

# A Systemic Look at the Norwegian Health Care System with Focus on Gestational Diabetes Mellitus

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**Abstract**—The human is a complex machine and the health care system is the mechanic hired to maintain and repair both the hardware and software. External forces are constantly pushing out “software-updates”, “bugs” and “viruses” affecting the human being in different ways. Finding the best way to treat a patient is challenging without knowing the patients background story. That story is formed from the moment the patient is born and is pushed in different directions by various sources. Family, friends, teachers, strangers, media, and for the last 15 years or so, social media, are all contributors to shaping the mind of a young individual. This paper looks closer at the physiological and psychological causes and effects of diagnosing pregnant women with Gestational Diabetes Mellitus (GDM), and the authors reflect and discuss how the Norwegian health care system can treat the condition in a way that supports individuality and complexity. Diseases that are correlated with certain lifestyles are frequently mentioned in media, often as warnings or motivation for a healthy lifestyle. However, the reasons for getting these diseases are more complex than usually presented. The entire fault is put on the individual's ability to live healthy, which is an unfair burden that may again result in low self-esteem and poor lifestyle choices. Systems thinking tools such as the conceptagon and systemigram are utilized in an attempt to capture the complexity of the problem and the system most suitable for solving it.

**Keywords** – *Systems thinking; Health information management; Systems engineering; Clinical diagnosis, Psychology*

## I. INTRODUCTION

Gestational Diabetes Mellitus (GDM) is a diagnosis seen in between 6-11% of pregnant Norwegian women [1]. Hormones due to the pregnancy causes the insulin to have lower effect and if the body is not able to compensate for this, the blood sugar levels may rise above a defined limit. The reason why the body is not able to compensate for the increased need for insulin is not well documented, but factors such as genetics, lifestyle, obesity, age, ethnicity and environment are often mentioned [2], [3]. The combination of these factors determines the risk of developing this condition. Most of the literature focus on the technical causes and effects of being diagnosed with GDM [4]–[6], while the psychological effects are not considered to the same degree. It is reasonable to assume that receiving such a diagnose will

have some effect on the wellbeing of the patient, in addition to the frequent need for blood sugar monitoring and potential medication. In today’s society, a person diagnosed with any kind of diabetes will automatically be exposed to some degree of stigma. The word diabetes is often correlated with laziness, low self-discipline and unhealthy eating. Many people will choose not to share the diagnosis with their surroundings, which may influence how well they are able to manage the condition. When a pregnant woman is diagnosed with GDM without receiving sufficient information from the doctor she will probably try to acquire the information herself. The Internet is overflowing with relevant, irrelevant, correct and incorrect information, which can be challenging to filter, and the patient may end up being stressed and worried. The purpose of this paper is to illustrate the complexity of the GDM diagnosis. By using systems thinking tools, the authors can look at the current gestational diabetes research from a new perspective. The Norwegian health care system is treated as the System of Interest (SoI), while the patient is seen as a stakeholder. The authors have used system engineering tools, such as the conceptagon and systemigram to create the models that are presented in section II. A research study of causes and effects of being diagnosed with GDM has been performed by the authors in section III before adding own reflections in section IV, and conclusion and further work in section V.

## II. MATERIALS AND METHODS

In order to analyze, synthesize and inquire the system of interest, a framework called conceptagon is utilized and described in the next subsections. A systemigram is developed and presented to identify the relationships and activities between the SoI and its stakeholders. Both the conceptagon and systemigram are included in the systems engineering toolkit and are helpful when striving to achieve a holistic view of a problem or system, according to the methodology done in other domains [7]–[10].

### A. Conceptagon

The conceptagon [11] is a framework for applied systems thinking. Its purpose is to present different concepts in a common language that system experts with different backgrounds can understand. The conceptagon, consisting of the SoI in the center and seven triples distributed around it, is shown in Figure 1. The triples each include three concepts

that are known as fundamental terms in several disciplines. During the next paragraphs, the authors describe the SoI through each of the concepts shown in the conceptagon.

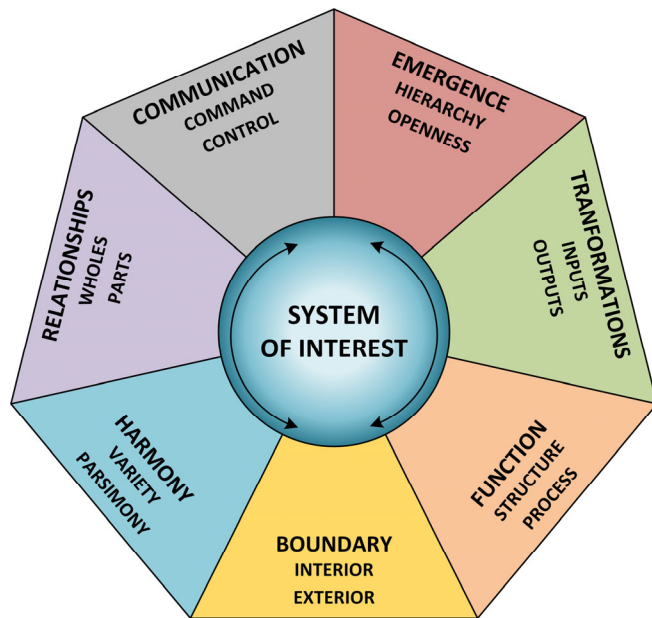


Figure 1 Conceptagon [11]

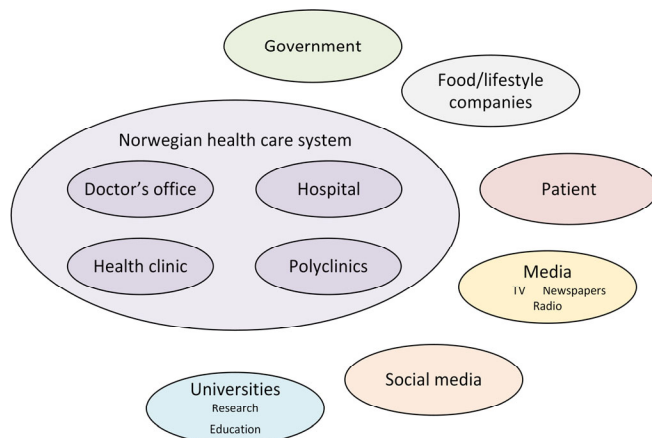


Figure 2 Boundaries

1) *Boundary:* The boundaries are defined by identifying the interior and the exterior of the SoI and are crucial for understanding what the SoI consists of. The interior includes factors that the SoI have control over and that is relevant to the problem presented in this paper, while the exterior identifies factors that must be taken into account. The SoI may be able to impact the external factors, but does not have control over them. Figure 2 presents the interior and exterior of the SoI. The Norwegian health care system is split into several divisions with different functions. The doctor's office is where the patient have their check ups and regular visits; the health clinic gives support to women during their pregnancy and follow up kids with check ups

and vaccines; the hospitals treats serious and acute illness; and the polyclinics treat patients that are in need of specialists. The government is shown as part of the exterior of the SoI. The Norwegian health care system is funded by the government. Universities often collaborate with the Norwegian health care system to get support from specialists and to stay on top of what kind of research is needed. Food and lifestyle companies, such as food producers and gyms, are often driven by a need to make money. They have an indirect impact on the SoI by affecting the patients in one direction or the other. The patient is also seen as part of the exterior and giving the patient the best care possible is the main purpose of the SoI. Media and social media are, like the food/lifestyle companies indirectly affecting the SoI by pushing unfiltered information, commercials, research, opinions and warnings on the patient.

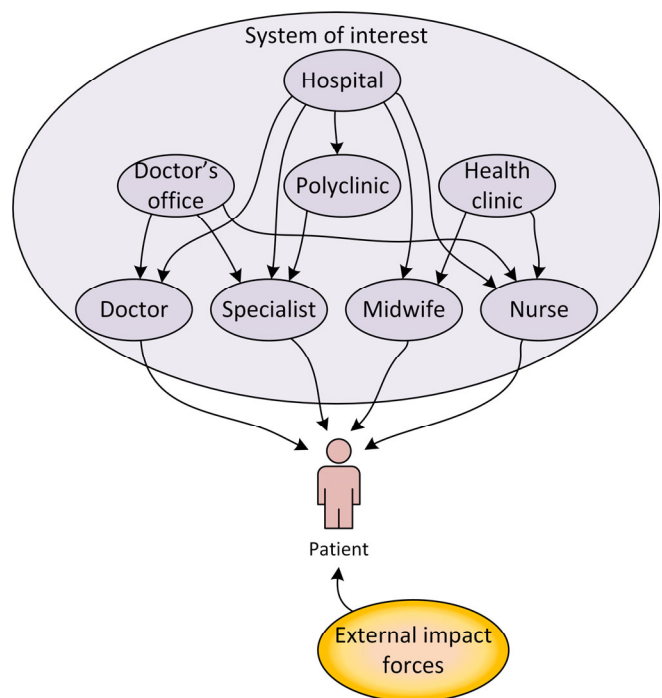


Figure 3 Functions

2) *Function:* As described in paragraph 1), the different divisions of the SoI have different functions. As illustrated in Figure 3, the patient will receive support and information from at least four different functions in the Norwegian health care system. The employees are stationed at different locations and use different computer systems. The patient needs to bring what is called a “health card” to each appointment, which is a piece of paper that the doctor, nurse, midwife or specialist fills out after each visit. Due to strict laws against sharing personal data, information cannot automatically be shared with other parts of the health care system in all cases.

3) *Transformations*: A system should always transform the given input to a desired output. Figure 4 shows that the patient gives input to the Norwegian health care system in form of body measurements (weight, height, etc.), test materials (blood, urin, saliva), personal history and reflections. The health care systems are tasked to use the given input to provide the patient a diagnose, suitable treatment, relevant information and necessary support.

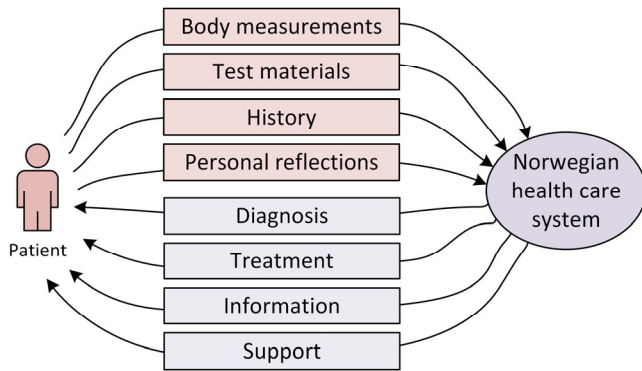


Figure 4 Transformations

4) *Emergence*: The Norwegian health care system is dependent on using reliable tools and cannot afford to be pioneers in using new technology. Machines, computer systems and medicine must all be certified to meet appropriate standards. The consequences of failure can be fatal. Introducing new medicine or treatment methods will therefore take time before it is approved and considered safe.

5) *Communication*: The divisions in the Norwegian health care system that is in focus during this paper are funded by the state or the county. Hospitals and polyclinics that are funded by the state will be able to offer more equal treatment throughout the country. The doctor's office and health clinics that are founded by each county might offer different services and level of support from county to county. Each facility has control over themselves, after complying with certain requirements, but the funding has an impact on the possibilities.

6) *Relationships*: To best support the patient, all parts of the system should work as a whole. The constantly increasing use of technology in today's society introduces a world of opportunities to integrate systems and share information. Despite this, the different functions in the Norwegian health care system are not sharing information in an effective manner. Security and restrictions for sharing personal data sets limitations and slows down the "digitalization". Today the patient needs to bring a "health card" to each appointment. After being diagnosed with GDM at the doctor's office, she needs to bring her "health card" to the health center and the ultrasound appointments and describe to them what the status is.

7) *Harmony*: The Norwegian health care system offers a large variety of services. As shown in Figure 5, the different functions are funded by different parts of the Norwegian government. The allocated resources for the different functions may therefore vary. The functions that are covered by the county are often low on resources, while the functions covered by the state have stricter requirements for resource allocation.

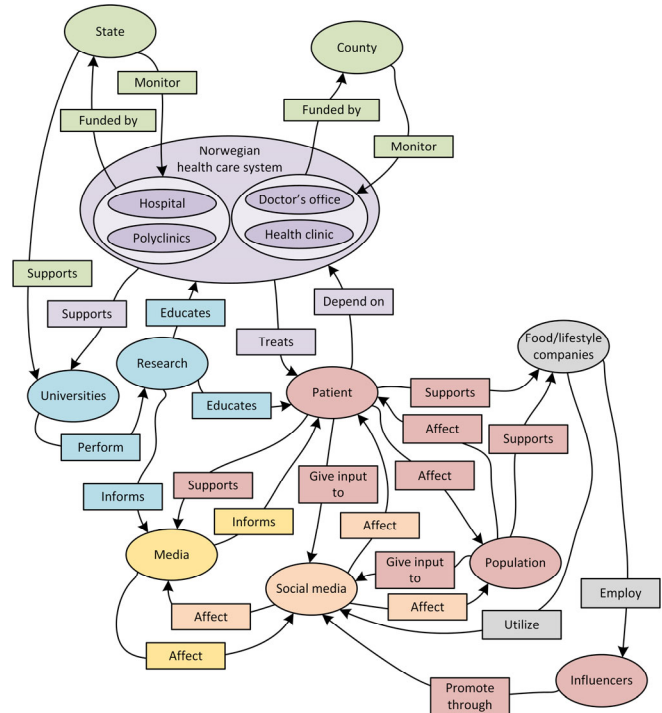


Figure 5 Systemigram

B. Systemigram

Identifying stakeholders and the relationship between them is useful to obtain a holistic view. Figure 5 presents a systemigram where the system of interest, its stakeholders and the relationships are identified. As illustrated, the patient is affected by a number of other stakeholders that cannot be controlled by the system of interest (SoI). It is important to identify these and acknowledge their presence. In that way, the health care system can develop means to reduce the negative effects these external factors may have on the patients.

III. RESEARCH STUDY

While gathering research, the authors aimed to answer the following three questions:

- What are the risk factors for being diagnosed with GDM?
- What are the potential physiological effects for the woman and baby?
- What are the potential psychological effects for the woman and what can these result in?

### A. Developing GDM

6-11% of pregnant Norwegian women are diagnosed with GDM [1]. The reasons for developing the condition are complex and not fully documented. What is known is that during a pregnancy, the hormones released in the body reduces the effectiveness of the insulin. In most cases the body is able to increase the insulin production sufficiently, but in other cases not. Factors that increases the risk of developing GDM are [12]:

- Glucosuria
- Family history of type 2 diabetes or GDM
- History of unexplained fetal demise
- High age
- Obesity

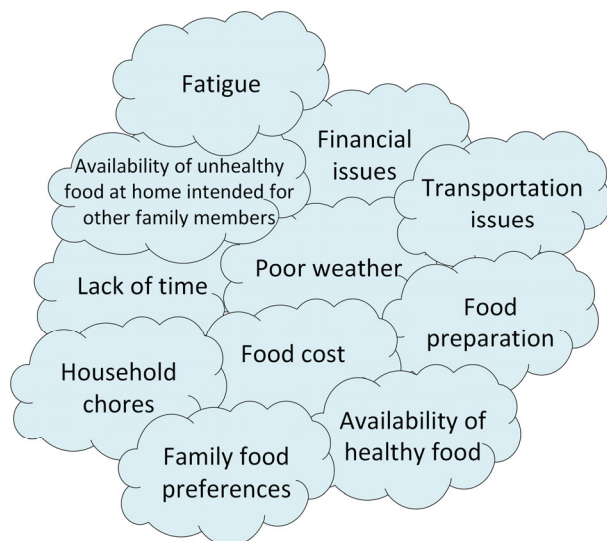


Figure 6 Barriers preventing people to lead a healthy lifestyle [13]

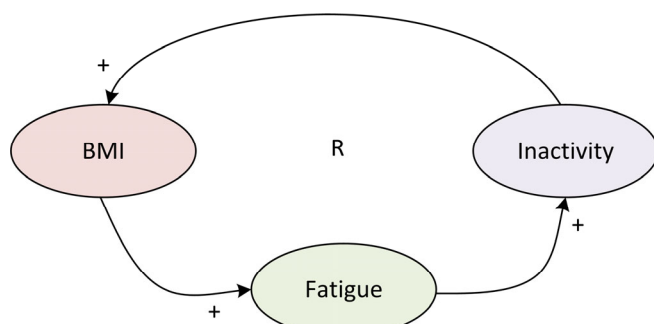


Figure 7 Causal loop diagram

If we look at the last point, obesity, which is the factor that is often in focus, the causes for this are again complex. Three commonly known factors for developing a high BMI are:

- Lifestyle
- Genetics
- Environment

When eating too much and/or unhealthy food and performing little exercise, the body will gain weight. How much and in what rate may depend on genetics. How to stop the obesity epidemic, that is frequently mentioned in the news these days, is not a question with a straightforward answer. The media’s focus and the “black and white” attitude of some people may be a contributing factor to the problem rather than the solution. Devsam et al. [13] mentions some barriers preventing people to lead a healthy lifestyle. These are illustrated in Figure 6. Barriers such as fatigue may also be observed as an effect of unhealthy lifestyle choices, resulting in a downward spiral that is hard to come out of. The reinforcing causal loop diagram in Figure 7 illustrates this phenomenon.

### B. Physiological effects of GDM

GDM is a condition that is usually limited to the pregnancy. A well-managed condition will not contribute to any dangerous consequences, but if the condition is not well managed the risk of serious complications for the baby, as listed below, may increase significantly [14]:

- High gestational birth weight
- Overall metabolic complications
- Stillbirth
- Shoulder dystocia

Similarly, if the condition is poorly managed, consequences for the mother may be [15]:

- Hypertension
- Cesarean delivery
- Risk of developing diabetes type 2 later in life

A positive outcome of receiving the diagnosis is actually that many women are able to change their lifestyle during pregnancy and able to maintain the new lifestyle after giving birth [16].

### C. Psychological effects of GDM

Evans and O’Brien say in their paper [17]:

*“The implication that impending motherhood is a condition of risk or peril that requires ‘surveillance, control, and intervention at any sign of deviation from normal’ might undermine one’s self-identity and desired level of autonomy as a pregnant woman.”*

Even a normal pregnancy introduces new thoughts, worries and changes to the body that in themselves can be overwhelming. Being informed about abnormalities can add unnecessary stress and worry. Several studies have been conducted on this topic and a common conclusion of most of these studies are that the women diagnosed with GDM have more negative emotions attached to their pregnancy and health than women without the diagnosis. Devsam et al. [13] conducted a study where they gathered the initial



responses from women who was diagnosed with GDM, before proposing a framework to enhance midwifery assessment. The initial responses are presented in Figure 8. The guilt could be related to not taking better care of themselves, staying in a stressful job or having the baby late in life. The women repeatedly asked questions about the causes of their condition and often blamed themselves for it [13], [18]. They also had negative reactions as to how to control the condition, as shown in Figure 9.

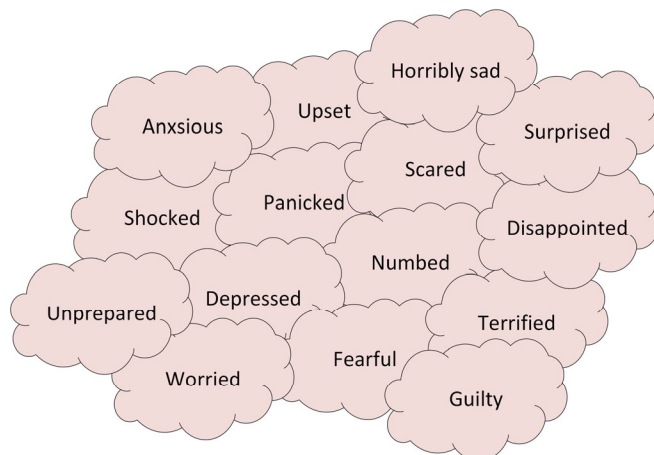


Figure 8 Initial response after being diagnosed with GDM [13]

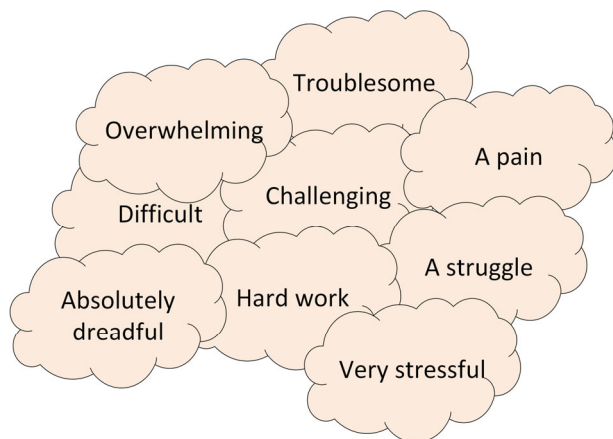


Figure 9 Reactions on how to manage GDM [13]

#### IV. REFLECTION AND DISCUSSION

Is the benefits of testing, diagnosing and treating pregnant women with GDM outweighing the negative psychological implications the diagnosis may have on the individuals? Jarrett [19] writes in his paper that:

*“The association between blood glucose concentrations and fetal weight is lost when adjustment is made for maternal weight and age.”*

He also states that:

*“The women with gestational diabetes in the original Boston studies had higher perinatal mortality, though the difference was not statistically significant, and the published analyses did not sufficiently examine the potential confounding variables, of which age and obesity were the most obvious.”*

This implicates that the GDM diagnosis itself is not causing the complications, and may only introduce extra stress to the patient. There is however reason to believe that receiving the diagnosis may have positive impact on the patient’s ability to change their lifestyle. According to Sjøgren et al. [16] 34% of the women included in their study that was diagnosed with GDM were able to stick to a healthy diet also after pregnancy. Egeland et al. [20] states that GDM does introduce higher risk of adverse perinatal outcomes. Detection and control of the diagnosis will help reduce these risks, but how can the health care system best treat and support the women receiving the diagnosis? As several studies show, the psychological impact on the patient is significant and should not be underestimated. Lawson et al. [18] states that women experience fear, depression and anxiety. It is important that the patient receives relevant and correct information immediately after the diagnosis has been set, to outweigh the often “one-sided” information introduced by the media. As described by Devsam et al. [13], Swedish women experienced a two weeks gap between receiving the diagnosis and having the first appointment at the specialized diabetes clinic where they had to seek information from books and the Internet in between. During the appointment with the specialist, their concerns were reduced. This implies that it is beneficial to reserve some time after the glucose intolerance test to properly inform and support the women that is diagnosed with GDM.

#### V. CONCLUSION

The first part of the paper presents the health care system as the system of interest by using different systems thinking tools. The purpose of using these tools is to illustrate the complexity of the system of interest and the gestational diabetes diagnosis in an understandable way. The last part of the paper discusses the physiological and psychological aspects of the diagnosis before discussing the positive and negative effects of being diagnosed. Even though the research is pointing in different directions regarding the potential consequences of GDM, the diagnosis can be a wakeup call that motivates the patient to adopt a healthier lifestyle. The psychological implications should not be underestimated, but considered to a greater extent in the health care system. Giving thorough information as close to the diagnosing as possible should be prioritized to avoid a long period where the patient seeks information that may turn out irrelevant or incorrect. Some future work could be a

research study investigating if rapid and thorough information reduces the negative psychological effects on the patient. Such a study may give the health care system motivation to prioritize giving the information earlier. Another interesting case for future work would be using systems thinking methods, such as the conceptagon and systemigram, to identify which factors have the most positive and negative impact on the psychology of the patient. This may contribute to finding focus areas for information flow.

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