in an acceptable range by making the system perform actions on the body. The sensors then measure the updated data from this same body. It is impossible for the CLMS to consider the body in its entirety. With this I mean that it is hard to measure everything that is there to measure about a body. This includes aspects that are hard to quantify such as the mood of people, or if they move their limbs in an energetic or slow way. CLMSs simply lack the instruments to do all this. Additionally, the algorithm would not know how to make sense of the body in its entirety. It cannot make sense of the body in the same way as humans can. It cannot use knowledge such as a broad variety of previous experiences and heuristics that clinicians might have in the context of medical care. To be able to compute the medical actions that need to be performed, the algorithms need to process digital data that can be quantified such that they can understand it. This digital data can only be obtained by interpreting certain physiological variables through the sensors which are attached to the body. These variables must then be stored in digital representations such that the algorithm can access them.

As becomes clear, it is during the explicit evaluation of the digital representation where the physical state of the body is indirectly considered. The digital representation does not contain all possible data that could potentially be derived from the body. For example, the brain stimulation system only measures two signals from the body (Camara et al. 2015, 2). Despite these simplifications, the digital representation is still sufficient for CLMSs to operate effectively. After all, consistent with their reductionist nature, CLMSs operate within a very specific scope. By attempting to manage a single condition, they only need a specific subset of all the information that the body contains. For example, the ICD only focusses on maintaining a proper heart rate. It does not try to manage all health problems that a patient might have.

There is not only a displacement of the bodies of patients that takes place when CLMSs consider digital representations to determine if medical actions need to be performed on the body. We can also see a displacement of the body when we consider the intent of CLMSs when they exert power over digital representations. Of course, CLMSs still have their effects on human bodies. However, as we can infer based on how CLMSs work, CLMSs operate with the intent of keeping measured physiological values in a certain range. These values are stored in the digital representation of the body. This happens by means of affecting the body until the physiological readings reach acceptable levels. Whatever happens to the actual body because of these actions is, from the perspective of the control algorithm, unimportant. As long as the variables in the digital representation get the proper values, the CLMS will have done its job.

Due to this explicit goal of the algorithm to get the values of the digital representation into an acceptable range, it is accurate to state that power is aimed at the digital representation rather than the body. This power can still be seen as power over life, even if it does not directly affect the body. This is due to the intertwinement of the body with digital representations. Affecting one also affects the other in some way. For all intents and purposes, this digital representation could actually be seen as being part of the human body from the perspective of the CLMS. Essentially, it could be said that life can be manipulated at the level of the digital. For example, the artificial pancreas analyzes the glucose of the patient (Daly et al. 2023, 204). By analyzing this blood, it attempts to quantify the glucose levels of the patient (Daly et al. 2023, 204). By injecting insulin into the body of the patient, it attempts to get the glucose value in a desired range (Daly et al. 2023, 204). In this way, the body is used as a means to achieve the desired glucose level. After all, the glucose levels of the body change. As a consequence, the variable that represents the glucose levels of the patient and is stored in the digital representation of the patient, also changes. Likewise, the glucose value could have been out of the desired range to begin with. This would have resulted in the digital representation not being in the desired state. This could have caused the CLMS to inject insulin in the first place. In this way, both the digital representation of the body of the patient, as well as the actual body, are fundamentally intertwined. In the context of CLMSs, they cannot be seen as separate objects that do not affect each other. Consequently, any power that is exerted over the bodies of patients is simply an indirect effect resulting from the normal operation of CLMSs. In this way, CLMSs enable biopower through biopolitical regulation of populations of patients. This is a consequence of them attempting to keep specific variables in a certain range. After all, they perform actions on the bodies of the patients to achieve this. At this moment, it could be said that CLMSs attempt to manipulate life at the level of the digital by attempting to change the variables stored in digital representations. Essentially, this results in the type of power that has a regulative effect on clinicians and patients. I described this type of power in section two. After all, the bodies of patients are being kept healthy as a result of the actions of CLMSs. Indirectly, this keeps the workload of clinicians low. The biopower that these CLMSs exert can therefore be seen as a byproduct of its normal functioning.

Of course, the design and deployment of CLMSs are done with the explicit intent to regulate the human body and keep it healthy. For this reason, the digital representation is designed to represent the human body. However, strictly speaking, these systems could work just as well if the sensors were fooled by presenting faulty data that does not originate from a human body. In this case, power would still be exerted over the digital representation of the supposed body since the system would simply continue to function as intended. Of course, no Foucauldian biopower would manifest here since no human body would be affected by any of the physical actions that these systems would be performing. This illustrates that, for the CLMSs, it does not really matter where the input comes from. In theory, it would still be able to function. Of course, it would not fulfill the envisioned purpose that its designers had to have a positive effect on life. This further illustrates that CLMSs, due to their autonomy, lack the intent of explicitly regulating the delimited body. This intent is something that clinicians and patients would have while performing their actions. Instead, CLMSs only care about affecting digital representations. This different intent further illustrates that the explicit target of power differs for humans compared to CLMSs. For humans it is the body, while for CLMSs it is the digital representation. This further illustrates the displacement of bodies by digital representations as the target of power.

Considering all that was just discussed, it is accurate to state that clinicians and patients are displaced by CLMSs and the digital representations that CLMSs use. Consider clinicians. As I illustrated earlier, CLMSs have taken over medical tasks from clinicians. With the introduction of CLMSs, these tasks are autonomously performed by CLMSs. As such, in the context of providing medical treatment, bodies of clinicians are displaced by CLMSs. The bodies of patients are displaced in two ways. The first is by automation. A similar reasoning as for the displacement of clinicians holds. It used to be the case that patients had to apply medical treatment to their bodies. However, CLMSs often take over this task and therefore displace the bodies of patients in the context of providing medical treatment. The second way relates to patients as being the target of medical treatment. Rather than the actual body being directly targeted with the intent to regulate its health, CLMSs solely consider digital representations of the body. This is true for determining if a medical action needs to be performed on the body. Rather than analyzing the entire body of a patient, CLMSs analyze a digital representation of it. It is also true for when an actual action is taken. The sole goal of the CLMSs here is to keep values that are part of the digital representation in a desired range. The effect that the medical actions have on the human body in the process of achieving these goals, are just indirect consequences of how CLMSs operate.

As mentioned earlier, Foucauldian biopower seems to place too much emphasis on delimited bodies. Despite the displacements, this emphasis is not always a problem. Consider the displacement of patients and clinicians by the CLMSs when it comes to performing medical actions on the body. We have seen that Foucauldian biopower has no trouble accounting for this displacement. After all, CLMSs still exert power over clinicians and patients that effectively regulates them. The second displacement is that of the bodies of patients. They are displaced by their digital representations. This is also not necessarily a problem for Foucauldian biopower. I illustrated that CLMSs primarily consider the digital representations of bodies for determining what actions to perform on the body to keep the values of the digital representation in desired ranges. Simply considering digital representations of patients does not necessarily result in them being regulated. CLMSs could conceivably consider these representations and do nothing with it. For this reason, the act of considering digital representations, even if they have displaced the bodies of patients, is no problem for Foucauldian biopower. Consider the hand gel example again. In determining where to place the dispensers, the government only has to consider statistics relating to sickness in a certain environment. Based on this, it can decide to place the dispensers in a certain area. The dispensers will then fulfill the role of regulating the health of the people in that area. In this example, only an abstraction of a human population was considered. This is not much different from abstractions of human bodies like digital representations. As such, the displacement of human bodies by digital representations when CLMSs attempt to determine what action to perform on the body, is not a problem for Foucauldian biopower.

As illustrated earlier, the goal of CLMSs is to regulate digital representations of the bodies of patients. In regulating these digital representations, CLMSs exert power over them. This happens at the digital level. It is in regulating these digital representations where a problem arises for Foucauldian biopower. As illustrated earlier, digital representations are the objects at which power is directed. The only goal of CLMSs is to regulate this digital representation such that its values remain in a desired range. Affecting the body of the patient with which it is intertwined, is just a means for these systems to achieve this goal. For these reasons, it can be said that CLMSs exert power over life at the level of the digital. As mentioned earlier, Foucauldian biopower takes human life and populations as its object. As such, power that is exerted over non-human objects falls outside its scope. Consequently, the power that CLMSs exert over digital representations is indescribable in terms of Foucauldian biopower. It is unreasonable not to interpret this power as a form of biopower. After all, we have seen that, in the context of CLMSs, human bodies and its digital representations are fundamentally intertwined with each other. Affecting one also affects the other. From this perspective, these digital representations can essentially be interpreted as being integrated with the body. Not only that, as we saw in section two, exactly because CLMSs explicitly attempt to regulate digital representations by affecting the corresponding human bodies, CLMSs are able to exert power over clinicians and patients by means of automation and personalized medicine. Considering all this, it is accurate to state that this power that is exerted over digital representations should be considered biopower. Unfortunately, Foucauldian biopower falls short in its ability to describe this power over non-human objects, even if the direct consequence of this power results in positive effects on clinicians and patients.

The descriptive, and therefore analytical, power and relevance of Foucauldian biopower would be greatly enhanced if it were to accommodate CLMSs where digital representations of human bodies play a crucial role. In this thesis, this crucial role of digital representations could clearly be seen in how they enable CLMSs in pushing the boundary of regulating human life. It is therefore important that, for a proper description of how power over life operates when medical actions are performed, biopower can also describe power that affects digital representations of patients. The ability of the concept of Foucauldian biopower to be able to analyze such power relations is critical. Its inability to do this leaves scientists and philosophers with an incomplete concept that will yield incomplete analyses that lack crucial power relations. In this case, these concern power relations involving CLMSs and the digital level at which these relations occur. Essentially, the displacement of the bodies of patients by digital representations further justifies why this new type of power should be describable as being a form of biopower. To be better able to describe this new power over digital representations, I propose that the concept of Foucauldian biopower should be modified.

This modification can be done in such a way that biopower can be used to describe power that is exerted over digital representations. As mentioned earlier, Foucauldian biopower traditionally takes the human body as its object. However, as described in the introduction and section one, the human body is seen as delimited by Foucault. By explicitly including an interpretation of what can be interpreted as a human body in the context of CLMSs, Foucauldian biopower can be used to properly describe power over these non-biological objects that are fundamentally intertwined with human life. With this modification, power over digital representations that exist at the digital level, can be better interpreted through the concept of biopower. After all, the problem was that CLMSs attempt manipulate the body at the level of the digital by modifying values that are stored in the digital representations of patients. This power over these digital representations is something that falls outside the scope of Foucauldian biopower due to digital representations not being part of a delimited human body.

One might argue that including such an interpretation of the body weakens the analytical power of the concept of Foucauldian biopower considerably. After all, digital representations of human bodies are, unlike human bodies, certainly not biological in nature. Not only that, but these representations are not even a part of a delimited human body. As such, including them as valid objects of biopower can be seen as negating the biological characteristic of this power.

At this point it is worthwhile to realize that the concept of human life is ever changing (Rose 2001, 20). What can be interpreted as human life is constantly being changed by technologies such as “biology, biomedicine and biotechnology” (Rose 2001, 20). This further illustrates the importance that biopower is constantly analyzed in light of new technologies that might change the way how the body is interpreted. As such, it is actually a good thing that these non-human digital representations are included as objects of biopower. After all, as argued in this section, due to the fundamental intertwinement of the bodies of patients and their digital representations, power that affects one also affects the other. As such, the entire idea of what human life entails, can be said to have been defined in part by how CLMSs operate. For this reason, the way in how Foucault saw the body, is no longer accurate in situations where CLMSs are used. The idea of the body being "closed and delimited" (Lemke 2011a, 94) has become outdated with the addition of the digital level where the digital representation resides and through which the body can be the object of power. Explicitly adding the interpretation of the body as also consisting of its digital representation, given that they are fundamentally intertwined, should be added to the concept of biopower. This allows the concept to be used to analyze the relevant power relations over life that include the digital level.

In this section, I have described how, in the context of performing medical actions, CLMSs displace the bodies of clinicians and patients. I have also described how, in the same context, digital representations displace the bodies of patients when it comes to being the object of consideration. With the object of consideration, I refer to the body that corresponds to the digital representation that the CLMS uses. This displacement refers to the process where it is being determined if the CLMS is going to perform a medical action or not. Additionally, the bodies of patients are also displaced by digital representations when it comes to why CLMSs perform medical actions on the body. Rather than performing actions on the body to preserve the health of that body, CLMSs perform actions on the body with the goal of regulating digital representations. I explained that the reason for this is that, when the state of the body changes, the state of its digital representation also changes. Finally, I noted that, despite CLMSs being compatible with the aims of Foucauldian biopower to have a positive effect on life, the original concept places too much emphasis on power over life as being power over a delimited human body. I proposed that the concept should be updated such that power over life, even if this involves non-biological objects such as digital representations, can better be described in terms of biopower.

Conclusion

I will now summarize the main points that are relevant for answering the research question. This question was defined as: ‘To what degree is the process through which closed-loop medical systems regulate the health of clinicians and patients describable in terms of Foucauldian biopower? How should Foucauldian biopower be modified if this process cannot be described?’

To be able to answer the first part of the research question, we must start by looking at the contents of section two. The goal of the second section was to investigate whether the power that CLMSs exert over clinicians and patients can be interpreted in terms of Foucauldian biopower. This was the first type of power that was relevant in how CLMSs are able to regulate clinicians and patients. In this section, I illustrated that CLMSs operate autonomously and can provide personalized medicine. By being able to do this, CLMSs reduce the workload of clinicians. The biggest reason for this is that CLMSs take over medical tasks from clinicians and patients. Additionally, patients do not have to go as often to clinicians as they used to. After all, they do not need as much guidance on medical actions since these are now performed by CLMSs. The reduced workload that CLMSs provide for clinicians, regulates their health since they are less likely to burnout. This also regulates the health of patients due to clinicians being less likely to make medical mistakes while performing their duties. The health of patients is therefore preserved. Of course, due to the automation and personalized medicine provided by CLMSs, the health of patients is also regulated. This is the case since CLMSs are simply better at executing these medical tasks on the bodies of patients resulting in tighter regulation of their health.

For both clinicians and patients, it is the case that their respective populations are also regulated. After all, a population consists of its individual members. CLMSs regulate the health of these individual members. This necessarily results in these populations themselves also being regulated. From this perspective, the power that CLMSs exert over clinicians and patients is of a biopolitical nature. Since biopolitics is a pole of biopower, this power can directly be seen as being biopower. I also illustrated that the benefits of CLMSs result in disciplinary power being exerted over individual clinicians and patients. Due to the use of CLMSs resulting in better health for clinicians and patients, the adoption of such systems is facilitated through the Foucauldian norm. The norm subtly pushes clinicians and patients towards using CLMSs. Essentially, this norm exerts disciplinary power over clinicians and patients. In this way, CLMSs play a crucial role in the exertion of disciplinary power. Disciplinary power is also a pole of biopower. As such, the benefits that result from the usage of CLMSs play a fundamental role in the exertion of biopower on individuals.

Besides establishing that CLMSs exert a positive power over life, it was also discussed that CLMSs could be described in terms of three interpretations of contemporary biopolitics. These interpretations were biopolitics as risk politics, molecular politics and ethopolitics. These interpretations were then linked to the three elements of contemporary biopower.

At this point, it is clear that at least the first type of power that is relevant for how CLMSs are able to exert a positive power over clinicians and patients is describable in terms of Foucauldian biopower. However, there was also a second type of power. This second type is power that is exerted over digital representations of the bodies of patients. In section three, I discussed this type of power. I described how CLMSs displace clinicians and patients. The bodies of clinicians are displaced because CLMSs can autonomously administer personalized medicine to the bodies of patients. Clinicians no longer have to perform these medical actions manually. Bodies of patients are displaced in three ways. First, patients do not have to administer medicine to their own bodies anymore. The CLMS does this. This displacement is therefore of a similar nature as the displacement of clinicians. Second, rather than examining and considering entire bodies of patients, CLMSs only explicitly consider a simplified digital representation that acts as an abstraction of the body. Solely by considering this representation, it can determine the actions to perform on the body. In this sense, patients are displaced by their digital representations. Third, algorithms in the CLMSs only have the goal of keeping variables that represent the physiological state of patients in a specific range. To achieve this, the sensors of the CLMS measure the relevant physiological data from the body of the patient. This value is then stored in the digital representation of the patient. The algorithm then determines if the current value of the variable is in the desired range. If not, it will exert power over digital representations by making the actuator perform medical actions on the body. The sensors then derive the most recent data from the body. The algorithm then considers this data again. The process then repeats. As became clear, CLMSs exert power over digital representations of the bodies of patients with the intent to regulate the variables that are stored within these representations. In this sense, the bodies of patients serve as a means to an end for CLMSs to achieve this goal. For this reason, it can be said that from this perspective, patients are displaced by digital representations as well.

From the perspective of Foucauldian biopower, there is no problem with describing the displacement of clinicians and patients by CLMSs when it comes to these systems taking over their medical tasks. As illustrated in section three, biopower does not necessarily originate directly from humans. The displacement of patients by digital representations when CLMSs consider what medical actions to perform on the bodies of these patients, is no problem for the same reason. The final type of displacement results in a problem for Foucauldian biopower. This type relates to the second way in which the bodies of patients are displaced by their digital representations. As a result of this displacement, CLMSs exert power over these digital representations by performing medical actions on the bodies of patients. The sole intent here was to regulate these digital representations rather than the bodies of patients. In this sense, the attempt to change the state of these digital representations can be interpreted as power that is being exerted over them. This power is exerted at the digital level. Nevertheless, in regulating these digital representations, the bodies of patients are automatically regulated as well. This is due to the fundamental intertwinement of the body and its digital representation.

If something changes in one, then something happens in the other as well. For this reason, power over life can be exerted at the digital level. Section three described that the main problem was that Foucauldian biopower traditionally describes power over human bodies and populations. As discussed, Foucault saw the body as being delimited. But if this regulation of digital representations is necessary for CLMSs to be able to regulate the health of patients and clinicians, then this power must be describable in terms of biopower. After all, from the perspective of CLMSs, these representations are essentially part of the body. If it cannot describe this, then the concept of biopower cannot be used as a tool to fully analyze the power relations that affect life and exist at the digital level.

When relating all this back to the research question, I can now answer the first part of this question in full. This first part was described as: 'To what degree is the process through which closed-loop medical systems regulate the health of clinicians and patients describable in terms of Foucauldian biopower?' I already noted that the first type of power, the power that CLMSs exert over clinicians and patients, is describable in terms of Foucauldian biopower. This was mainly because of the positive effects that CLMSs have on the health of clinicians and patients. These effects are consistent with the aims of biopower to have positive effects on life. Additionally, CLMSs can be described in terms of the discussed interpretations of contemporary biopolitics and biopower. The problem lies with the second type of power. This is power that CLMSs exert over digital representations of the bodies of patients. This power over life that is exerted at the digital level is not describable in terms of Foucauldian biopower due to it not being biological or being part of the delimited interpretation of the body that Foucault had. Yet, for CLMSs to function, these digital representations are crucial. As a result, the process through which CLMSs are able to regulate the health of clinicians and patients is only partly describable in terms of Foucauldian biopower.

To answer the second part of the research question, we need to look at the remainder of section three. Here, I suggested that the concept of Foucauldian biopower should be modified. This is necessary if power over digital representations is to be describable in terms of Foucauldian biopower. I noted that, in the context of CLMSs, this modification can be achieved by adding an explicit interpretation of the body to the concept of biopower. This interpretation describes the body as no longer being consistent with the delimited view of the body that Foucault had. Instead, it describes it as being fundamentally intertwined with its digital representation. As such, this digital representation could be interpreted as being part of the body. The idea behind these modifications was that power that is exerted at the digital level over digital representations can be described in terms of biopower. As illustrated earlier, power over digital representations is necessary for CLMSs to work as intended and, as such, results in them being able to regulate clinicians and patients as well as their corresponding populations. Because of this, power over these digital representations must be describable in terms of Foucauldian biopower if it is to be used for analyzing power relations over life at all relevant levels when CLMSs are involved.

Now the final part of the research question can be answered. This part was defined as: 'How should Foucauldian biopower be modified if this process cannot be described?' Foucauldian biopower should be modified by including the explicit interpretation of the body as being fundamentally intertwined with its digital representation. This means that this digital representation can be seen as being part of the body. This expands the scope of biopower to include power relations that occur at the digital level and describe power over digital representations of the bodies of patients.

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