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EUROPEAN HEALTHCARE FRAUD & CORRUPTION NETWORK

Guide to undertake a risk measurement exercise

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Introduction

In this guide the NHS method for fraud measurement is set out in eight steps. The basis of this guide is the *Statistical Report* of the NHS Counter Fraud Service which describes the statistical issues involved in designing and analysing a risk measurement exercise.

This guide tries to make the measurement more usable by working out the method in steps and by using a practical example. The used example is based on the Dutch healthcare situation. In this guide the chosen example is a simple one group based work out. A more complicated example with subgroups and decisions about other types of incorrectness is worked out in a second document *(A worked out example for using the 'NHS fraud measurement exercise' method).*

In principle the method of the NHS Counter Fraud Service is usable in every country. But, the valid value of every measurement strongly depends on the way the measurement is defined and worked out. For that, it is extremely important to describe how the measurement has to be taken place. If not, there's no guarantee that the results can be interpreted in a useful manner.

The guide will lead in eight steps to an estimation of occurrence of fraud and an estimation of the costs of fraud. These steps can be splitted into the following three phases:

Phase 1: Design of a risk measurement exercise

1. Describe, classify and choose the group to examine
2. Calculate the minimal needed sample size for a certain degree of uncertainty
3. Select the cases that are included in the risk measurement exercise

Phase 2: Examination of a risk measurement exercise

4. Examine the selected cases

Phase 3: Analysis of a risk measurement exercise

5. Calculate the occurrence of fraud
6. Calculate the statistical uncertainty
7. Calculate the costs of fraud
8. Calculate the statistical uncertainty in the costs of fraud

1. Design of a risk measurement exercise

1.1. Step 1: Choose the group to examine: define and classify

Before undertaking a risk measurement exercise, it is important that some consideration is given to the exact nature of the exercise to be performed. The first thing you have to do is to give an exact definition of what is measured. Is it about fraud or incorrectness or both? And then give an exact definition. It is also preferable to use the same definition for fraud (or incorrectness) in each country that adopts the NHS-method. Using the same definition of fraud enables to compare the results of the different countries.
The second thing you have to do is to classify the healthcare-situation in your country. Each country does have it's own healthcaresystem. So, each country will have it's own specific types of fraud depending on this system. And also, each country will have it's own groups and subgroups.

If there's a good definition and a good classification of the healthcare-situation it is possible to define the risk measurement exercise. The following issues should be considered:

a. which type (or types) of fraud are to be examined?
b. which groups will be included?
c. how will each case be classified?

The answers to these questions will be specific to each individual exercise. However, it may be preferable to perform separate risk measurement exercises for different types of fraud.

Example, define and classify

What you have to know before defining
In the Netherlands each healthcare-contractor (pharmacists, family doctors, hospitals, etc) has to declare each care-action by sending a declaration (bill) to the insurance company of the patient involved. A single declaration is mostly a part of a total form for one month. Each type of care-action is coded and each code does have a fixed price.

Defining fraud
It may be possible to declare something that hasn't really done (nothing has done/ something else cheaper has done). Before talking about fraud it is important to consider if we're talking about intentional or unintentional actions. To make this difference we will talk about "illegal declarations" and then split out in unintentional illegal declarations (mistake) and intentional illegal declarations (fraud).

	Intentional > fraud
Illegal declaration	
	Unintentional > mistake/ error

For now we won't think further about the fraud-definition. But it may be preferable to give a more exact definition. Issues to consider are: the role of misleading, the role of corruption (organised fraud) and where to draw the line between intentional and unintentional.

Classify the healthcare
In the Netherlands the healthcaresystem is based on four kinds of 'strata':

- "AWBZ": this is a basic insurance for every citizen (obligatory) . It includes healthcare for people who cannot care for theirself (anymore) in a normal manner (handicapped persons, older people, etc.).
- National Healthcare Service: this is a insurance for every citizen with a lower income. It provides in basic healthcare such as pharmacy, hospitalcare, family doctor, dentistcare, etc.
- Private insurance: this is a insurance for everyone with a higher income. It provides in basic healthcare such as pharmacy, hospitalcare, family doctor, dentistcare, etc.
- Additional insurance: this is a voluntary insurance for everyone who wants extensional healthcare like for example physiotherapy.

To understand the Dutch healthcaresystem it is needed to look at it from two sides: the contractors and the insurants.

Each citizen or insurant pays a basic premium for the obligatory insurance (AWBZ), so everybody is insured for this type of healthcare. Besides this premium everybody pays a premium for normal basic care (dentist, family doctor, hospitalcare, etc) depending on the amount of income. For that, there is a so called income limit. Everybody can take an additional insurance if he or she thinks that the basic insurance is not good enough for the personal situation. Of course, this is not for free.

As a healthcontractor you are AWBZ-contractor or contractor for the other insurance basis. These are physically different types of healthcare contractors. An AWBZ-contractor is paid from a central fund. As a contractor working for 'the other' insurance's it depends on where and how the patient is insured which insurance company will pay the bill. In this construction the contractor mostly sends a bill or declaration to the insurance company of the patient, or the contractor sends the bill directly to the patient.

Choose the group(s)/ types of illegal actions to examine
In principle each care-action must be declared with a declaration (it does not work like this in all situations, but it would be to complicated to explain right now). For that, there are two sides who can work out an illegal action: a contractor or an insurant. So, we do have to make a choice for the measurement. The choice for now will be to examine the contractors side.
Then there are a lot of different types of contractors, also depending on the type of insurance (contractors for AWBZ are other contractors then contractors for NHS/ Private insurance and additional insurance). In this example we will start with examining declarations of pharmacists for National Healthcare Service.
The last decision is the decision about the type of fraud we want to examine. For now, we will only examine fraud (not other kinds of incorrectness). The type of fraud we will examine is called 'simulation': something is declared that didn't take place.

The object that will be examined can be described as:

- **Declaration of pharmacists** for National Healthcare Service
- examine just **fraud** or **not fraud**
- the type of fraud we're looking for is **simulation**

1.2. Step 2: Calculate sample size

After defining the measurement the next step is to calculate the sample size. It is generally not achievable to examine all possible cases in a particular fraud area. Therefore, any risk measurement exercise will only be performed on a sample of the total cases within each country. As a result, the results of the sample might not be exactly the same as the results that would be obtained if it was possible to measure all cases. Therefore, all results from a risk measurement have some **degree of uncertainty** attached to them.

The amount of uncertainty is dependent on (amongst other factors) the size of the sample. A large sample will provide an estimate that has less uncertainty in the results than a small sample. Therefore, the exercise should be of a large enough size to give an accurate estimate of the occurrence of fraud, but not so large that it wastes resources on examining an unnecessarily large number of cases.

The following formula can be applied to calculate the sample size for a risk measurement exercise. By using this formula you must know that it can only be used if cases in the sample are chosen at random and the whole population has to be a large number of cases. (Then, in statistical terms, we speak about a standard normal curve and the following formula can be used.)

$$n >= (Z^2.p.(1-p))/ U^2$$

where:
n = sample size
p = proportion of cases where fraud is present
1 – p = proportion of cases where fraud is not present
U = desired level of uncertainty
Z = constant value based on the level of confidence required. Takes value 1,96 for 95 %, and value 2,58 for 99 % confidence

As you see, there are three factors to consider when determining the correct sample size. These are as follows:

1. estimated occurrence of fraud (p)
2. (desired) degree of uncertainty (U)
3. confidence in the degree of uncertainty (Z is based on the level of confidence)

It is not possible to determine the required sample size without some estimate of the occurrence of fraud (p). Such an estimate of the fraud rate could be based on any number of resources. For example, it could come from the results of a smaller pilot study. Alternatively, it could come from the results from other countries (if they are likely to be similar), or even from the investigator's knowledge of the area of fraud.

The second factor is the desired degree of uncertainty. In some situations, it might be necessary to produce figures with less uncertainty than others. Note that to provide less uncertainty in the results, a larger sample size will be required.

The final consideration is the level of confidence that the sample can measure the uncertainty within the required value. You can never be 100% sure that the true occurrence of fraud (which would be obtained if it were possible to examine all possible cases) will lie within the required degree of uncertainty. However, the survey should be of a suitable size so that there is a fairly high level of confidence that the true fraud value is within the required degree of uncertainty. A higher level of confidence will require a larger sample size. A commonly used level of confidence is the 95% confidence level, although sometimes a 99% confidence level is used.

Example, calculate the minimal sample size

Based on earlier rough examinations and on experience we think that the occurrence of fraud amongst declarations of pharmacists is about 1 %. The desired degree of uncertainty will now be ± 0,5 %. We aim at a level of confidence of 95 %. The constant value Z for 95 % confidence is 1,96.
The sample size is now calculated with the following formula.

$$n >= (Z^2.p.(1-p))/ U^2$$

$$n >= (1{,}96^2 . 0{,}01 . 0{,}99) / 0{,}005^2 = 1.521{,}3$$

The minimal sample size is calculated as **1.522** declarations.

1.3. Step 3: Select the cases

After calculating the sample size the next step is to select the cases that will be included in the risk measurement exercise. For the results of the exercise to be applicable to all possible cases, the cases in the sample must be representative of cases as a whole. For example, in a survey of hospital patients, the patients in the survey should have the same characteristics as all hospital patients in the country. If the cases surveyed in the exercise are not representative of cases as a whole, then the results of the exercise will not be generalisable, and the risk measurement exercise will not provide any useful information.

So, at first, it is very important that the (sub)groups in the measurement are well defined, so the right cases can be selected. And secondly, the cases selected should be as widely spread from all possible cases as is achievable. The most important guideline is that the cases should be chosen at random. Nowadays there are computers to do this job for you. Almost any softwareprogram that works with data can produce a list of random cases.

Working with subgroups
In some measurement exercises, the occurrence of fraud may be calculated separately for subgroups of the main sample. In such instances, it is likely that the results from the subgroups will be combined in order to get an overall estimate of fraud.
In such situations, a single sample size should be calculated for the exercise as a whole, and then the cases should be divided into each of the subgroups. An important decision is how many cases to select in each subgroup. This will be dependent on the main objective of the risk exercise. The main aim of the exercise could be either of the following:

1) To calculate the occurrence of fraud for each subgroup separately.
2) To determine the overall occurrence of fraud for all subgroups combined.

If option 1) is the most important aim, then it is sensible to examine a similar number of cases in each of the subgroups. This will enable a reasonably accurate estimate of fraud for each subgroup.
If option 2) is the most important aim, then more cases should be drawn from the largest subgroups. This strategy will give the most accurate estimate of fraud when the results from the subgroups are combined.

2. Examination of a risk measurement exercise

2.1. Step 4: Examination of the cases

After the cases are selected someone has to decide whether a case is fraud or not. This decision has to be made by examination of every single case. It is strongly recommended to describe in general how the cases will be examined and which decisions as a result of this examination can be made. If every single case is examined otherwise, the results will not be valid. Although, in the analysis of the data there will be a calculation of the certainty and the degree of confidence, but these are only valid values if the total examination has taken place in the same manner.
Secondly, you have to decide before examination on what basis a single case is described as fraud or not fraud. This, of course, depends on the definition of fraud (step 1). The basis for the decision must be the same for every single case.
It is recommended to record the results of the examinations in a database or spreadsheet. That will make the analysis easier. It is also recommended to record the amount of fraud.

3. Analysis of a risk measurement exercise

3.1. Step5: Calculate the occurrence of fraud

The analysis of the data involves calculating two main values:

1) An estimate of the occurrence of fraud (or fraud rate)
2) The uncertainty in the estimate of fraud.

The analysis of all risk measurement exercises follows the same pattern. However, the exact calculations depend on whether all cases are grouped together, or whether the total sample is divided into subgroups.
The simplest method of analysis is performed when all cases surveyed are considered as a single group. A more complicated method of analysis is required when the cases in the survey are divided into different subgroups. In this guide we will work out an analysis based on one single group (see the document *A worked out example for using the 'NHS fraud measurement exercise' method* for a more complicated work out with subgroups).

The occurrence of fraud is calculated as the proportion of examined cases that are fraudulent (which is sometimes given as a percentage value). This is calculated as the number of cases with fraud compared with the total number of cases examined. The formula for the calculation of the occurrence of fraud is given here:

$$\mathbf{p = n_{fraud} / (n_{fraud} + n_{no\ fraud})}$$

where:
p = proportion of fraudulent cases
nf = number of cases with fraud
nn = number of cases with no fraud.

Unresolved cases

It may not be possible to determine whether all cases have an occurrence of fraud or not, as there may be insufficient information to make a decision. These cases may be marked as 'unresolved'.
One issue involves what to do with the unresolved cases. There are three possible options:

a) Treat all unresolved cases as fraudulent
b) Treat all unresolved cases as non-fraudulent
c) Omit unresolved cases from the analysis completely.

If there are a large number of unresolved cases, then option c) is probably the most sensible. However, this would assume that the occurrence of fraud in the unresolved cases is the same as in the resolved cases. It may be possible to perform more than one of these analyses in order to compare the results from a number of different scenarios.

Example, calculate the occurrence of fraud

In our example there are examined 1.550 declarations. The results of the examination:
Fraud: 23
No fraud: 1.519
Unresolved: 8
The occurrence of fraud is now calculated with the following formula.

$\mathbf{p = n_{fraud} / (n_{fraud} + n_{no\ fraud})}$

p = 23 / (23 + 1.519) = 0,015 = **1,5 %**

3.2. Step 6: Calculate the statistical uncertainty

After calculating the occurrence of fraud the amount of uncertainty attached to each estimate is calculated. Uncertainty in the estimate occurs because the occurrence of fraud that is calculated from the exercise might be different from the value obtained if it was possible to examine all possible cases, rather than just a sample. Besides this statistical uncertainty there's also an uncertainty in the factor "no fraud", because it will not be possible to know for sure that there was really no fraud involved. For now we will only focus on the statistical uncertainty, but it's important to keep this notion in mind for interpretation of the results.

The uncertainty is determined by calculating an interval within which it is highly likely that the value for all cases would lie. In statistical terminology, this is often referred to as a 'confidence interval'. Initially, a value called the standard error (SE) is calculated and from this measure, the amount of uncertainty is calculated.
A decision has to be made as to the degree of confidence that the actual fraud rate (for all possible cases) will lie within the confidence interval. It is necessary to be fairly confident that this value will lie within the confidence interval. Often, 95% or 99% confidence intervals are calculated.

U = Z . SE(p)

where:
U = uncertainty in estimate of fraud
p = proportion of fraudulent cases
SE(p) = standard error of p; SE(p) = √ [p(1-p) / n] (under conditions)
1-p = proportion of non-fraudulent cases
n = nf + nn = total number of cases in data analysis
Z = constant value based on the level of confidence required. Takes value 1.96 for 95% confidence, and value 2.58 for 99% confidence.

By using this formula you must know that it can only be used if cases in the sample are chosen at random and the whole population has to be a large number of cases. The formula used for SE(p) can only be used if the number of cases in the sample complies with the following rule of thumb:

n . p >= 5   AND n . (1 – p) >= 5

where:
p = proportion of fraudulent cases
$n = n_{fraud} + n_{no\ fraud}$ = total number of cases in data analysis

Example, calculate the statistical uncertainty

First, we look at the conditions for using the formula. The conditions are:

n . p >= 5   AND n . (1 – p) >= 5

1.542 . 0,015 = 23
1.542 . 0,985 = 1.519
Both values are higher than 5.

Secondly, use the formula for calculating the uncertainty:

U = Z . SE(p)
SE(p) = √ [p(1-p) / n]

U = 1,96 . √((0,015 . 0,985) / (1.542)) = 0,0061

The uncertainty is calculated as 0,0061 = ± 0,6 %.

The occurrence of fraud is calculated as **1,5 % ± 0,6 % with 95 % confidence**.

3.3. Step 7: Calculate the costs of fraud

The first stage in the analysis of a fraud measurement exercise is to calculate the occurrence of fraud. The second stage is to calculate the costs of the fraud. There are a number of methods that can be used to calculate the total cost of fraud. A simple method is to calculate the average cost of cases of fraud, and multiply this value by the number of expected fraud cases for the whole population to obtain the total cost of fraud. The following formula is then used to calculate the total costs of fraud.

C = p . Ac . N

where:
C = Total cost of fraud
p = Proportion of cases with fraud
Ac = Average cost of fraud for an individual case
N = total number of cases for whole population.

Example, calculate the costs of fraud

For every single examination we know the costs of fraud, because it was record in a database. With that knowledge it turned out that the total costs of fraud for the 23 fraud cases are: € 1.123,34.
The average costs per fraud case now can be calculated: € 1.123,34 / 23 = € 48,84
We also know that the total amount of declarations of pharmacists in one year to the NHS is: 11.234.456 (it is all fictional)
The costs of fraud can now be calculated:

C = p . Ac . N

C = 0,015 . € 48,84 . 11.234.456 = **€ 8.184.250,-**

3.4. Step 8: Calculate the statistical uncertainty in the costs of fraud

As in the proportion of fraud, there will also be a uncertainty in the costs of fraud. This uncertainty is based on the same uncertainty calculated before. The uncertainty in the total cost of fraud can be calculated by using the following formula.

C = U . Ac . N

where:
C = Total cost of fraud
U = Uncertainty in the estimate of fraud
Ac = Average cost of fraud for an individual case
N = total number of cases for whole population.

Example, calculate the uncertainty in the costs of fraud

C = U . Ac . N

C = 0,006 . € 48,84 . 11.234.456 = **± € 3.319.768,-**

The costs of fraud are calculated as **€ 8.184.250,- ± € 3.319.768,- per year with 95 % confidence**.

The uncertainty in the costs is now based on the uncertainty in the occurrence of fraud and the calculated average costs per fraudcase. Notice that this calculated average costs itself has its own standard error and for that it would be more correct to involve this uncertainty in the calculation.

4. Finally

4.1. Subgroups and types of incorrectness

The analysis used in this guide is based on one single group (pharmacists) and on a measurement of one decision (fraud or no fraud). For a more complicated example is now referred to the document *A worked out example for using the 'NHS fraud measurement exercise' method.* By working out a risk measurement with subgroups you have to work with a weight for every subgroup, but the calculations are in principle based on the same formula. For using more then one decision about the type of fraud it is especially important that the sample size is calculated for each possible decision.

4.2. Comparison between countries (benchmarking)

Because each country does have it's own specific healthcaresystem it is not really possible to compare the results of a risk measurement exercise directly. But it may be possible if:

- there's a just extrapolation for each country
- the occurrence of fraud is expressed into costs of fraud

Although it all strongly depends on the manner the risk measurement exercise is defined in each country. For that, it is preferred to define fraud and to define risk measurement exercises together. By working out together the NHS methodology it is also recommended to start with the same contractorgroup in each country (for example pharmacists).

4.3. An estimation of the costs of a fraud measurement exercise

Although this guide simply tells in eight steps how to set up a fraud measurement exercise, it has to be said that the method takes a lot of time to work it out in a practical situation. Especially the examination of the single cases in the sample is very labour-intensive. To give any notice to the costs we will do a rough estimation of the costs of a sample with a 1.000 sample measurement exercise.

Design and analysis:	40 hours
Examination:	1.000 cases * 1 hour = 1.000 hour
Costs per hour:	€ 50,-
Total costs:	1.040 * € 50,- = € 52.000,-

4.4. What about earlier in the process detected fraudcases?

In an ideal situation the computersystem first detects fraudcases based on a combination of several variables of the declaration/ contractor. So, if that's the case, what should we do in the analysis with the cases that are already detected?
To answer this question you have to know if the cases in the sample are selected from the population with or without already detected cases. If already detected cases are in the sample than use the calculations as worked out above. If not, you have to think about the aim of the measurement:

1. if you want to measure the occurrence of fraud after the automatic detection process (the detectionprocess is seen as an environmental variable): use the calculations as worked out above;
2. if you want to measure the occurrence of fraud with already detected cases: involve the results of detected cases in the analysis of the results. How these results should be involved in the analysis strongly depends on the specific situation.

4.5. Using the method in other measurement exercises

Please note that this document should provide the basic information required to perform a risk measurement exercise. However, it is not possible to examine every statistical issue related to conducting surveys. Books on survey methods should be consulted for further issues.
It should be possible to design and analyse a risk measurement exercise using these guidelines. However, it is recommended that the design and analysis be performed under the guidance of a statistician.