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Unwarranted Absence of Variation in the Healthcare Sector[1]

Summary

The Norwegian Ministry of Health and Care Services demands in its purchasing documents that regional health trusts reduce unwanted variations in the use of specialist health services. A challenge described by the Office of the Auditor General of Norway (Riksrevisjonen) is that it should be considered on a case-by-case basis whether detected variation in service use is unwarranted or warranted. The examples in this article show that there may also be reason to consider on a case-by-case basis whether an *absence* of variation in service use is unwarranted or warranted. The examples also show that the extent of problematic under-treatment in specialist health services may be greatest in the area where the extent of unexplained variation is the least. Therefore, it is not obvious that requiring reductions in unwarranted variation is an effective policy measure. An alternative that could be considered is to design purchasing documents that emphasize compliance with the prioritization regulation to a greater extent than today.

Background and Introduction

It is widely known that the population's use of healthcare services is influenced by factors that cannot be observed by those analyzing data. Differences in healthcare utilization that cannot be explained by patient characteristics are alternatively referred to as unexplained, undesired, or unwarranted variation (Riksrevisjonen, 2019). Hermansen (2017) expresses that "it is problematic when variation occurs without being able to explain it based on patient preferences or disease prevalence in the population. Such undesired variation arises from both overuse and underuse of healthcare services, and both have detrimental consequences for both patients and society." The term undesired variation is used similarly in recent research literature on important issues such as geographic variation in the treatment of ADHD (Mykletun et al., 2021) and in parliamentary reports (Meld. St. 7 (2019--2020)). The Ministry of Health and Care Services (HOD) has demanded since 2015 that hospitals reduce undesired variation in the use of healthcare services.

With a publicly funded healthcare system, principles of resource allocation and prioritization are necessary in the sector, and the principles of prioritization are regularly debated in Norway. HOD's requirement to reduce undesired variation can be seen as a measure to limit the extent of randomness in patient prioritization. Trust and willingness of the population to pay taxes to maintain the service can be weakened if resources are used inefficiently or if patient treatment priorities are influenced by chance. Weakened trust may arise if an impression forms that some patients receive fewer services than necessary, while others receive more than they need.

It is not difficult to agree that undesired variation is precisely that - undesired. However, it is a challenging task to define clear criteria for distinguishing this type of variation from desired variation. According to Riksrevisjonen (2019), unjustified variation "... may indicate overutilization, underutilization, or both." At the same time, Riksrevisjonen emphasizes that each case must be assessed on a discretionary basis whether a detected case of variation is undesired or not.

In the following, we use the following definition of unexplained variation in the use of specialized healthcare services: "Variation in the use of specialized healthcare services that cannot be explained

[1] The original article by Godager, G. (2023), was published in Norwegian. You can access it at https://doi.org/10.23865/magma.v26.1432 . This version is translated to English by the author using AI-tools.

by variations in disease or patient preferences."[2] The article illustrates two main points. Firstly, it provides examples of how unexplained variation in the use of specialized healthcare services can be attributed to imperfect referrals[3] from primary healthcare - factors that hospitals have limited influence over. Secondly, it gives examples of cases where society may find it desirable to accept unexplained variation in the use of specialized healthcare services.

The article has the following structure: The next section describes the sources of imperfect referrals. We define referral probability and present a thought experiment outlining expected outcomes[4] for a set of populations with the same disease prevalence, utilizing hospitals that operate identically and without any forms of imperfections. Subsequent sections describe the variation in service utilization at the specialized healthcare service level that arises due to imperfect referral decisions in primary healthcare. We conclude with a brief discussion of possible policy implications.

Referral Decisions in Primary Health Care

In Norway, general practitioners (GPs) are responsible for referring patients who need evaluation and/or treatment to specialist healthcare services. It is well known that there is unexplained variation in the referral practices of GPs, and Førde et al. (2011) characterize such variation as undesirable, while Godager (2012) shows that the quality of referral decisions can be of the highest standard in regions where there is significant unexplained variation in referral rates. It is human to make mistakes (Kohn et al, 1999). Perfect medical assessments are an ideal that does not always apply in practice. This means that doctors' diagnostic assessments can be imperfect, and one should not expect the same diagnostic precision for all assessments conducted.

Diagnostic precision influences general practitioners' (GPs') referral decisions. Variation in diagnostic precision leads to unexplained variation in observed referral rates, and it is not easy to determine whether the variation in referral rates is desired or undesirable. Even though physicians have access to relevant knowledge, experience, and medical guidelines, there will always be some uncertainty and discretion involved in referral decisions. Therefore, two doctors may make different referral decisions even when faced with seemingly identical patients. Likewise, the diagnostic precision of a single doctor can be affected by the circumstances of the decision-making situation.

There are several sources of variation in the decision-making situation for GPs in the regular GP scheme. It is often claimed that GPs who know their patients well are more accurate in their diagnostic assessments compared to substitute doctors who must make diagnostic assessments without prior knowledge of the patient (Sandvik et al., 2022; Hetlevik et al., 2021). It is well known that there is significant geographic variation in the duration of GP contracts (Abelsen et al., 2015) and the extent of substitute usage (Gaski & Abelsen, 2018). Therefore, the extent to which a doctor knows the patient when making referral decisions will vary geographically, and it is commonly believed that continuity in the doctor-patient relationship influences referrals and the use of specialist healthcare services (Sandvik et al., 2022; Hetlevik et al., 2021). If residents in municipalities with extensive use of substitute GPs experience more unnecessary referrals to specialist healthcare services than residents in municipalities with a well-functioning regular GP scheme, this would be an example of how conditions in primary healthcare can lead to variation in the use of specialist healthcare services that is not due

[2] The definition resembles the description of undesired variation given by Hermansen (2017). An example of explained variation in the use of specialized healthcare services is if the proportion of residents receiving treatment for lung cancer is lower in areas where the proportion of daily smokers is lower.

[3] The term “imperfect referrals” is used in this text to refer to referral processes that are not perfect.

[4] We use the terms expected outcomes, expected number of referrals, etc., because referrals typically exhibit random variations even when prevalence and referral probability are constant. The variation discussed in this text is therefore not variation that arises from rates realized in data fluctuating around a specific probability.

to patient morbidity or preferences. Differences in referral practices among GPs can thus be a source of observable variation that cannot be explained by differences in health and illness. Godager and Iversen (2017a, 2017b) analyze imperfect referral decisions and derive the composition of a GP's referral probability. In the following, we use the same approach as Godager and Iversen (2017a, 2017b) to describe expected outcomes for a set of patient populations exposed to imperfect referral processes.

The starting point in the thought experiment we will now use is that a certain proportion of a GP's listed residents are referred to specialist healthcare for evaluation of a specific disease, while other patients are not referred for evaluation of this disease. As described in Godager and Iversen (2017a, 2017b), a simple, binary assessment on whether to refer or not will lead to four different outcome categories if there are imperfect assessments.

Table 1 Outcomes categories under imperfect referral decisions

		Patient's Condition: Has the disease	Patient's Condition: Does not have the disease
Doctor's Decision	**To refer**	Outcome where the sick patient is referred	Outcome where the healthy patient is referred
	Not to refer	Outcome where the sick patient is not referred	Outcome where the healthy patient is not referred

As shown in Table 1, among the persons referred for evaluation, there are expected to be persons who have the disease. At the same time, among the persons referred for evaluation, there are expected to be persons who do not have the disease. Similarly, there will be two different types of patients who do not receive referrals: With imperfect assessments, among the persons not referred for evaluation, some persons are expected to have the disease. At the same time, among the persons not referred for evaluation, there are expected to be persons who do not have the disease.

The framework used by Godager and Iversen (2017a, 2017b) is reproduced in Box 1. In the simple thought experiment, we are now going to use, we assume a standardized patient population of 2,000 people where 5 percent of the listed individuals have the particular disease for which referrals are made.[5] The precision of diagnostic tests is often quantified by indicating the test's sensitivity and specificity; Godager and Iversen (2017a, 2017b) use these measures to describe diagnostic precision in referral decisions.[6]

We assume that the specialist healthcare services to which referrals are made are standardized, and that the evaluation and treatment of patients with the disease is desirable for society. For simplification, we will assume that the specialist healthcare services have perfect diagnostic precision, while the GPs are imperfect. The probability of referring a patient with the disease is given by: 2) ps_1, and the probability of referring a patient without the disease is given by: 3) $(1 - p)(1 - s_2)$. The probability of not referring a patient with the disease is given by: 4) $p(1 - s_1)$, and the probability of not referring a patient who does not have the disease is given by: 5) $(1 - p)s_2$.

[5] A Prevalence at five percent corresponds roughly to the occurrence of ADHD or asthma, diseases that are normally assessed in specialist health services. A population size of 2,000 has only been chosen to get integer numbers in the examples.

[6] Lydersen (2017) provides the following definition: 'Sensitivity is the probability that a sick patient gets the correct result, i.e., a positive test. Specificity is the probability that a healthy patient gets the correct result, i.e., a negative test'.

Box 1 Referral probability as derived by Godager and Iversen (2017b).

p is prevalence

s_1 = Pr(refer | sick patient) , $(1 - s_1)$ = Pr(not refer | sick patient)

s_2 = Pr(not refer | not sick patient) $(1 - s_2)$ = Pr(refer | not sick patient)

r = Pr(refer) , the referral probability

The referral probability, *r*, is a function of prevalence, *p*, sensitivity, s_1, and specificity, s_2 : given by:

1) $r = ps_1 + (1 - p)(1 - s_2)$

The probability of referring a patient with the disease is given by

2) ps_1 ,

The probability of referring a patient without the disease is given by

3) $(1 - p)(1 - s_2)$.

The probability of not referring a patient with the disease is given by

4) $p(1 - s_1)$,

The probability of not referring a patient without the disease is given by

5) $(1 - p)s_2$.

We now provide examples of how variation in sensitivity, s_1, and specificity, s_2, creates variation in referral probabilities between doctors in the same catchment area and between catchment areas. We create hypothetical "doctor types" by combining different values for sensitivity and specificity. We describe the characteristics of the different doctor types in Table 2.

Table 2 Quality of referrals for two doctors in each of the three catchment areas, 1, 2, and 3.

Referrals in catchment area 1	
Doctor 1A has the best precision in catchment area 1: s1 = 99.00%; s2 = 95.00% 99% of the sick are referred, 95% of the healthy are not referred.	Doctor 1B has the second-best precision in catchment area 1: s1 = 97.00%; s2 = 92.00% 97% of the sick are referred, 92% of the healthy are not referred.
Referrals in catchment area 2	
Doctor 2A has the best precision in catchment area 2. Doctor 2A is exactly like doctor 1A. (s1 = 99.00%; s2 = 95.00%)	Doctor 2B has the second-best precision in catchment area 2: s1 = 95.00%; s2 = 94.00% 95.00% of the sick are referred, 94.00% of the healthy are not referred.
Referrals in catchment area 3	
Doctor 3A has the best precision in catchment area 3. Doctor 3A is exactly like doctor 1A. (s1 = 99.00%; s2 = 95.00%)	Doctor 3B has the second-best precision in catchment area 3: s1 = 93.00%; s2 = 94.68% 93.00% of the sick are referred, 94.68% of the healthy are not referred.

Doctors 1A, 2A, and 3A are characterized by a sensitivity of 99 percent and a specificity of 95 percent, which means that 99 percent of the sick and 5 percent of the healthy are referred. In catchment area 1, we find doctor 1A and 1B. Doctor 1B is characterized by a sensitivity of 97 percent and a specificity of 92 percent. In catchment area 2, we find doctor 2A and 2B. Doctor 2B is characterized by a sensitivity of 95 percent and a specificity of 94 percent. In catchment area 3, we find doctor 3A and 3B. Doctor 3B has a sensitivity of 93 percent and 94.68 percent specificity. We can see that doctors 1A, 2A, and 3A have the best diagnostic precision as they have the highest sensitivity and specificity. We see that doctor 1B is the doctor with the lowest specificity at 92 percent, while doctor 3B has the lowest sensitivity at 93 percent.

Table 3 Expected outcomes of the referral decisions by the six doctors in the three catchment areas.

Catchment area 1						
	Referred			**Not referred**		
	Total	with the disease	without the disease	Total	with the disease	without the disease
Lege 1A	194	99	95	1 806	1	1 805
Lege 1B	249	97	152	1 751	3	1 748
Catchment area 2						
	Referred			**Not referred**		
	Total	with the disease	without the disease	Total	with the disease	without the disease
Lege 2A	194	99	95	1 806	1	1 805
Lege 2B	209	95	114	1 791	5	1 786
Catchment area 3						
	Referred			**Not referred**		
	Total	with the disease	without the disease	Total	with the disease	without the disease
Lege 3A	194	99	95	1 806	1	1 805
Lege 3B	194	93	101	1 806	7	1 799

The expected outcomes of the referral decisions by the six doctors in the three catchment areas is described in Table 3. We see that each of the three doctors 1A, 2A, and 3A in each of the three catchment areas is expected to refer a total of 194 people. Of the 194 referred by each of doctors 1A, 2A, and 3A, it is expected that 99 patients have the disease, while 95 of the 194 referred do not have the disease. We further see in Table 3 that doctor 1B is expected to refer a total of 249 people. Of the 249 referred by doctor 1B, it is expected that 97 patients have the disease, while 152 of the 249 referred do not have the disease. We also see that doctor 1B is expected to fail to refer three people who have the disease, which is three times the corresponding number of non-referred sick patients among doctors 1A, 2A, and 3A.[7]

When comparing the expected extent of sick patients not receiving referrals by doctor 1A and doctor 1B, an important point that was also emphasized by Godager and Iversen (2017a) emerges: it may well be desirable for society that the doctor who refers the most should have referred even more. Doctor 1B is expected to refer a total of 249 people, and as many as 152 of these are expected to be healthy. For doctor 1B, it is expected that three sick people miss out on being referred.

In Table 3, we also see that doctor 2B is expected to refer a total of 209 people, of which 95 are expected to have the disease, while 114 of the referred are not expected to have the disease. We also see that doctor 2B is expected to fail to refer five people who have the disease. Thus, in catchment area 2, it is the doctor who refers the most (doctor 2B) who most likely should have referred a few more sick patients, while the doctor who refers the fewest (doctor 2A) had only one single case of missed referral where a patient with the disease was not referred.

Doctor 3B is expected to refer a total of 194 people, and the number of referrals is expected to be identical to the number referred by each of doctors 1A, 2A, and 3A. Although the expected number of referrals does not differ from doctors 1A, 2A, and 3A, the composition of the patients referred by doctor 3B will be different. Of the 194 patients expected to be referred by doctor 3B, 93 will have the disease, while 101 of the referred are expected to be healthy. We also see that doctor 3B is expected to fail to refer seven people who have the disease.

Table 4 Total number of referrals and variation in referrals in each of the three catchment areas.

	Catchment Area 1	Catchment Area 2	Catchment Area 3
Total referred	443	403	388
Number of sick without referral	4	6	8
Number of healthy referred	247	209	196
Coefficient of variation of referrals	0.18	0.05	0

We can now summarize the results and make qualitative assessments of the referral processes. We summarize the results aggregated by catchment area for each of the three catchment areas in Table 4. We use the coefficient of variation as a measure of variation in each catchment area.[8] An important point to note is that the observed variation is expected to be different in the three catchment areas 1, 2, and 3, despite the patient population being standardized so that there are no health differences between the patient populations of the different doctor types. Our example with the three catchment areas shows how variation that appears unexplained to those interpreting the data can arise because patient populations experience differences in the precision of referral decisions. We will now use the results in Table 4 to illustrate why findings of unexplained variation in referrals provide insufficient information to design measures. In Table 4, we see that the variation is greatest in catchment area 1,

[7] How unfortunate such a false negative is will vary from disease to disease and is influenced by both the treatment costs and the extent to which the healthcare service is able to solve the health problem.

[8] The coefficient of variation is defined as follows: coefficient of variation = standard deviation / mean value. In intake area 1, the average number of referrals per doctor is (194 + 249) / 2 = 221.5, and the standard deviation is 38.9. The coefficient of variation is 38.9 / 221.5 = 0.18. The choice of variation measure will not affect the ranking of variation in the examples in this text.

with a coefficient of variation of 0.18, and second highest in catchment area 2, with a coefficient of variation of 0.05. We see that the outcome where patients with the disease do not receive referral to specialist healthcare occurs least in catchment area 1, where there is the greatest variation in the number of referrals.

Since the patient population in the three catchment areas is identical, and the sensitivity and specificity of the doctors are unobservable, the variation in referral rates that one would expect in catchment area 1 would have to be categorized as unexplained variation for those attempting to interpret the data. Our thought experiment illustrates how the extent of unexplained variation can be large in one catchment area and small in another. Although different extents of unexplained variation have been detected, there is still a lack of information needed to design policy measures: We see that in catchment area 1, there are few patients who miss a necessary referral. At the same time, in catchment area 1, there is a larger number of healthy individuals being referred compared to the other catchment areas. Whether measures that contribute to reducing the extent of unexplained variation in referrals provide greater or lesser welfare depends on how society values unnecessary referrals versus missed referrals.[9] To determine which of the catchment areas 1, 2, and 3 uses society's resources in the best way, more information is needed. To compare catchment areas 1 and 3, we need to know whether the societal benefit of four fewer missed referrals outweighs the disadvantage of referring 51 more patients who do not have the disease. Therefore, more value assessment information is needed to determine whether it is appropriate to implement measures to improve referral decisions and, if so, to determine whether it is most advantageous for society for regional health trusts to implement measures in catchment area 1 or whether society would benefit more from implementing measures in catchment area 3, where no variation in referrals has been observed.[10] Two possible cases, case A and case B, are:

A) Referral processes in catchment area 3 are better for society than referral processes in catchment area 1.

B) Referral processes in catchment area 1 are better for society than referral processes in catchment area 3.

Case A may be relevant if the costs of an unnecessary referral are high while the welfare benefit of treating a sick patient is low. Case B may be relevant if the costs of an unnecessary referral are low while the welfare benefit of treating a sick patient is high. We now imagine that there exists a policy measure that makes it possible to "make catchment area 1 function like catchment area 3." If case A applies, it would be desirable for society to implement improvement measures in catchment area 1 to "make catchment area 1 function like catchment area 3"—thereby reducing unexplained variation in referrals in the area where the extent of unexplained variation is initially the greatest.

It is different if case B applies. In this case, it would not be desirable for society to implement the improvement measure, as catchment area 1 functions best initially. Case B shows that unexplained variation in referral rates may be desired, as measures to reduce variation can lead to reduced welfare.

If there were a measure that made it possible to "make catchment area 3 function like catchment area 1," it would be desirable to introduce such a measure, thereby introducing unexplained variation in

[9] An unnecessary referral shares common characteristics with a diagnostic test indicating a so-called false positive. Similarly, the example of sick individuals missing a referral shares common characteristics with a false negative diagnostic test.

[10] More information is also needed about the costs of any measures to influence the referral processes as well as the expected effectiveness of alternative improvement measures. However, regardless of the costs of any improvement measures, the extent of unexplained variation is not a suitable indicator for deciding where it is appropriate to implement measures.

referrals in an area where there was no unexplained variation initially. Thus, case B gives us an example that the absence of variation in referral rates can be undesirable! In catchment area 3, there is an absence of observed variation in the number of referrals since both doctor 3A and doctor 3B refer 194 patients to specialist healthcare. Catchment area 3 is the catchment area where the fewest patients are referred, with 388 referred patients. We also see that the most referrals occur in catchment area 1, with 443 referred patients. We see that the outcome where patients with the disease do not receive a referral to specialist healthcare occurs most frequently in catchment area 3, where there is an absence of observable variation in the number of referrals. If doctor 3B had referred the seven patients with the disease who were not referred, on top of the 194 who are already referred, it would have resulted in greater variation in the number of referrals.[11]

Service Intensity in Specialist Health Services

In what follows, we envision that each of the three catchment areas has a hospital that only assesses the referred patients. We assume for simplification that there is no imperfection in diagnostic assessments in specialist healthcare and that neither over-treatment nor under-treatment exists in this part of the healthcare service. All referred patients receive the same treatment if they have the disease, while no one without the disease receives treatment for the disease.

Table 5 Unexplained variation at the hospital level

	Hospital 1 in Catchement area 1	**Hospital 2 in Catchement area 2**	**Hospital 3 in Catchement area 3**
Number referred	443	403	388
Number of sick among the referred	196	194	192
Percentage of referred receiving treatment	44,2 %	48,1%	49,5 %
Percentage of population receiving treatment[12]	9,8 %	9,7 %	9,6 %

There are two types of unexplained variation at the hospital level: there can be unexplained variation in service intensity measured as the number of initiated treatments relative to the number of referred patients, and there can be unexplained variation in service intensity measured as initiated treatments relative to the number of patients in the catchment area.

If service intensity is measured relative to the number of referred patients, the intensity is highest at hospital 3, where disease is detected and treatment initiated in 49.5 percent of the referred patients, and lowest in hospital 1, where disease is detected and treatment initiated in 44.2 percent of the referred patients. If service intensity is measured relative to the size of the catchment area, there are small differences in service intensity. Measured in this way, the intensity is lowest in hospital 3, where disease is detected and treatment initiated in 9.6 percent of the patients in the catchment area, and highest in hospital 1, where disease is detected and treatment initiated in 9.8 percent of the patients in the catchment area.

How can hospitals respond to a request from HOD to reduce variation in service use that is not due to health differences? We see that if hospitals emphasize differences in service use measured as intensity

[11] The coefficient of variation would have changed from 0.00 to 0.03 in this example

[12] Note that in the Published Norwegian version of the document, there is an error in last line in table 5. Percentages were computed with wrong denominator (1000 instead of the correct 2000 patients). Table 5 in this version is correct.

per referred patient, any measures to follow up on HOD's request to reduce variation not due to health differences will be aimed at reducing service intensity in hospital 3 (which already treats the lowest proportion of the catchment area) or increasing service intensity in hospital 1 (which already treats the highest proportion of the catchment area). If hospitals emphasize differences in service use measured as service use per resident in the catchment area, hospitals will find that the relative difference in service use between the two catchment areas with the highest and lowest number of services per resident is just over two percent. As described by Riksrevisjonen (2019), such variation will be understood as normal.

Discussion and Conclusion

We have seen that descriptions of unexplained variation in the use of specialist health services provide limited information about the causes of the variation. We have seen that unexplained variation in the use of specialist health services can arise from variation in GPs' referral practices. We have also seen that the extent of problematic under-treatment in specialist health services can be greatest in the area where the extent of unexplained variation is the least.

It can be challenging to distinguish between desired and undesired variation. We have also provided examples showing that unexplained variation in service use can be desirable, supporting Office of the Auditor General’s conclusion that it must be assessed on a case-by-case basis whether a detected case of variation is unwanted or not.

The examples in this article show that there are good reasons to conduct further investigations even when there is little or no observed variation, as the absence of variation can hide under-treatment or other forms of inefficient resource use. The assignment documents require further investigations if there is observed variation in service use. There are no corresponding requirements for investigations of service use if the service use varies little.

Principles for resource use and prioritization are needed in a publicly funded healthcare system, and it is probably a good idea to design the hospitals' assignment documents in a way that supports these principles. The requirement to reduce unwanted variation was probably introduced with the intention of limiting the extent of randomness in prioritizing between patients. However, it is not obvious that the assignment documents' requirement to reduce unwanted variation is purposeful. An alternative that could be considered is to design assignment documents that emphasize compliance with the prioritization regulation to a greater extent than today.

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