Care & Cure Combined: Using Simulation to Develop Organization Design Theory for Health Care Processes

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Model documentation
When printing, it is advised to do so in color, especially section 5, the sensitivity analysis.

Contents

1. Abbreviations

Table 1 Abbreviations used in the model and/or model documentation

abbreviation	description
%HR	outcome variable: percentage high-risk pregnant women in the system
%HR$_{mp}$	outcome variable: percentage high-risk pregnant women that is being cared for in the wrong organization (midwifery practice)
AT	adjustment time
BCV	base case value
C	change
CO	collaboration
H's	hospitals
HR	high-risk
HR$_{MP \searrow H}$	high-risk pregnant women from midwifery practices to hospitals
iv	initial value
LR	low-risk
LR$_{H \searrow MP}$	low-risk pregnant women from hospitals to midwifery practices
MP's	midwifery practices
PW	pregnant women
QoC	quality of care
S	scenario
SA	sensitivity analysis
TR	trust
TR$_{H \searrow MP}$	trust hospitals have in midwifery practices
TR$_{MP \searrow H}$	trust that midwifery practices have in hospitals
TfE	Table for effect
WP	work pressure

2. Exogenous variables and graphs

Table 2 Exogenous variables and graphs

PREGNANT WOMEN	Value base case	units	Motivation
new pw per week	100		
length of stay pw	32	weeks	A pregnancy takes in theory 40 weeks (max 42), the first consultation is around 8-10 weeks. It is assumed that all pregnant women present themselves at this time and that all pregnancies will on average take 40 weeks.
% pw presenting with hr	15%		22.7% presents themselves to secondary care[1] 48% of the pregnant women who present themselves at the hospital have a high-risk pregnancy at the start*** An unknown percentage of the high-risk pregnancies will be presented in primary care
iv % lr presenting in mp	70%		77.3% of the pregnant women present themselves in primary care[2] Of the 22.7% of the pregnant women who present themselves in secondary care[3], 39% has a low-risk pregnancy*** An unknown percentage of the pregnant women who present themselves in primary care has a high-risk pregnancy
iv % hr presenting in h	62%		48% of the pregnant women who present themselves at the hospital have a high-risk pregnancy at the start*** 13% of the pregnant women who present themselves at the hospital have a pregnancy in which care can be shared between midwife and obstetrician***
iv pw lr mp	68.61		calculated by the model for equilibrium
iv pw hr mp	66.89		calculated by the model for equilibrium
iv pw lr h	44.65		calculated by the model for equilibrium
iv pw hr h	139.83		calculated by the model for equilibrium
PERCEIVED WORK PRESSURE			
reference perceived work pressure mp	1.1		Observation*
reference perceived work pressure h	1.2		Observation*
AT capacity mp	26	weeks	Interview**
AT capacity h	52	weeks	Interview**
AT perceived work pressure	1	week	
regular consultations in h	13		13 consultations are recommended[4]
extra consultations in h for hr	4		13 consultations are recommended[5] 17 consultations are conducted in the hospital***
regular consultations in mp	12		12 consultations are conducted at the midwifery practice, both for the low-risk as for the high-risk pregnancies***
extra consultations for hr mp	4		idem as extra consultations in h for hr (see above)
iv % regular consultations mp in mp	100%		
% extra consultations mp in mp	50%		
iv % regular consultations h in h	100%		
% extra consultations h in h	100%		
AT % consultations	12	weeks	

[1] Stichting Perinatale Registratie Nederland, 2009 See Case Study Chapter
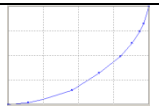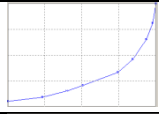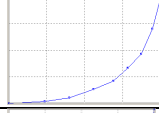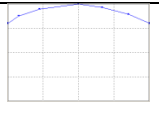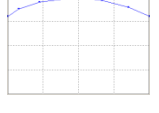
[2] Stichting Perinatale Registratie Nederland, 2009 See Case Study Chapter
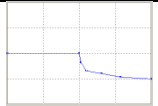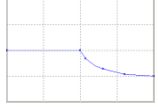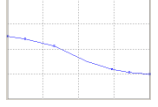
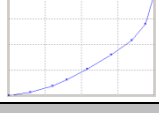[3] Stichting Perinatale Registratie Nederland, 2009 See Case Study Chapter

[4] (Heineman, Bleker, J. L. H. Evers, & Heintz, 2004) See Case Study Chapter

[5] (Heineman, Bleker, J. L. H. Evers, & Heintz, 2004) See Case Study Chapter

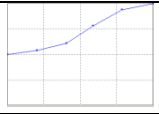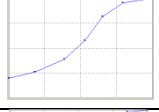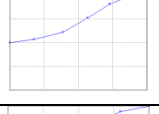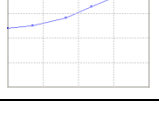|			
TfE collaboration on % consultations in mp by mp			Decreasing curve through (0,100), (0,7;100) and (1,50). Collaboration has to be at least 0.7 before midwives will allow obstetricians to do preventative consultations.
TfE trust on % consultations in mp by mp			Decreasing curve through (0,100), (0,8;100) and (1,50). Trust has to be at least 0.7 before midwives will allow obstetricians to do preventative consultations.
TfE collaboration on % consultations in h by h			Decreasing curve through (0,100), (0,7;100) and (1,50). Collaboration has to be at least 0.8 before obstetricians will allow midwives to do preventative consultations. This curve is more conservative than the curve for midwives because obstetricians see less advantage of having care consultations in midwifery practices than midwives see the advantage of having cure consultations in hospitals.
TfE trust on % consultations in h by h			Decreasing curve through (0,100), (0,8;100) and (1,50). Trust has to be at least 0.8 before midwives will allow obstetricians to do preventative consultations. This curve is more conservative than the curve for midwives because obstetricians see less advantage of having care consultations in midwifery practices than midwives see the advantage of having cure consultations in hospitals.
TRUST			
iv trust mp in h	0.4		Chapter 6
iv trust h in mp	0.25		Chapter 6
AT trust	16	weeks	Midwives only find out in aftercare whether or not a woman was correctly cared for by the hospital during her pregnancy. Also, obstetricians often find out during delivery whether or not a woman has been taken care of rightfully in primary care.
max trust	1		Chosen definition of trust: between 0 and 1
acceptable % hr in mp	10%		
acceptable % lr in h	10%		
TfE lr h on trust mp in h			Decreasing S-curve with beginning (0,1) and ending (4,0). Special point is (1,1): As long as the ratio of low-risk pregnancies in the hospital is less than 1, the number of low-risk pregnancies in the hospital is acceptable for midwives.
TfE hr mp on trust h in mp			Decreasing S-curve with beginning (0,1) and ending (4,0). Special point is (1,1): As long as the ratio of high-risk pregnancies in the midwifery practice is less than 1, the number of high-risk pregnancies in the midwifery practice is acceptable for obstetricians.
COLLABORATION			
iv collaboration	0.4		Chapter 6
iv degree to which collaboration is voluntary	0.8		In some cases collaboration is prescribed, but collaboration between midwives and obstetricians is merely voluntary.
REFERRALS			
iv referral % from h to mp	5%		25 women are referred from the hospital to the midwifery practice, out of the (39+13)% of the 447 women that presented themselves to the hospital***. However, later on in the care process, no pregnant women are referred to the midwifery practice. Thus the average percentage is lower.
iv referral % from mp to h	15%		unknown percentage
AT referring pw	12	weeks	
max flow from h to mp	100%		It is assumed that when collaboration and trust both are at their max, that referral percentage of low-risk pregnant women from h to mp is 100%
max flow from mp to h	100%		It is assumed that when collaboration and trust both are at their max, that referral percentage of high-risk pregnant women from mp to h is 100%
AT refer from h to mp	4	weeks	

AT refer from mp to h	10	weeks	
TfE trust h in mp on referral pw from h to mp			Increasing graph with the extremes (0,0) and (1,1)
TfE trust mp in h on referral pw from mp to h			Increasing graph with the extremes (0,0) and (1,1)
TfE collaboration on referral pw from h to mp			Increasing graph with the extremes (0,0) and (1,1)
TfE collaboration on referral pw from mp to h			Increasing graph with the extremes (0,0) and (1,1)
QUALITY OF CARE			
iv max quality of care mp****	0.8		Midwives lack cure competences, therefore they will not be able to deliver a quality of care of 1 (quality of care is defined on a scale from 0 to 1)
iv max quality of care h****	0.8		Obstetricians lack care competences, therefore they will not be able to deliver a quality of care of 1 (quality of care is defined on a scale from 0 to 1)
AT max quality of care	10	weeks	
TfE consultations mp in h on quality of care mp			Top-parabolic curve with the extremes (0,0.8) and (100,0.8) and the top (50,1). When all consultations in the mp are conducted by the midwifery practice, the max quality of care of the mp is suboptimal because midwives lack cure competences. When all consultations in the mp are conducted by the hospital, then the max quality of care is also suboptimal because obstetricians lack care competences.
TfE consultations h in mp on quality of care h			Top-parabolic curve with the extremes (0,0.8) and (100,0.8) and the top (50,1). When all consultations in the h are conducted by the hospital, the max quality of care of the h is suboptimal because obstetricians lack care competences. When all consultations in the h are conducted by the midwifery practice, then the max quality of care is also suboptimal because midwives lack cure competences.
AT delivered quality of care	4	weeks	
weight of perceived effect work pressure on quality of care	0.7		
TfE trust on quality of care mp			Increasing S-curve with the extremes (0,0.5) and (1,1).
TfE trust on quality of care h			Increasing S-curve with the extremes (0,0.6) and (1,1).
TfE collaboration on quality of care mp			Increasing S-curve with the extremes (0,0.5) and (1,1).
TfE collaboration on quality of care h			Increasing S-curve with the extremes (0,0.8) and (1,1).

TfE perceived work pressure mp on quality of care mp			The graph is a straight line from (0,1) to (1,1), and till (2, 0.5) it is a decreasing function
TfE perceived work pressure h on quality of care h			The graph is a straight line from (0,1) to (1,1), and till (2, 0.5) it is a decreasing function
LOW-RISK TO HIGH-RISK			
iv % pw lr to hr mp	77%		77% of the pregnant women in the midwifery practice develop a complication during pregnancy***
iv % pw lr to hr h	60%		
min % lr to hr	40%		
AT lr to hr	4	weeks	
time developing hr in mp	10	weeks	
time developing hr in h	10	weeks	
time recovering hr in mp	8	weeks	
time recovering hr h	8	weeks	
% pw hr to lr mp	15%		
% pw hr to lr h	10%		
TfE quality of care mp on % pw lr to hr mp			Decreasing S-curve through (0,2.5) and (1,1)
TfE quality of care h on % pw lr to hr h			Decreasing S-curve through (0,2.5) and (1,1)
COSTS			
iv ratio costs mp:h	0.5		
EXTRA FOR SCENARIO 5			
AT % pw presenting to organization	4	weeks	
% hr more in h	1.5		
% lr more in h	0.5		
EXTRA FOR SCENARIO 3			
AT ratio costs mp:h	26	weeks	
goal ratio costs mp:h in S3	1		
goal degree to which collaboration is voluntary	0.1		
AT degree to which collaboration is voluntary	12	weeks	
EXTRA FOR SCENARIO 1 & 4 & 5			
goal max quality of care h	1		
EXTRA FOR SCENARIO 2 & 4			
AT collaboration	26	weeks	
goal collaboration with S3	1		
goal collaboration with S2	0.8		
start intervention	10	weeks	
duration intervention	52	weeks	
* observation: ** interview: *** Pieters et. al. (2010) **** indirect modeled in the graph			

3. Additional details of the model and scenarios

Collaboration and trust

CO and TR have an effect on the same variables: on the referral percentages between the two types of organizations, on the QoC of the two organizations, and on the degree to which organizations outsource consultations. The effects of CO and TR are linked together by the degree to which CO is voluntary. The structure to calculate the effect of CO and TR is illustrated below with the first effect, that of the referral percentages (Figure 1). Note that in the model there are two referral percentages ($LR_{H \to MP}$ and $HR_{MP \to H}$). The structure for both referral percentages is the same, although $LR_{H \to MP}$ is based on $TR_{H \to MP}$ and $HR_{MP \to H}$ is based on $TR_{MP \to H}$.
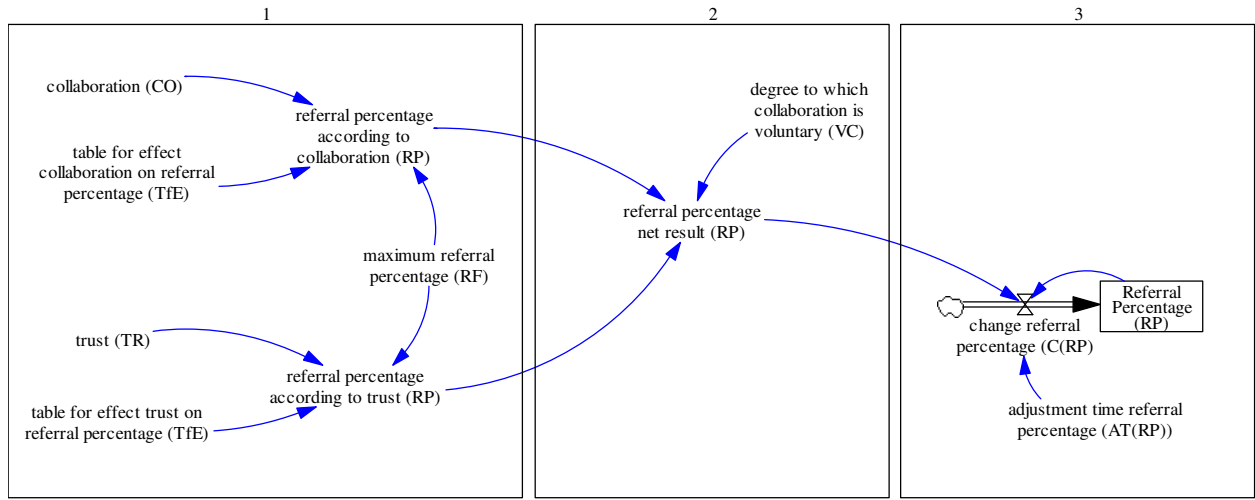
Figure 1 Effect collaboration and trust on referral percentage

Firstly, the referral percentages based on the level of CO and based on the level of TR are calculated.

$$RP_{CO} = TfE_C(CO) * RP_{max}$$
$$RP_{TR} = TfE_T(TR) * RP_{max}$$

Secondly, the referral percentage is based on the goal according to CO, the goal according to TR, and the degree to which the CO is voluntary. This net result, RP_{net} is a weighted average of the RP_{TR} and the RP_{CO}: the higher the degree to which CO is voluntary, the more weight is given to TR; and the lower the degree to which CO is voluntary, the more weight is given to CO. However, when the RP_{TR} is higher than the referral percentage based on the weighted average, RP_{TR} is leading. The reason for this is that trust outweighs the net result of CO and TR: even when the net result is low, when trust is high, the organizations will collaborate, even though it is not officially formalized.

$$RP_{net} = max\ (VC * RP_{TR} + (1 - VC) * RP_{CO},\ RP_{TR})$$

Thirdly, the actual referral percentage (stock) is adjusted based on the RP_{net}, the previous referral percentage and the time it takes to adjust the stock to the new level.

$$C_{(RP)} = (RP_{net} - RP)/AT_{RP}$$

The other effects of CO are calculated in the same way.

Effects of trust

TR has three effects. For the first effect, that on the referral percentages between the two types of organizations, an "individual form" of trust is used: for the percentage $LR_{H \rightarrow MP}$ the $TR_{H \rightarrow MP}$ is used and for the percentage $HR_{MP \rightarrow H}$ the $TR_{MP \rightarrow H}$ is used. The percentage of PW that one organization is willing to refer to the other organization depends on the level of their own trust in the other organization.

However, for the other two effects (the effect on the QoC and the effect on the degree to which outsourcing of consultations takes place) a more "collective form" of trust is used.

$$Min(TR_{MP \rightarrow H}, TR_{H \rightarrow MP})$$

The reason behind this is that for TR to have an impact on the QoC and on the degree of outsourcing, both organizations have to trust each other. The degree of the effect is determined by the common level of trust in the system, i.e. the minimum of $TR_{MP \rightarrow H}$ and $TR_{H \rightarrow MP}$.

Quality of care

QoC is modeled for both MP's and H's. The structure presented below is equivalent for both types of organizations (See also Figure 2).

First, the maximum QoC is calculated. The desired maximum QoC is determined by the degree to which consultations are outsourced to the other organization and by the assumptions made in the scenarios. The maximum QoC is calculated by the following:

$$D\ QoC_{max} = if\ then(scenario\ in\ place,\ DS\ QoC_{max},\ TfE_{DoO}(DoO))$$
$$C\ QoC_{maz} = (D\ QoC_{max} - QoC_{max})/AT_{QoCmax}$$

Second, collaboration and trust determine the quality of care that will be delivered. Note that here the minimum level of trust in the system is used (see above). The maximum QoC that an organization can deliver is decreased by the degree to which organizations collaborate and trust each other. Less trust and less collaboration makes the organizations deliver less QoC. The degree to which trust and collaboration have an effect is determined by the voluntariness of

collaboration. When collaboration is voluntary, the QoC that will be delivered is mainly determined by the level of trust in the system. When collaboration is not voluntary, the QoC will be determined mainly by the level of collaboration in the system. However, when the QoC because of trust is higher than the weighted average of both, trust prevails.

$$QoC_{CO} = TfE_{COonQoC}\ (CO) * QoC_{max}$$
$$QoC_{TR} = TfE_{TRonQOC}\ (TR) * QoC_{max}$$
$$QoC_{CO/TR} = max\ (QoC_{TR},\ (1\text{-}VC) * QoC_{CO} + VC * QoC_{TR})$$

Thirdly, the delivered quality of care is calculated, which is affected by the work pressure.

$$D\ QoC_{del} = W_{WPtoCO/TR} * TfE_{wp}(WP) * WP + (1 - W_{WPtoCO/TR}) * QoC_{CO/TR}$$
$$C\ QoC_{del} = (D\ QoC_{del} - QoC_{del})/AT_{QoCdel}$$
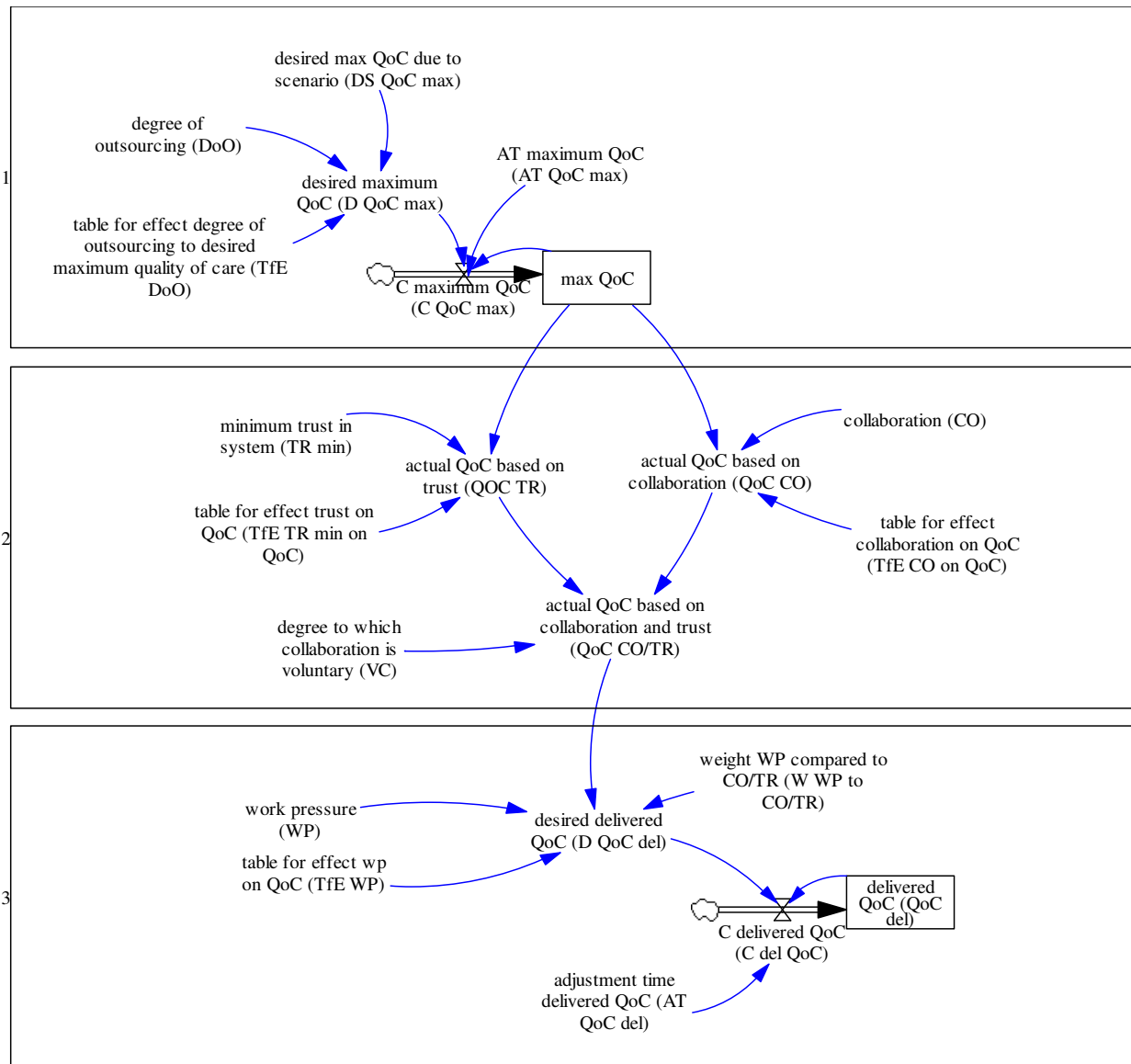
Figure 2 Calculation of delivered quality of care

Scenario 3: x% Integrated care model

In the integrated care scenario a certain percentage of MP's is integrated with the H's. Due to the fact that a certain percentage of MP's integrate with H's, some special adjustments have to be made in the model:

1. PW are moved from MP's to H's according to the percentage of MP's that integrate with the H's.
2. Staff is moved from MP's to H's according to the percentage of MP's that integrate with the H's.

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3. The way PW present themselves to MP's and H's is changed according to the percentage of MP's that integrated with the H's.
4. $TR_{H \to MP}$ is based the following: the percentage HR_{MP} is compared to an acceptable level of HR_{MP}. When less PW are taken care of in MP's, this acceptable level also decreases. It will be linear adjusted with the percentage of MP's that integrate with the H's. Note that no adjustments will be made the other way around: the acceptable level of LR_H will not change due to integration of MP's with H's.
5. CO and TR have an effect on QoC_H. These effects will be linear adjusted to the percentage of MP's that integrate with H's. Imagine the following: if most MP's integrate with the H's, the collaboration of the H's with the small number of independent MP's that remain won't affect the QoC_H that much, because not much "business" will be done with them, for as the majority of PW are being taken care of in the H's. The same holds for the trust that H's have in MP's. Note that no adjustments will be made the other way around. MP's still depend on the CO with the H's and the level of trust of these independent MP's in the H's still affects their QoC in the same way as before.
6. The model uses t=10 and t=11 to adjust to these changes. During these twee weeks, regular dynamics in the model are put off, the changes are made, and on t=12, when everything is in place again, the dynamics of the model take over again.

4. Model Limitations

Pregnant women
Regarding the behavior of pregnant women, the model assumes that their behavior does not change because of the quality of care that the different organizations deliver. One might argue that pregnant women might be attracted to the type of organization with the highest quality of care. However, due to the two-tiered structure in Dutch perinatal care, it is more or less prescribed that pregnant women presents themselves to the lowest type of care possible, i.e. midwifery practices in primary care. The high-risk pregnant women that present themselves to midwifery practices often don't know they have a high risk, and the low-risk pregnant women that deliver themselves to the hospitals don't present themselves "out of the blue", they already have a history with the obstetric department. The behavior of how pregnant women present themselves to the organizations is therefore independent of the quality of care that the organizations actually deliver. And yes, pregnant women might present themselves to a different provider within a category (to a different midwifery practice or to a different hospital in the region), but the scope of this model (inter-organizational dynamics between types of care providers) does not allow for modeling individual midwifery practices and individual hospitals in a region.

Regarding the complications of pregnant women, the severity of complications is not modeled. One might argue that the lower the quality of care that is delivered, the worse the

condition of the pregnant women and the higher the demand for services (in the extreme case pregnant women have to be held in the hospital for several days or weeks) or the higher the demand for different types of care (vaginal delivery versus caesarean section). One might argue that there is a gradual change in the degree of complications, with a different effect on the demand for care. Instead, only the number of pregnant women with a high-risk pregnancy is modeled (and thus not the severity of the complication) and the effect on the care process (the extra demand that the high risks are generating) is modeled.

The satisfaction of pregnant women and the resulting behavior is not modeled. When pregnant women are not satisfied with the quality of care they have received, they will either present themselves to the same care provider again, or they might even present themselves to another care provider.

It is expected that there are no changes in preferences of pregnant women for either the midwifery practices or hospitals. In practice however, over the years a trend is emerging that pregnant women like to deliver in the hospital due to new technologies (for example availability of pain medication). Although this can be done under the supervision of a midwife from a midwifery practice, it might result in more pregnant women presenting themselves to hospitals at first.

Professionals and their behavior
One might argue that dynamics within organizations are of importance. For example the collaboration between midwives and obstetricians working in the hospital might have an effect on the quality of care that is delivered. However, the scope of the model is the inter-organizational level; we are interested in the dynamics between organizations and its effect on outcome. Modeling the dynamics within an organization or department is therefore too detailed.

The scope of the model is the inter-organizational level; we are interested in the dynamics between organizations and its effect on outcome (i.e. the number of high-risk pregnant women). Modeling the different interventions that can be delivered within an organization or department is therefore too detailed.

In the model, the acceptable level of perceived work pressure is set above 1. As a result, there will always be a gap between the maximum quality of care and the delivered quality of care.

In the model hospitals and midwifery practices are modeled each as one identity. However, in a region there often are multiple hospitals and multiple midwifery practices. These actors each interact individually, which has an effect on overall collaboration between midwifery practices and hospitals (see for example (Pieters et al., 2011).

Referral behavior should maybe also be determined by the level of effective competence. The higher the cure competences of midwives, the more obstetricians trust them? The higher the care competences of obstetricians, the more midwives trust them? I do not think so, because then there is competition. However: if midwives have better risk selection competences, they will refer pregnant women with a risk earlier and this increases trust. Obstetricians will refer healthy

women to midwives because they know that they will get them back whenever there is something wrong because midwives do understand.

Shouldn't trust also depend on quality of care? Or on the visibility of quality of care? And expressed in percentage pregnant women that develop complications: visible for hospital and not for midwifery practice.

The effect of new staff is not modeled. In practice, new staff often has less competences and new staff might result in a decrease in collaboration and trust.

Other
This model assumes a certain health care system. The health care system in the Netherlands hardly knows any competition in terms of quality or effectiveness. In addition, insurance companies hardly have any say in which type of care gets refunded. The model might be different for systems where insurance companies have a greater influence in the actual delivery of care.

Medicalization of care is not modeled. The more pregnant women are seen by obstetricians, the more interventions will be done, and one the one hand the lower the complications (because one discovers complications earlier), but on the other hand also the higher the complications (because of overtreatment) (ref).

It is assumed that the delays in referring patients between the types of organizations and the delay it takes for pregnant women to develop a high-risk pregnancy and discover from it do not change. In reality, this might do.

5. Sensitivity analysis
This section describes the sensitivity analysis (SA) in detail. The following process is followed:

1. The individual scenarios (scenario 1, 2 and 3) are tested to gain insight into the robustness of the outcomes. The tests can be categorized as follows:

   A. Tests regarding the assumptions of the scenario, thus regarding the changes that are made in the model when the scenario starts. For example, in the first scenario, the improved hospital model, the $\%LR_{H \to MP}$ changes to 0%. But what if it does not decrease to 0%? Thus these test assumptions made in the scenario.
   B. Tests regarding direct effects of changes that are made in a scenario. For example, in the second scenario, the collaborative model, collaboration is increased. Collaboration has three direct effects: on the referral percentages, on the quality of care, and on the degree to which consultations are being outsourced. What if these variables are more or less responsive to changes in collaboration? Thus these test assumptions made in the model.
   C. Tests regarding other relations and assumptions. Thus these test assumptions made in the model.

2. For each individual scenario, the most important assumptions/variables/relations are defined. They are marked in the last column of Table 3.
3. The combined scenarios (scenario 4 and 5) are tested on those assumptions/variables/relations which appeared to have an effect in the individual scenarios of which the combined scenario is constructed. For example, for scenario 4, where the improved hospital model and the collaborative model are combined, only the variables that have proven to have an effect in scenario 1, the improved hospital model, and in scenario 2, the collaborative model, are tested. If necessary, some tests on variables are added or left out.
4. Overall, the most important assumptions/variables/relations are defined, based on both the individual and combined scenarios.
5. Finally, these most important ones are tested again against all five scenarios. The base scenarios have a particular order in how effective they are in terms of the outcome variables. When the most important assumptions/variables/relations are changed, does it change the mutual order of the scenarios? The following guidelines are applied.
   a. Only one assumption is changed per scenario. So no combinations of changing assumptions are tested.
   b. When an assumption is changed, it is changed for all scenarios.

Table 3 provides an overview of the different sensitivity analyses that are conducted and what their results are in terms of the two main outcome variables: the percentage of high-risk pregnant women (%HR) and the percentage of high-risk pregnant women that is being taken care of by the wrong organization (i.e. midwifery practices) (%HR$_{MP}$). SA 1-2 refers to the second sensitivity test of the first scenario. "Test" refers to the category of tests as described above (A, B, C).

Table 3 Overview sensitivity analysis (SA)

SA	description	test	%HR	%HR$_{MP}$	important
Scenario 1: improved hospital model					
1-1	%LR$_{H \to MP}$	A	-	-	-
1-2	maximum QoC$_H$	A	+	+	*
1-3	responsiveness TR$_{MP \to H}$ to LR$_H$	B	-	+	*
1-4	responsiveness %LR$_H$ to HR$_H$ to QoC$_H$	B	+	+	*
1-5	responsiveness TR$_{H \to MP}$ to HR$_{MP}$	C	-	-	-
Scenario 2: collaborative model					
2-1	intended level of CO	A	+	+	*
2-2	duration of project	A	+	+	-
2-3	voluntariness of CO	A	+	+	*
2-4	responsiveness %HR$_{MP \to H}$ to CO	B	+	+	*
2-5	responsiveness %LR$_{H \to MP}$ to CO	B	+	+	*
2-6	responsiveness QoC$_{MP}$ to CO	B	-	-	-

2-7	responsiveness QoC_H to CO	B	-	-	-
2-8	responsiveness outsourcing MP to CO	B	+	-	*
2-9	responsiveness outsourcing H to CO	B	-	-	-
Scenario 3: 10% integrated care model					
3-1	percentage of integration	A	+	+	*
3-2	maximum QoC_H	A	+	+	*
3-3	$\%LR_{H \to MP}$	A	-	-	-
3-4	responsiveness $TR_{MP \to H}$ to LR_H	B	-	+	*
3-5	responsiveness $\%LR_H$ to HR_H to QoC_H	B	+	+	*
Scenario 4: improved hospital model & collaborative model					
4-1	maximum QoC_H	A	+	+	*
4-2	intended level of CO	A	+	+	*
4-3	voluntariness of CO	A	+	+	*
4-4	responsiveness $\%HR_{MP \to H}$ to CO	B	+	+	*
4-5	responsiveness $\%LR_{H \to MP}$ to CO	B	-	+	*
4-6	responsiveness outsourcing MP to CO	B	-	-	-
4-7	responsiveness outsourcing H to CO	B	-	-	-
4-8	responsiveness $\%LR_H$ to HR_H to QoC_H	B	+	+	*
4-9	responsiveness $TR_{MP \to H}$ to LR_H	C	-	-	-
4-10	responsiveness $\%LR_{MP}$ to HR_{MP} to QoC_{MP}	C	+	-	*
4-11	responsiveness $TR_{H \to MP}$ to HR_{MP}	C	+	+	*
Scenario 5: 20% integrated care model & collaborative model					
5-1	percentage of integration	A	+	+	*
5-2	maximum QoC_H	A	+	+	*
5-3	intended level of CO	A	-	+	*
5-4	voluntariness of CO	A	-	+	*
5-5	responsiveness $\%LR_H$ to HR_H to QoC_H	B	+	+	*
5-6	responsiveness $\%HR_{MP \to H}$ to CO	B	-	+	*
5-7	responsiveness $\%LR_{H \to MP}$ to CO	B	-	+	*
5-8	responsiveness outsourcing MP to CO	B	-	-	-

- = outcome of scenario does not change, + = outcome of scenario does change, * = important assumption/variable/relation

SA 1-1: Referrals from hospitals to midwifery practices

Questioning

In the first scenario, the percentage $LR_{H \to MP}$ decreases to 0%. Reason for this is that there is no need to send LR to the MP's, for as there are midwives in the hospital who can perfectly take care of these LR. But what if these midwives are only employed to provide care to HR, and that they will not be used to take care of LR. What if it is agreed upon that LR belong in MP's instead of in H's?

Variations

Let's assume that H's are willing to refer a certain percentage of the LR to MP's, but that H's are also likely to still hold on to some LR. Let's assume that the regular dynamics of the systems, in

terms of trust and collaboration, are still in place. Let's multiply the percentage $LR_{H \to MP}$ by 0, 0.25, 0.5, 0.75 and 1 (0 representing H's do not refer any LR to MP's, 1 representing H's will do as the dynamics of the system subscribe, thus based on trust and collaboration).

Results

The results for the two main outcome variables are given in Figure 3 and Figure 4. It appears that the degree to which H's are reluctant in referring LR to MP's when they employ midwives themselves doesn't really affect the outcome in the system as a whole. Reason for this is that in the base case they refer 5% of the LR back to MP. Making this percentage lower doesn't have as much of an impact.

Figure 3
total % high-risk pregnant women (%HR)

Figure 4
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

base
s1 referral multiplier 0 (base scenario)
s1 referral multiplier 025
s1 referral multiplier 050
s1 referral multiplier 075
s1 referral multiplier 1
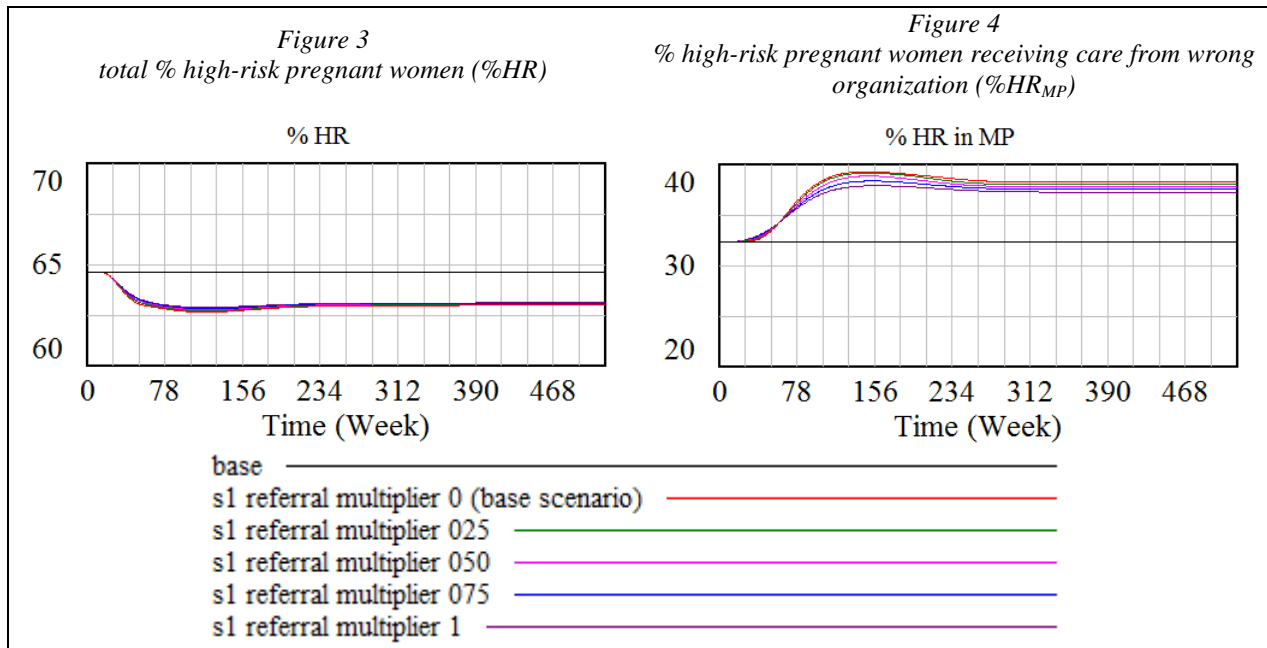
Conclusion

Changing the assumption that the percentage of $LR_{H \to MP}$ decreases to 0% does not have a substantial effect on the outcomes.

SA 1-2: Maximum quality of care in hospitals

Questioning

In the first scenario, the maximum QoC in H's increases from 0.8 to 1. Reason for this is that H's are now able to deliver both the care and the cure to PW (midwives are good at delivering care, whereas obstetricians are good at delivering cure). Further, it is expected that midwives and obstetricians work perfectly well together. What if this isn't the case? What if the maximum QoC is lower than 1? And what if it is even lower than the current setting?

Variations

The max QoC$_H$ takes on the following values: 1, 0.9, 0.8, and 0.7.

Results

A change in the maximum QoC_H results in a change in the outcomes also. The lower the max QoC_H, the higher the %HR (Figure 5), and the lower the $\%HR_{MP}$ (Figure 6).

Firstly, regarding the %HR, the %HR is determined by the degree to which PW develop a HR-pregnancy. This, in turn, is determined by the deliv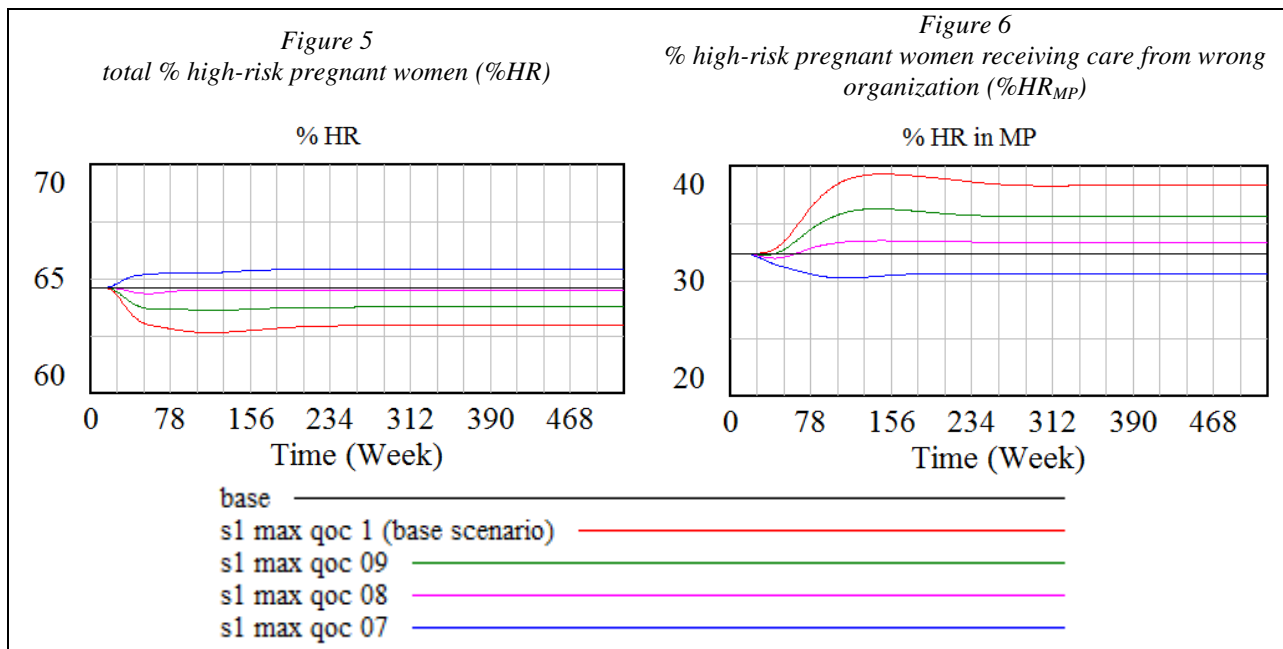ered QoC_H and QoC_{MP}. The QoC_{MP} does not change substantially, the QoC_H does differ in the tests conducted here. Accordingly, the %HR changes: the higher the QoC_H, the lower the degree to which PW develop a HR-pregnancy in H's and because the performance of MP's remains the same, the lower the total %HR.

Secondly, regarding the $\%HR_{MP}$, the $\%HR_{MP}$ is determined by $TR_{MP \to H}$. This is determined by the relative number of LR_H. Because H's hold on to LR, they have midwives to take care of those LR, the relative number of LR_H increases. As a result $TR_{MP \to H}$ decreases and thus $HR_{MP \to H}$ decreases. Therefore, the $\%HR_{MP}$ increases compared to the base of this scenario.

But why is it that when QoC_H reaches a lower level than in the base of this scenario that HR_{MP} decreases below the base level of this scenario? When the QoC_H decreases below 0.8, the percentage $LR_H \to HR_H$ increases, leaving less LR_H. As a result, $TR_{MP \to H}$ increases, $HR_{MP \to H}$ increases, lowering HR_{MP} compared to the base level of this scenario. Note that in the theoretical case where QoC_H lowers even further, this loop would result in an even lower $\%HR_{MP}$. This is somewhat counterintuitive for as when H's deliver very low quality of care, MP's would probably decide not to send $HR_{MP \to H}$ because they can deliver higher QoC themselves. However, the feedback from QoC to referral behavior is not modeled. QoC is something that is hard to grasp and therefore it is hard to interpret by others and thus it is hard to act explicitly upon it. Therefore it is chosen to have referrals depend on trust and thus on the actual number of LR or HR, which is more visible to the organizations.

Figure 5
total % high-risk pregnant women (%HR)

% HR

Time (Week)

Figure 6
% high-risk pregnant women receiving care from wrong organization (%HR_MP)

% HR in MP

Time (Week)

base
s1 max qoc 1 (base scenario)
s1 max qoc 09
s1 max qoc 08
s1 max qoc 07

Conclusion

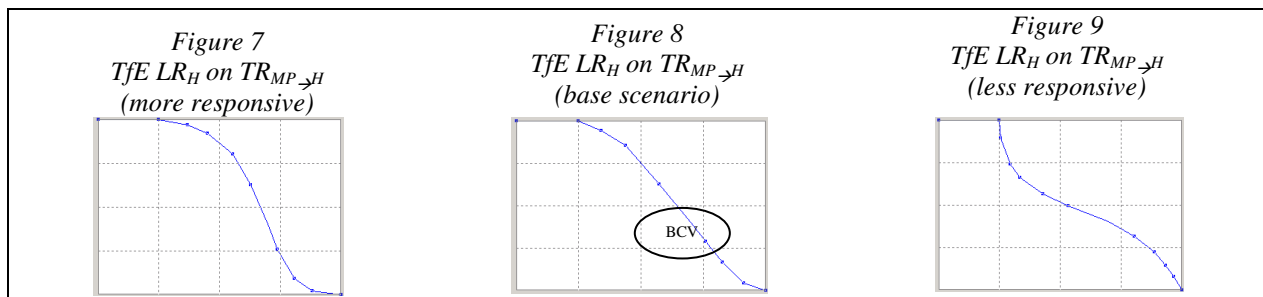The QoC_H is of importance to both outcome variables: % HR and $\%HR_{MP}$.

SA 1-3: Trust midwifery practices have in hospitals

Questioning

The first scenario of increasing the quality of care in H's sounds attractive. However, the net outcome is not as positive as one would expect. Indeed, the quality of care that H's deliver increases and thus the percentage of LR_H to HR_H decreases. However, LR_H relative to the total number of pregnant women in the system increases. This results in a lower $TR_{MP \to H}$. But what would happen if the relation between the LR_H and $TR_{MP \to H}$ would change? What if it would be more or less responsive to changes?

Variations

Three different relations between the LR_H and $TR_{MP \to H}$ are modeled: one being the base scenario (Figure 8), one being more responsive in the area of the base case value (BCV) (Figure 7) and one being less responsive in the area of the BCV (Figure 9). The BCV here is around 2.8 (x-scale of figures is defined 0-4 and the y-scale is defined on 0-1). Note that that the minimum and maximum values of the relation do not change.

Figure 7
TfE LR_H on $TR_{MP \to H}$
(more responsive)

Figure 8
TfE LR_H on $TR_{MP \to H}$
(base scenario)

Figure 9
TfE LR_H on $TR_{MP \to H}$
(less responsive)

BCV

Results

The $\%HR_{MP}$ changes according to changes in the responsiveness of $TR_{MP \to H}$ to the number of LR_H: the more responsive, the higher the $\%H_{MP}$ (Figure 11). In this first scenario, the QoC_H improves due to the extra midwives that are working in the H's. As a result, and because the $LR_{H \to MP}$ decreases to 0, the LR_H increases. With a more responsive relation between LR_H and $TR_{MP \to H}$, the $TR_{MP \to H}$ decreases more, and the less the $HR_{MP \to H}$ and thus the higher the $\%HR_{MP}$.

However, making this ratio more or less responsive doesn't really affect the %HR; the %HR in the system is for all three degrees of responsiveness about the same (Figure 10). The %HR is mainly determined by the QoC_H and the QoC_{MP}. For all these sub-scenarios the max QoC_H increases to 1 and the max QoC_{MP} remains the same and because the effects of TR, CO and WP on the QoC (resulting in the delivered QoC) are about the same in the three sub-scenarios, the %HR will remain about the same.

20

Figure 10	Figure 11
total % high-risk pregnant women (%HR)	% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

base
s1 trust mp in h less
s1 trust mp in h (base scenario)
s1 trust mp in h more

Conclusion

The responsiveness of $TR_{MP \to H}$ to LR_H is of importance to one of the outcome variables: %HR$_{MP}$.

SA 1-4: Percentage low-risk pregnant women to high-risk pregnant women in hospital

Questioning

In the first scenario, the max QoC_H is increased from 0.8 to 1 (out of 1). QoC_H has a direct effect on the percentage pregnant women that develop a high-risk pregnancy in H's. What if the percentage LR_H to HR_H is more responsive to changes in the QoC_H?
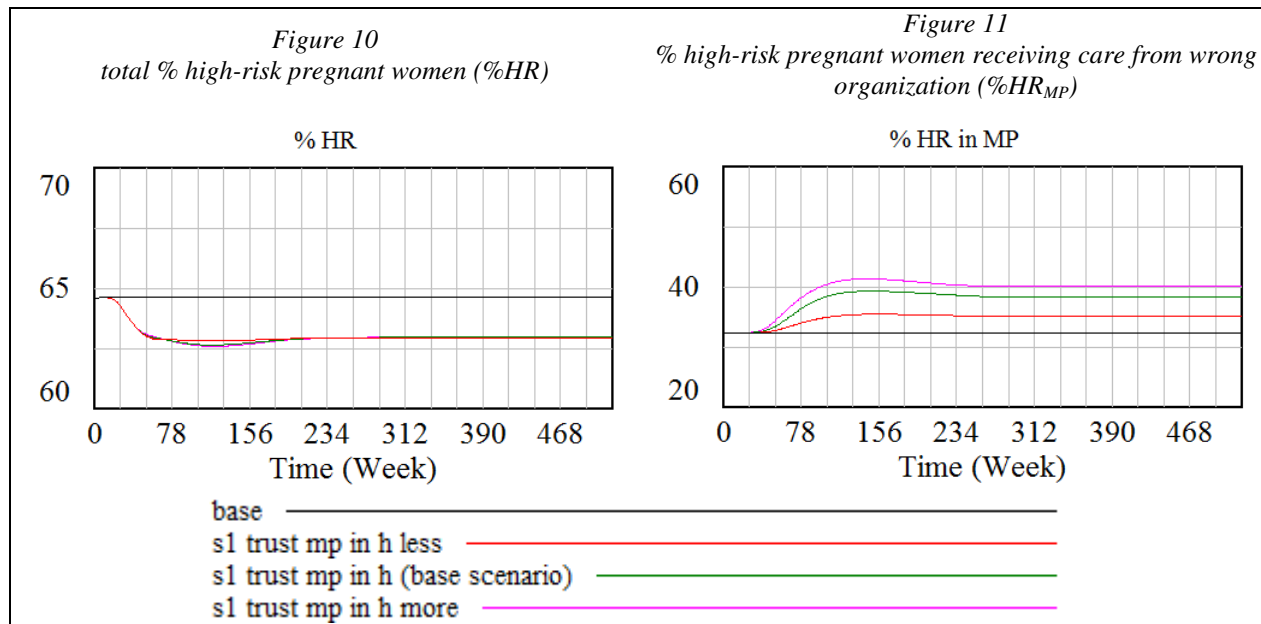
Variations

Three different relations between the percentage LR_H and HR_H are modeled: one being the base scenario (Figure 13), one being more responsive in the area of the base case value (BCV) (Figure 12) and one being less responsive in the area of the BCV (Figure 14). The BCV here is around 0.55 (x-scale of figures is defined 0-1 and the y-scale is defined on 0-3). Note that that the minimum and maximum values of the relation do not change.

Figure 12	Figure 13	Figure 14
TfE QoC_H on % LR_H to HR_H (more responsive)	TfE QoC_H on % LR_H to HR_H (base scenario)	TfE QoC_H on % LR_H to HR_H (less responsive)

21
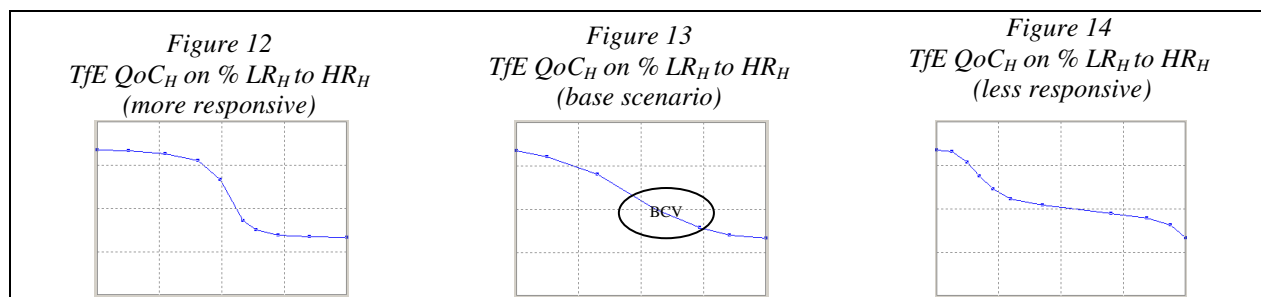
Results

Making the percentage LR_H to HR_H more/less responsive to changes in the QoC_H results in a lower/higher %HR (Figure 15) and in a higher/lower $\%HR_{MP}$ (Figure 16).

Firstly, regarding the %HR, the %HR determined by the degree to which PW develop a high-risk pregnancy, which is directly determined by the QoC_H and QoC_{MP}. Changing the responsiveness of the degree to which LR in H's develop into HR to changes in QoC_H results therefore directly into a larger or smaller effect (for as the QoC_{MP} remains the same in this scenario).

Secondly, regarding the $\%HR_{MP}$, the $\%HR_{MP}$ is determined by $TR_{MP \rightarrow H}$, which is determined by the relative number of LR_H. A change in responsiveness of $\%HR_H$ to QoC_H (as described above) has also an effect on the percentage LR_H, and thus on $TR_{MP \rightarrow H}$.

Figure 15
total % high-risk pregnant women (%HR)

Figure 16
% high-risk pregnant women receiving care from wrong organization ($\%HR_{MP}$)

Conclusion

The responsiveness of the percentage $LR_H \rightarrow HR_H$ to QoC_H is of importance to both outcome variables: %HR and $\%HR_{MP}$.

SA 1-5: Trust hospitals have in midwifery practices

Questioning

One might think that $TR_{H \rightarrow MP}$ will not have an effect in the first scenario of improved hospital care, for as this TR is expressed in $LR_{H \rightarrow MP}$, and this number decreases to zero (scenario setting). However, overall trust in the system has an indirect effect on the QoC_{MP} and on the QoC_H. So would the outcome of this first scenario change if the responsiveness of $TR_{H \rightarrow MP}$ to HR_{MP} would change?

Variations

Three different relations between HR_{MP} and $TR_{H \to MP}$ are modeled: one being the base scenario (Figure 18), one being more responsive in the area of the BCV (Figure 17) and one being less responsive in the area of the BCV (Figure 19). The BCV here is around 2.0 (x-scale of figures is defined 0-4 and the y-scale is defined on 0-1). Note that that the minimum and maximum values of the relation do not change.
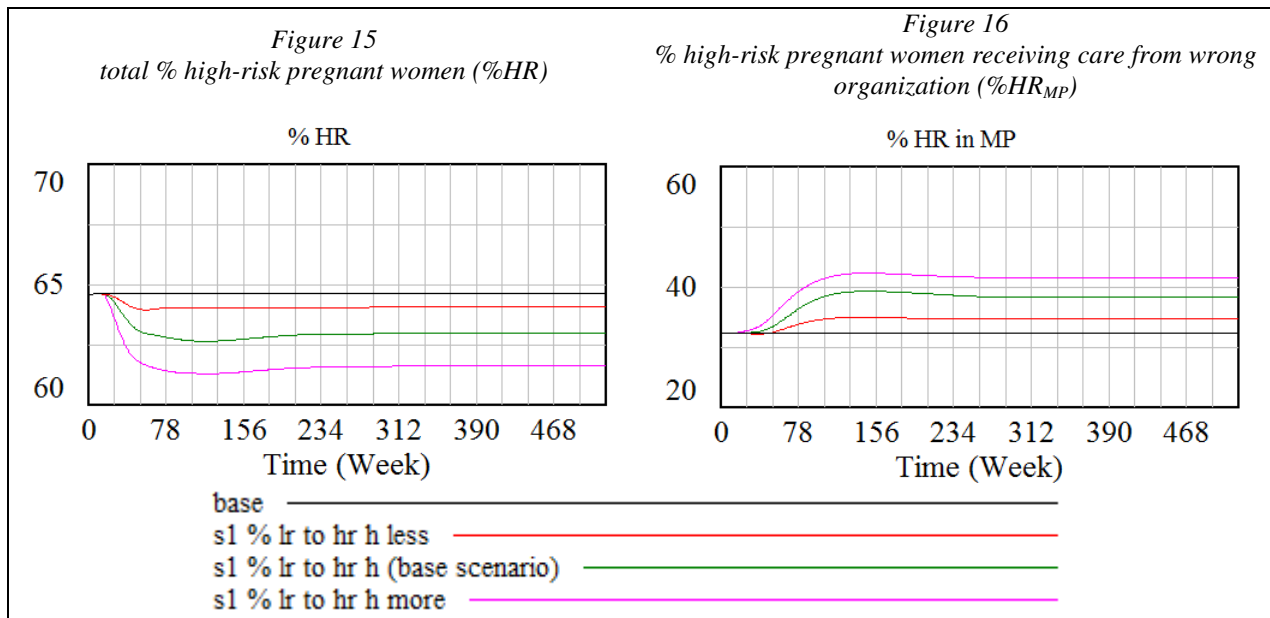

Figure 17
TfE HR_{MP} on $TR_{H \to MP}$
(more responsive)

Figure 18
TfE HR_{MP} on $TR_{H \to MP}$
(base scenario)

Figure 19
TfE HR_{MP} on $TR_{H \to MP}$
(less responsive)
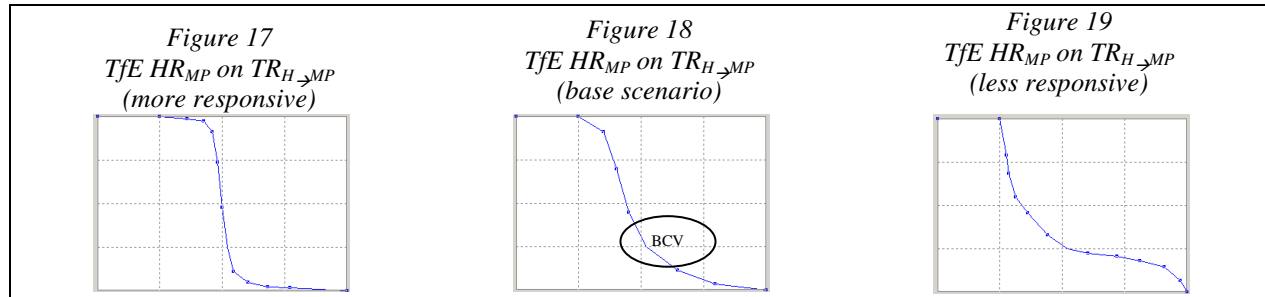
Results

The effect of HR_{MP} on $TR_{H \to MP}$ does not change the outcome variables %HR and %HR_{MP} substantially when its responsiveness changes (Figure 20 and Figure 21). The minimum trust in the system indeed responds to the change in responsiveness, but the effect on the delivered QoC is rather low. The effect of trust on QoC is restricted by the effects of collaboration and of work pressure.

Figure 20
total % high-risk pregnant women (%HR)

Figure 21
% high-risk pregnant women receiving care from wrong organization (%HR_{MP})
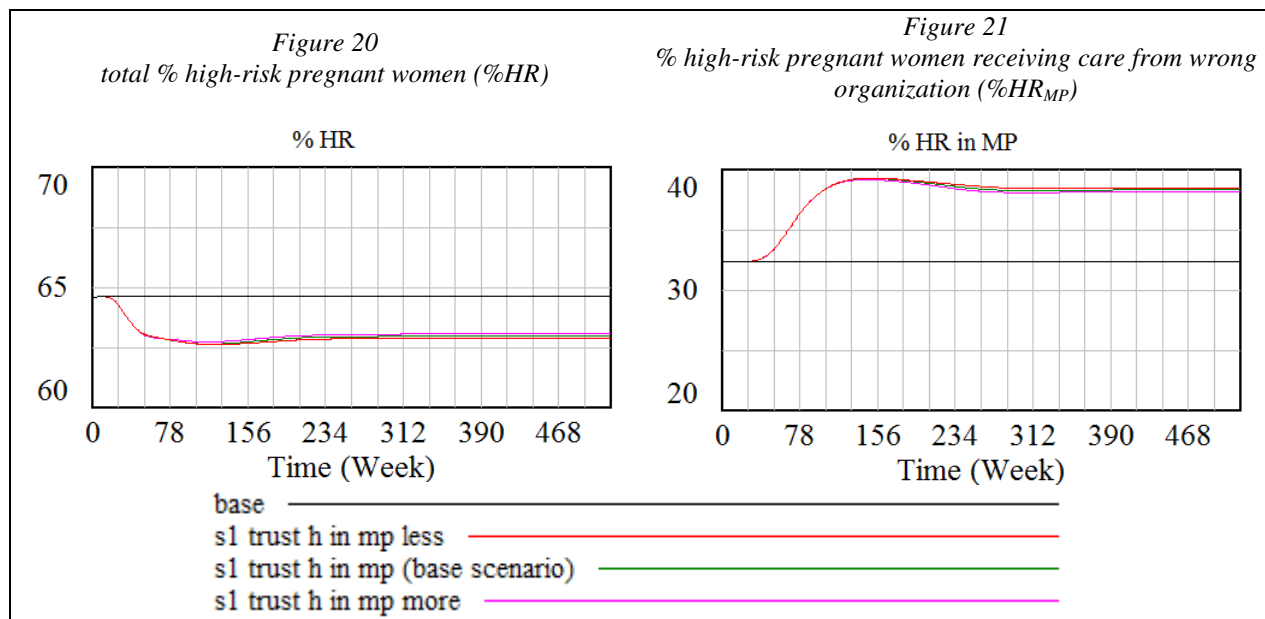
Conclusion

Changing the responsiveness of $TR_{H \to MP}$ to HR_{MP} and does not have a substantial effect on the outcomes.

SA in summary: scenario 1

The results of the tests are given below Figure 22. The first two concern assumptions of the scenario, the others assumptions made in the model.

1. Changing the assumption that H's will stop referring LR to MP's does not affect the outcomes. See SA 1-1.
2. Changing the assumption that max QoC_H will increase to 1 does change the outcomes. The lower the QoC_H, the higher %HR and the lower $\%HR_{MP}$. See SA 1-2.
3. Changing the responsiveness of $TR_{MP \rightarrow H}$ to changes in LR_H has an effect on one outcome variable. The more responsive the relation, the larger the effect on the $\%HR_{MP}$. See SA 1-3.
4. Changing the responsiveness of $\%LR_H \rightarrow HR_H$ to changes in QoC_H has an effect on both outcome variables. The more responsive the relation, the lower the %HR, and the higher the $\%HR_{MP}$. See SA 1-4.
5. Changing the responsiveness of $TR_{H \rightarrow MP}$ to changes in HR_{MP} does not have an effect on the outcome variables. See SA 1-5.
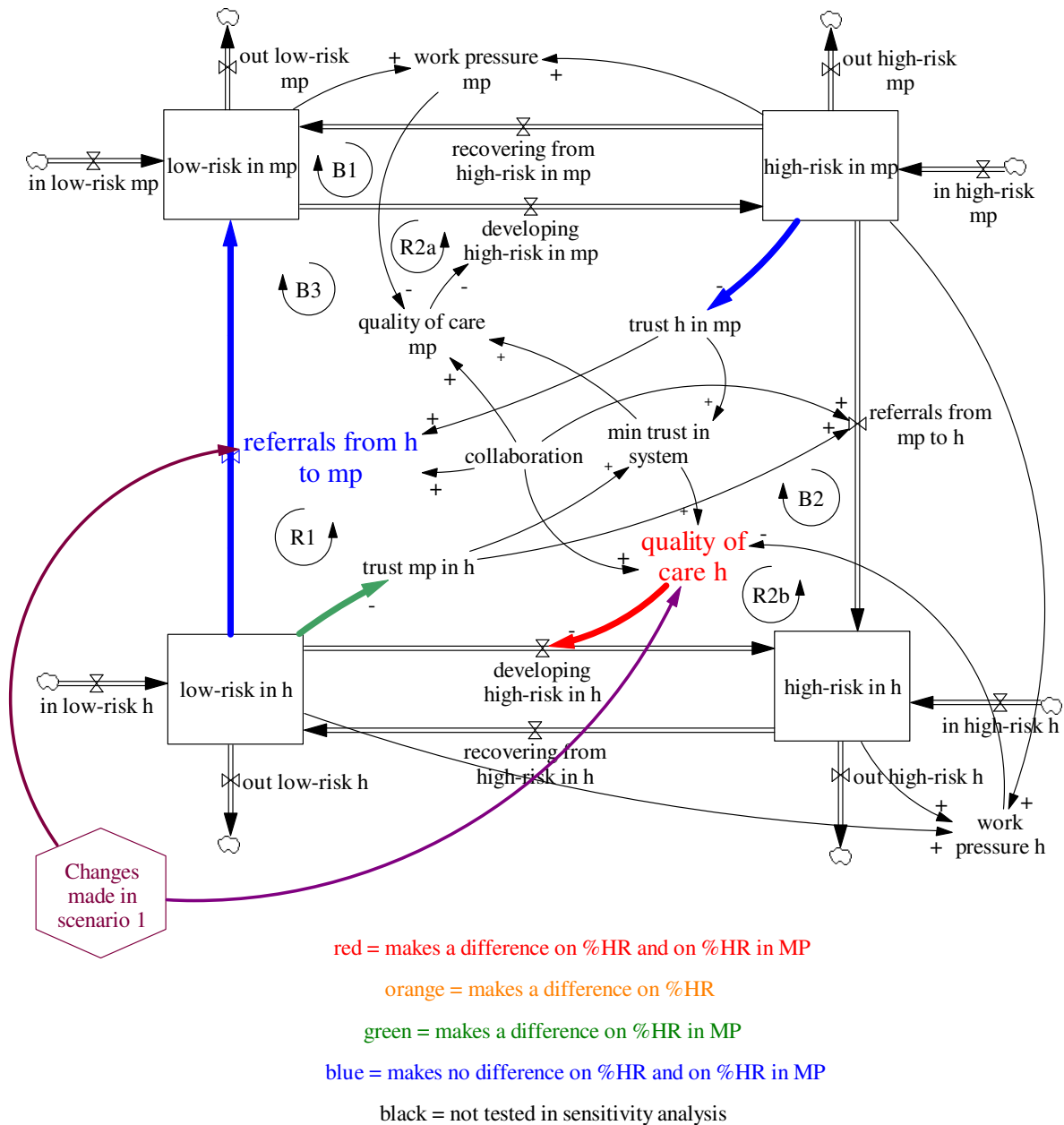
Figure 22High level stock and flow diagram with results of sensitivity analysis scenario 1

SA 2-1: Intended level of collaboration

Questioning

The level of collaboration in the base case is 0.4 (out of 1). In the second scenario, the intended level of collaboration is increased to 0.8. What would happen if the intended level of collaboration is set lower than 0.8, or even higher?
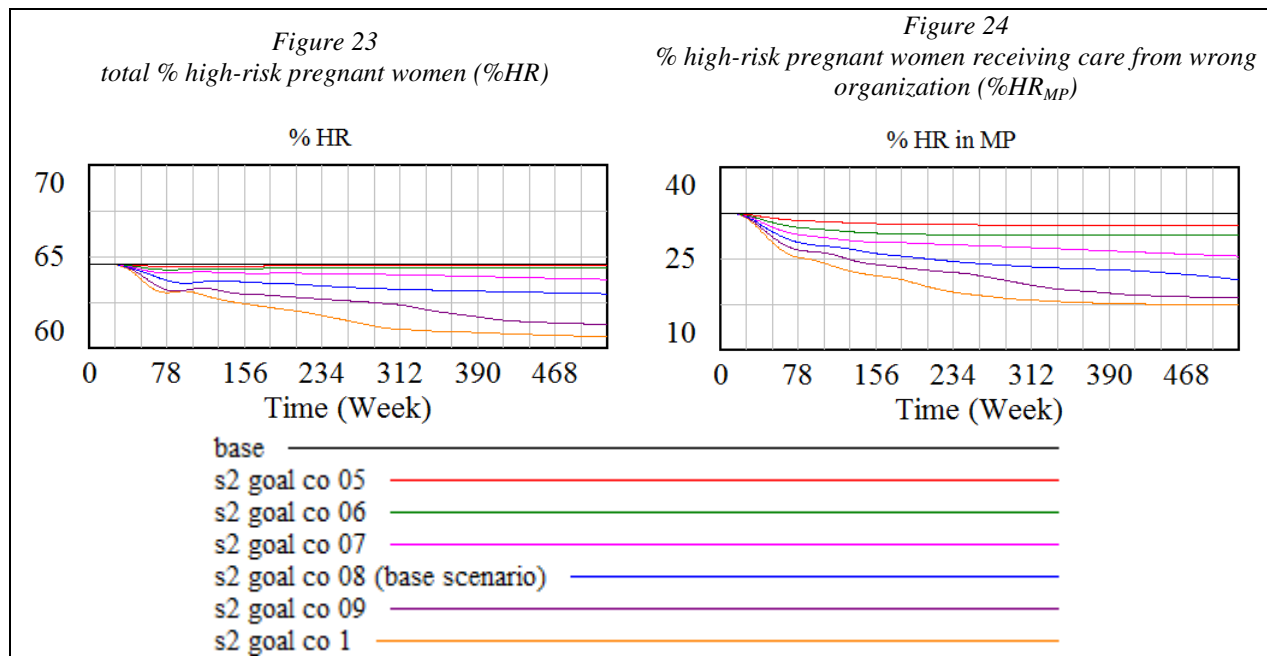
Variation

The intended level of collaboration after the start of the improvement project is set at the following values: 1, 0.9, 0.8, 0.7, 0.6, and 0.5.

Results

Changing the intended level of collaboration compared to the base scenario results in changes in the outcomes: a lower intended level of CO (between 0.4 and 0.8) results in less optimal outcomes, a higher level of intended level of CO (above 0.8) results in more optimal outcomes (Figure 23 and Figure 24). How come?

CO has three effects: on the referral behavior of the organizations, on QoC, and on the degree to which consultations are outsourced. By having an effect on referral behavior, increasing CO thus increases the number of PW that are being referred to the organization where they belong, thereby reducing %HR$_{MP}$. As a result of this, trust between the organizations increases. An increase in CO and an increase in trust both cause an increase in QoC, and thus reducing the number of PW that develops a high-risk pregnancy (%HR).

Figure 23
total % high-risk pregnant women (%HR)

Figure 24
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

Conclusion

The intended level of CO is of importance to both outcome variables: %HR and %HR$_{MP}$.

SA 2-2: Duration of the project

Questioning

In the second scenario, that of improved collaboration, the duration of the improvement project is set at 52 weeks. The delay of adjusting the level of collaboration is set at 26 weeks. As a result, in the scenario, where the intended level of collaboration is set at 0.8, the actual level of
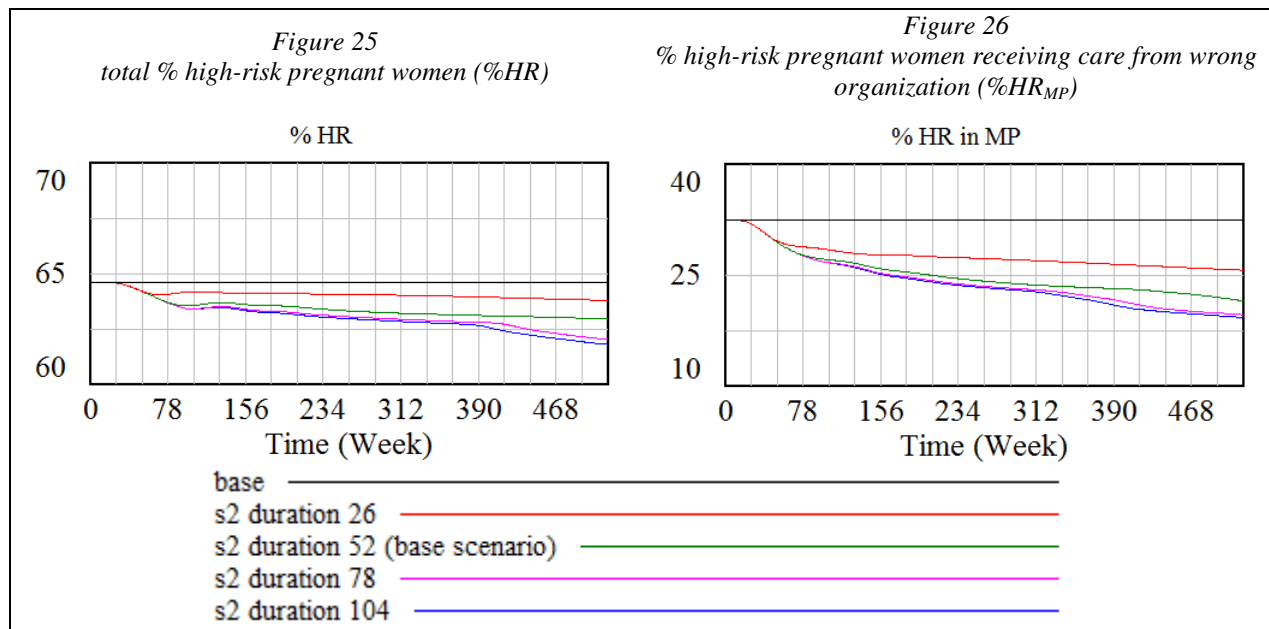
collaboration reaches almost 0.75. What would happen if the 0.8 is actually reached? So what if the improvement project would run longer, thereby giving it more chance to actually reach the intended level? And what if the project would be shorter than 52 weeks?

Variations
The duration of the project is set at the following values: 26, 52, 78, and 104.

Results
Setting the duration of the collaboration project longer results in better outcomes: the %HR is higher (Figure 25) and the %HR$_{MP}$ is higher (Figure 26). Setting the duration of the collaboration project shorter results in less optimal outcomes. In the base scenario, the intended level of CO is not fully reached, due to the time it takes for CO to adjust to a new goal. Increasing the duration of the project gives the actual CO more time to mature to the intended level, and thus the results will be better (see also SA2-1). Decreasing the duration of the project makes that CO has even less time to reach the intended level, and thus will end in a lower level, resulting in less optimal outcomes. This basically corresponds to the tests with a lower level of CO (lower than 0.8).

Figure 25
total % high-risk pregnant women (%HR)

Figure 26
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

Conclusion
Making a change in the duration of the project has the same effects as changing the intended level of CO. Therefore, changing this variable will not be part of any further analysis.

27

SA 2-3: Voluntariness of collaboration
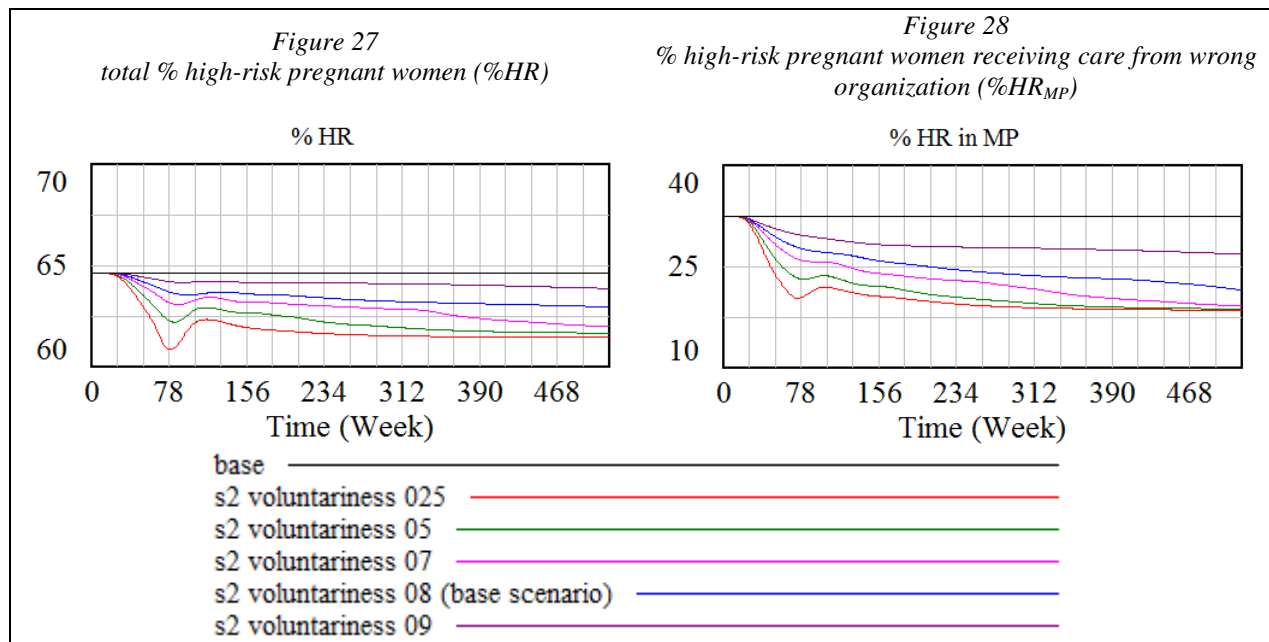
Questioning
In the second scenario, the collaborative model, CO changes. The effect of CO on the system depends among others on the degree of voluntariness. The current degree of voluntariness is set at 0.8 (out of 1). What if the CO is less voluntary and stricter?

Variations
The degree of voluntariness takes on the following values: 0.9, 0.8, 0.7, 0.5 and 0.25. Note that the value 1 is not included in this list for as setting the voluntariness at 1 implies that CO does not have an effect; all behavior is based on TR only. Also note that the value 0 is not included in this list for as setting the voluntariness at 0 implies that TR does not have an effect; all behavior is based on CO only. In addition, a voluntariness of 0 basically equals being tied together so closely that one kind of did integrate into 1.

Results
Changing the degree of voluntariness has an effect on the %HR (Figure 27) and on the %HR$_{MP}$ (Figure 28): the lower the voluntariness of the CO, the lower the %HR and the lower the %HR$_{MP}$. To gain insight into this, one has to understand the relation between the reinforcing trust loop (R1) and the effect CO has on it. R1 states that the higher the TR, the more referrals between organizations, the more PW are being cared for by the right organization, and thus the higher the TR. CO is an external stimulus on this loop: increasing CO forces more referrals between H's and MP's. The degree to which CO has this effect depends on the voluntariness of the CO: the lower the voluntariness, the more effect.

Figure 27
total % high-risk pregnant women (%HR)

Figure 28
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

base
s2 voluntariness 025
s2 voluntariness 05
s2 voluntariness 07
s2 voluntariness 08 (base scenario)
s2 voluntariness 09

Conclusion

The voluntariness of CO is of importance to both outcome variables: %HR and %HR$_{MP}$.

SA 2-4: Referrals from midwifery practices to hospitals

Questioning

The first effect of CO is on the referral rates between H's and MP's. One can question the chosen relation between CO and the %HR$_{MP \to H}$. What would happen when this referral rate would be more or less responsive to changes in CO?

Variations

Three different relations between CO and %HR$_{MP \to H}$ are modeled: one being the base scenario (Figure 30), one being less responsive in the area of the BCV (Figure 29) and one being more responsive in the area of the BCV (Figure 31). The BCV is on 0.4 (x-scale of figures is defined 0-1 and the y-scale is defined on 0-1). Note that that the minimum and maximum values of the relation do not change.

Figure 29
TfE CO on %HR$_{MP \to H}$
(less responsive)

Figure 30
TfE CO on %HR$_{MP \to H}$
(base scenario)

Figure 31
TfE CO on %HR$_{MP \to H}$
(more responsive)

Results

The two main outcome variables do change when the responsiveness of %HR$_{MP \to H}$ to CO changes (Figure 32 and Figure 33). Making the relation more responsive increases the system's performance. CO is an exogenous variable which is increased in this scenario. The reinforcing loop R1 is one of the main loops in the model, and making this loop directly more responsive to changes in the CO has a real impact on the outcomes.

Figure 32
total % high-risk pregnant women (%HR)

Figure 33
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

| % HR | % HR in MP |

base
s2 hr mp to h less
s2 hr mp to h (base scenario)
s2 hr mp to h more
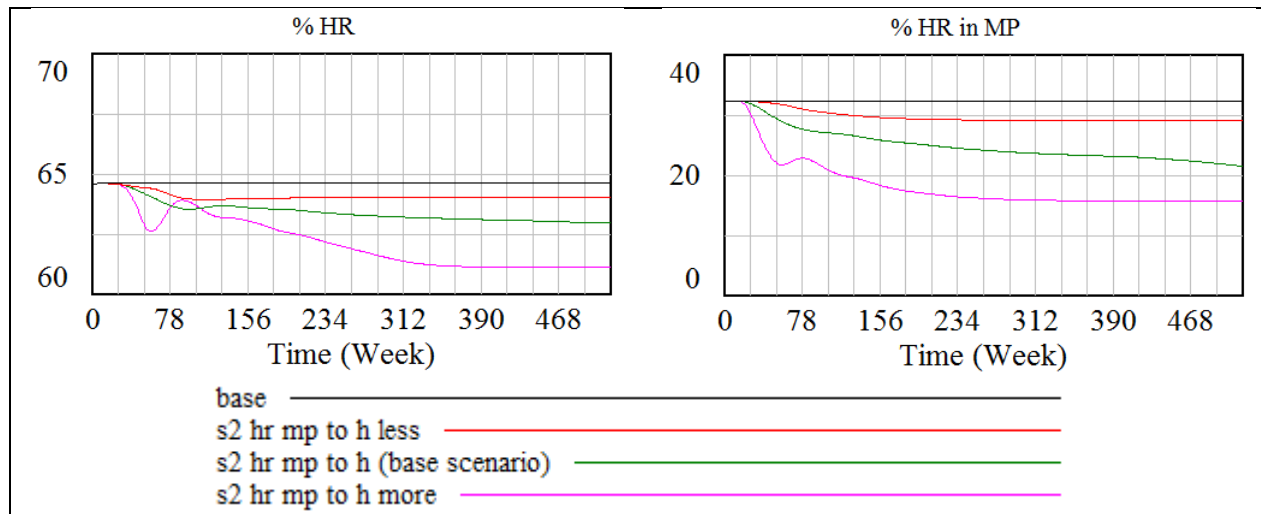
Conclusion

The responsiveness of the $\%HR_{MP\to H}$ to changes in CO has an effect on both outcome variables: $\%HR$ and $\%HR_{MP}$.

SA 2-5: Referrals from hospitals to midwifery practices

Questioning

The first effect of CO is on the referral rates between H's and MP's. One can question the chosen relation between CO and the $\%LR_{H\to MP}$. What would happen when this referral rate would be more or less responsive to changes in CO?

Variations

Three different relations between CO and $\%LR_{H\to MP}$ are modeled: one being the base scenario (Figure 35Figure 30), one being less responsive in the area of the BCV (Figure 34) and one being more responsive in the area of the BCV (Figure 36). The BCV is on 0.4 (x-scale of figures is defined 0-1 and the y-scale is defined on 0-1). Note that that the minimum and maximum values of the relation do not change.

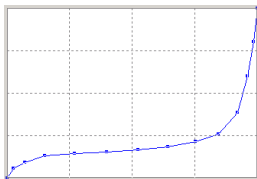
Figure 34
TfE CO on $\%LR_{H\to MP}$
(less responsive)

Figure 35
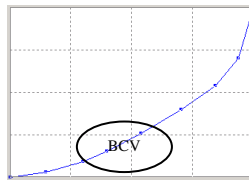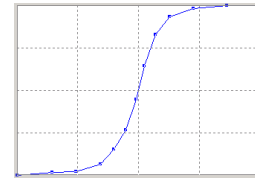*TfE CO on $\%LR_{H\to MP}$*
(base scenario)

BCV

Figure 36
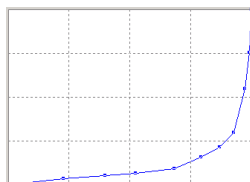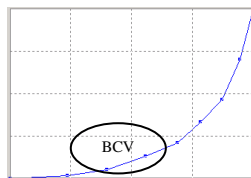*TfE CO on $\%LR_{H\to MP}$*
(more responsive)
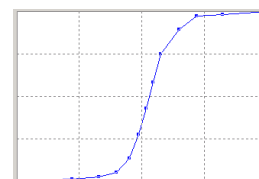
Results

The two main outcome variables do change when the responsiveness of $\%LR_{H \to MP}$ to CO changes (Figure 37 and Figure 38). Making the relation more responsive increases the system's performance. CO is an exogenous variable which is increased in this scenario. The reinforcing loop R1 is one of the main loops in the model, and making this loop directly more responsive to changes in the CO has a real impact on the outcomes.

Making the relation less responsive does not really change the outcomes. <explain>

Figure 37
total % high-risk pregnant women (%HR)

Figure 38
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)
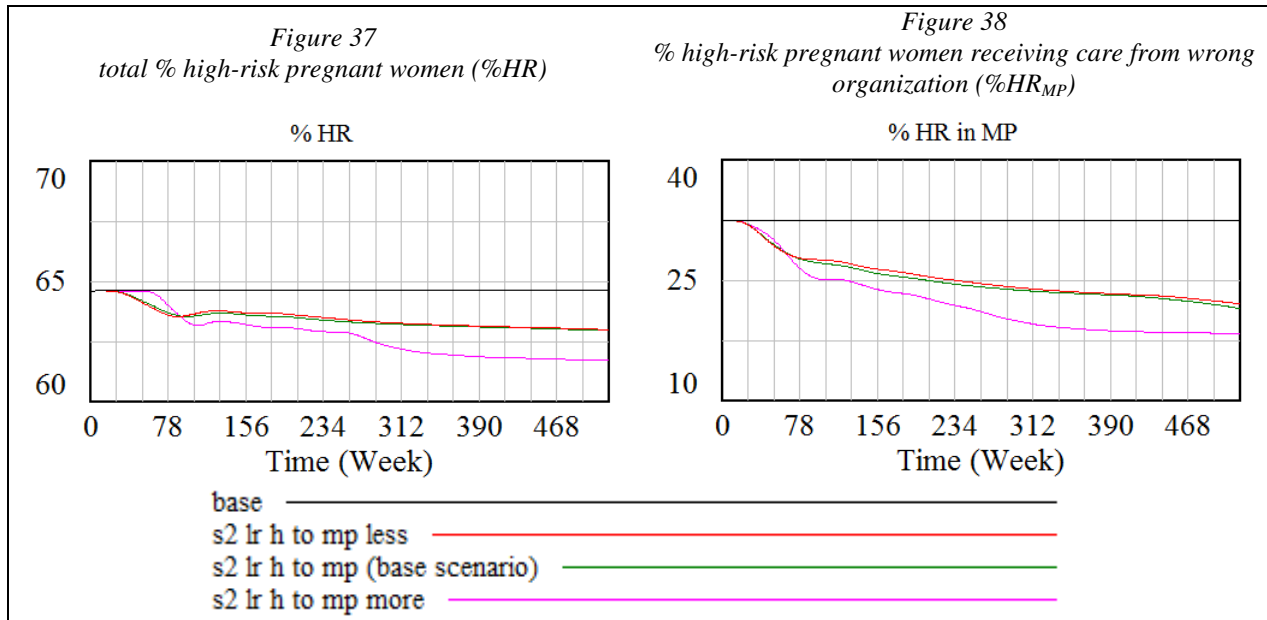
Conclusion

The responsiveness of the $\%LR_{H \to MP}$ to changes in CO has an effect on both outcome variables: %HR and %HR$_{MP}$, although only when the relation is made more responsive.

SA 2-6: Quality of care midwifery practices

Questioning

The second effect of CO is on the delivered QoC. What would happen when the QoC$_{MP}$ would be more or less responsive to changes in CO?

Variations

Three different relations between CO and QoC$_{MP}$ modeled: one being the base scenario (Figure 40), one being less responsive in the area of the BCV (Figure 39) and one being more responsive in the area of the BCV (Figure 41). The BCV is on 0.4 (x-scale of figures is defined 0-1 and the y-scale is defined on 0.5-1). Note that that the minimum and maximum values of the relation do not change.

Figure 39   Figure 40   Figure 41

31

TfE CO on QoC$_{MP}$
(less responsive)

TfE CO on QoC$_{MP}$
(base scenario)

TfE CO on QoC$_{MP}$
(more responsive)
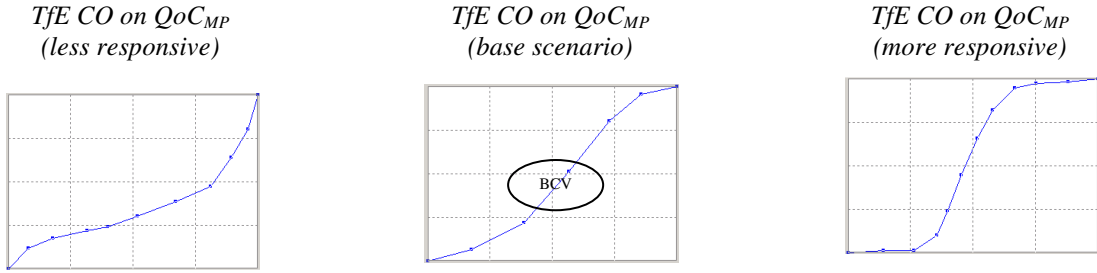
Results

Changing the responsiveness of QoC$_{MP}$ to CO does not really change the outcome variables %HR and %HR$_{MP}$ (Figure 42 and Figure 43). QoC$_{MP}$ is affected by WP on the one hand and by CO and TR on the other hand. The weight of CO and TR is determined by the voluntariness of CO. Because the voluntariness of CO in this scenario is set fairly high (0.8 out of 1), CO does not have that much effect on QoC$_{MP}$, and thus also not on the rest of the outcomes presented here.

Figure 42
total % high-risk pregnant women (%HR)

Figure 43
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

Conclusion

Changing the responsiveness of QoC$_{MP}$ to CO does not have a substantial effect on the outcomes.

SA 2-7: Quality of care hospitals

Questioning

The second effect of CO is on the delivered QoC. What would happen when the QoC$_H$ would be more or less responsive to changes in CO?

32

Variations

Three different relations between CO and QoC_H modeled: one being the base scenario (Figure 45), one being less responsive in the area of the BCV (Figure 44) and one being more responsive in the area of the BCV (Figure 46). The BCV is on 0.4 (x-scale of figures is defined 0-1 and the y-scale is defined on 0.5-1). Note that that the minimum and maximum values of the relation do not change.
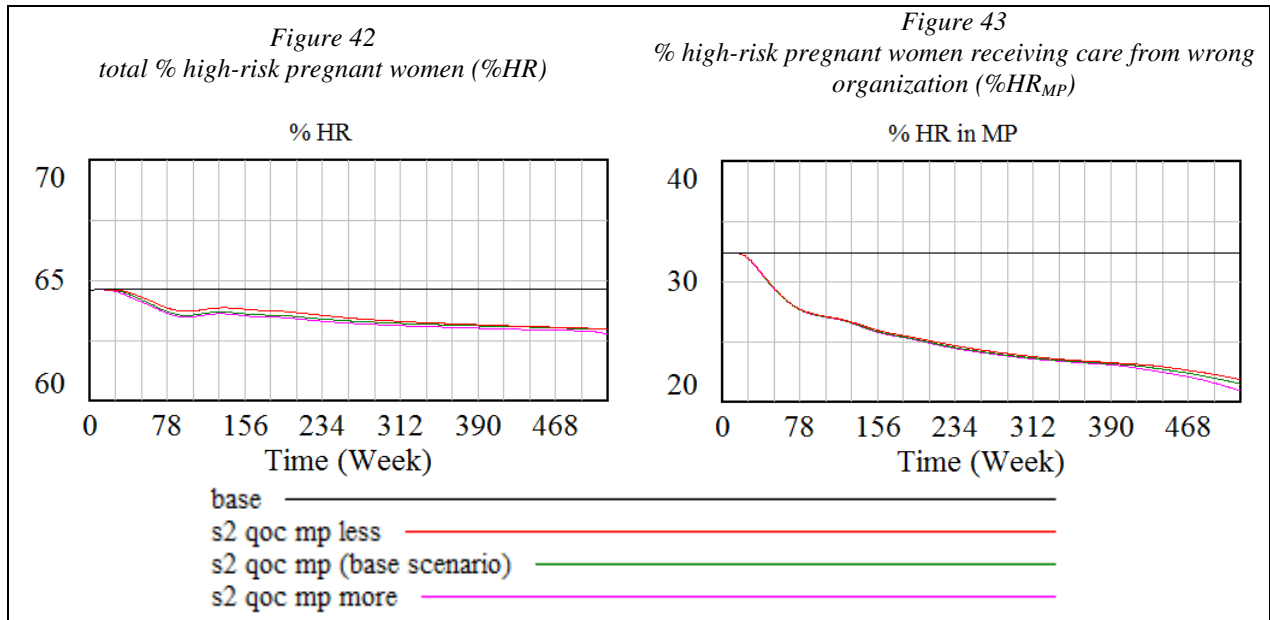

Figure 44
TfE CO on QoC_H
(less responsive)

Figure 45
TfE CO on QoC_H
(base scenario)

Figure 46
TfE CO on QoC_H
(more responsive)
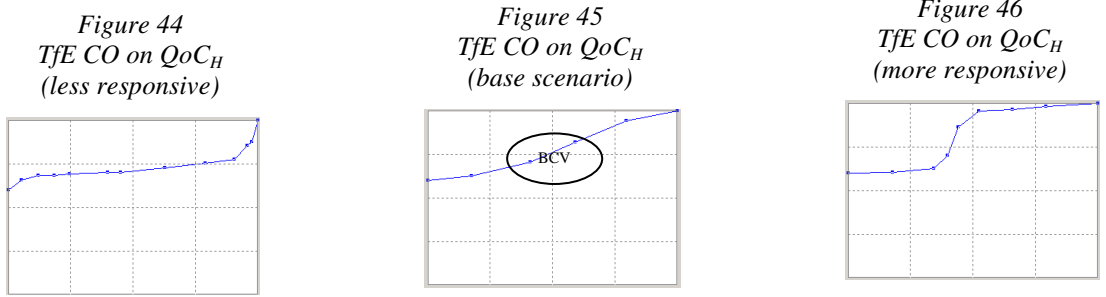
Results

Changing the responsiveness of QoC_H to CO does not really change the outcome variables %HR and $\%HR_{MP}$ (Figure 42 and Figure 43). QoC_H is affected by WP on the one hand and by CO and TR on the other hand. The weight of CO and TR is determined by the voluntariness of CO. Because the voluntariness of CO in this scenario is set fairly high (0.8 out of 1), CO does not have that much effect on QoC_H, and thus also not on the rest of the outcomes presented here.

Figure 47
total % high-risk pregnant women (%HR)

Figure 48
% high-risk pregnant women receiving care from wrong organization ($\%HR_{MP}$)
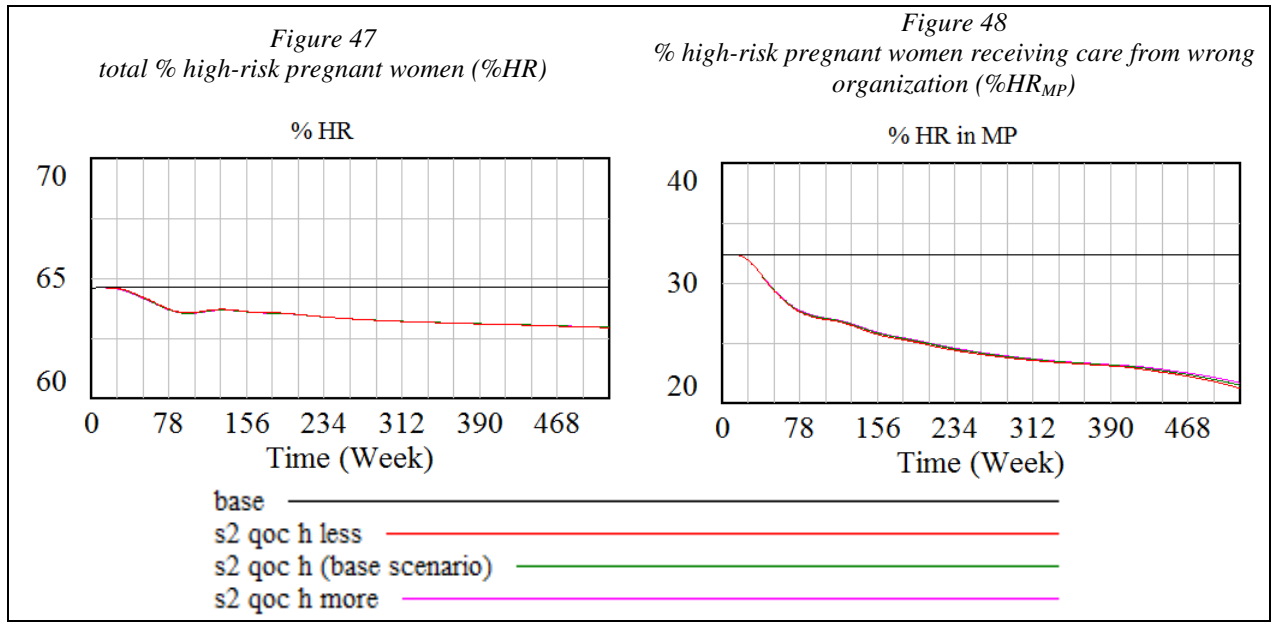
Conclusion

Changing the responsiveness of QoC_H to CO does not have a substantial effect on the outcomes.

SA 2-8: Outsourcing consultations in midwifery practices

Questioning

The third effect of CO is on the degree to which organizations outsource consultations. What would happen when the number of consultations that will be outsourced by MP's is set more responsive to changes in CO?

Variations

CO has an effect on the percentage of consultations that will be outsourced by MP's. Figure 49 present the base scenario for the table which determines the effect of CO on the percentage of consultations that will be outsourced by MP's and Figure 50 presents a more responsive relation. The BCV is on 0.4 (x-scale of figures is defined 0-1 and the y-scale is defined o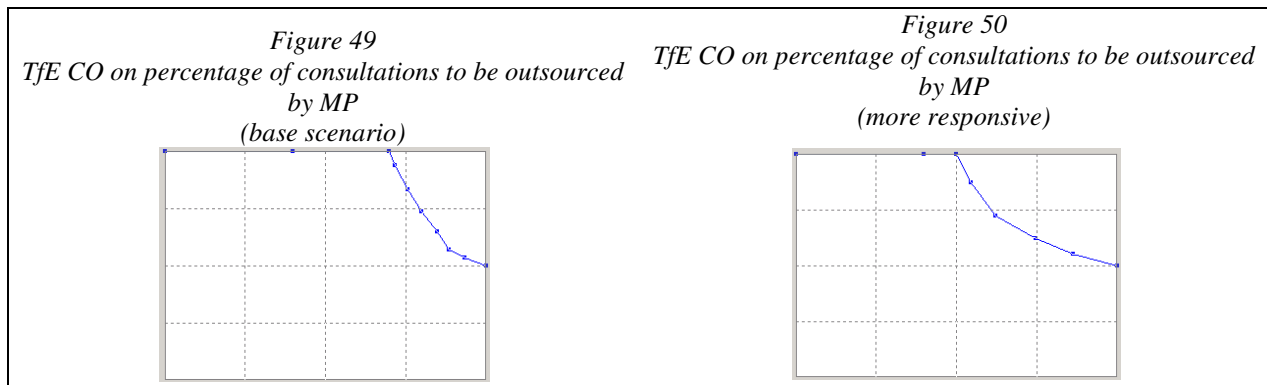n 0-100). Note that in the base scenario, CO has to be 0.7 before any effect occurs. In the analysis, this is changed to 0.5.

Figure 49
TfE CO on percentage of consultations to be outsourced by MP
(base scenario)

Figure 50
TfE CO on percentage of consultations to be outsourced by MP
(more responsive)

Results

The increased responsiveness of the percentage of consultations outsourced by MP's to CO results in a lower %HR (Figure 51), but it hardly has any effect on the %HR$_{MP}$ (Figure 52).

Firstly, regarding the %HR, the outsourcing of consultations by MP's has an effect on the QoC$_{MP}$. Making the percentage of consultations that will be outsourced by MP's more responsive to changes in CO makes that the QoC$_{MP}$ and the %LR$_{MP}$→HR$_{MP}$ also become more responsive to those changes. This results in less HR.

Secondly, regarding the %HR$_{MP}$, the %HR$_{MP}$ is determined by the LR$_H$. Changing the responsiveness of the QoC$_{MP}$ to changes in CO does not directly affect the QoC$_H$, and thus it doesn't directly affect LR$_H$ (either by the TR$_{H→MP}$ or by LR$_H$→HR$_H$). As a result the changes in %HR$_{MP}$ due to changes in the responsiveness are small.

Figure 51
total % high-risk pregnant women (%HR)

Figure 52
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

% HR		% HR in MP

Conclusion

Changing the responsiveness of outsourcing consultations by MP to changes in CO does have a small effect on one of the outcome variables (%HR), but has no substantial effect on the other outcome variable (%HR$_{MP}$).

SA 2-9: Outsourcing consultations in hospitals

Questioning

The third effect of CO is on the degree to which organizations outsource consultations. What would happen when the number of consultations that will be outsourced by H's is set more responsive to changes in CO?

Variations

CO has an effect on the percentage of consultations that will be outsourced by H's. Figure 53 present the base scenario for the table which determines the effect of CO on the percentage of consultations that will be outsourced by H's and Figure 54 presents a more responsive relation. The BCV is on 0.4 (x-scale of figures is defined 0-1 and the y-scale is defined on 0-100). Note that in the base scenario, CO has to be 0.7 before any effect occurs. In the analysis, this is changed to 0.5.
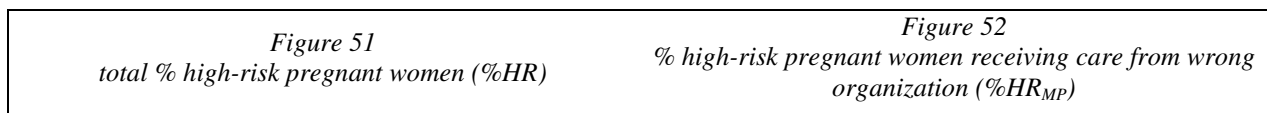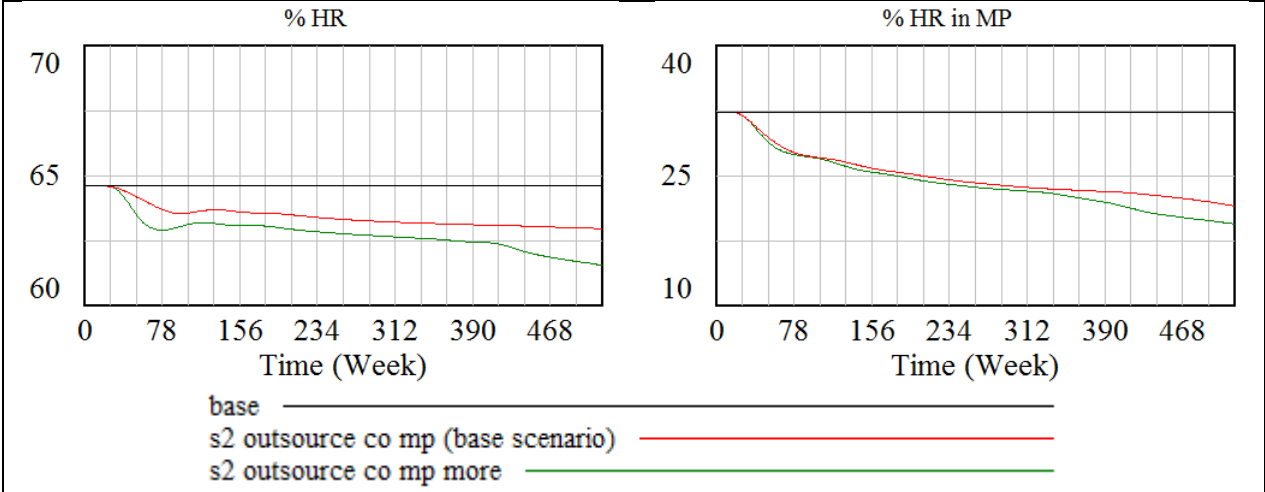
Figure 53 TfE CO on percentage of consultations to be outsourced by H *(base scenario)*	*Figure 54* TfE CO on percentage of consultations to be outsourced by H *(more responsive)*
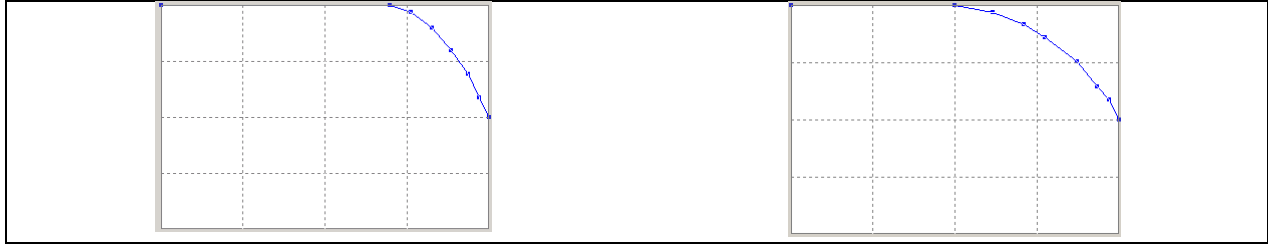
Results

The increased responsiveness of the percentage of consultations outsourced by H's to CO results in no substantial changes in the outcome variables (Figure 55 and Figure 56). This is caused by the following dynamics. More consultations being outsourced by H's to MP's results in a higher QoC_H. As a result, the $LR_H \rightarrow HR_H$ decreases and thus there are more LR_H. As a result $TR_{MP \rightarrow H}$ decreases which results in less $HR_{MP \rightarrow H}$, and thus in more HR_{MP} and thus in less $TR_{H \rightarrow MP}$. However, a lower TR in the system has a negative effect on QoC. And therefore the %HR in the system does not change much, neither does the $\%HR_{MP}$.
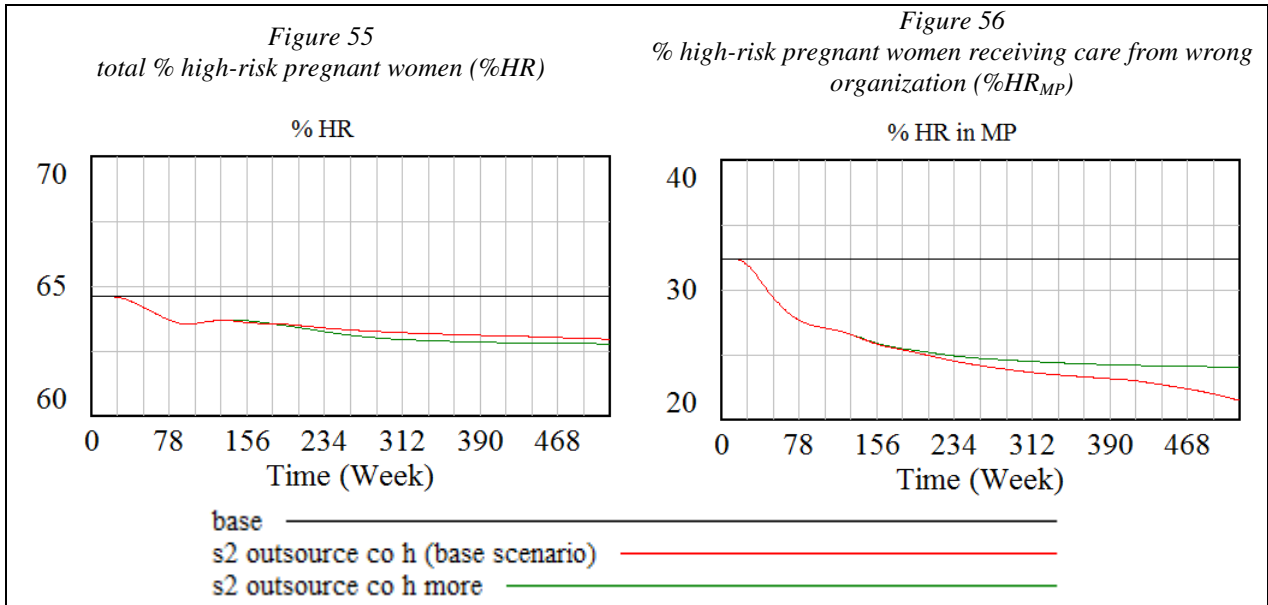
Figure 55
total % high-risk pregnant women (%HR)

Figure 56
% high-risk pregnant women receiving care from wrong organization ($\%HR_{MP}$)

Conclusion

Changing the responsiveness of outsourcing consultations by MP to changes in CO does have a small effect on one of the outcome variables (%HR), but has no substantial effect on the other outcome variable ($\%HR_{MP}$).

SA in summary: scenario 2

The results of the tests are given below and in Figure 57. The first three concern assumptions of the scenario, the others assumptions made in the model.

36

1. Changing the intended level of CO has an effect on both outcome variables. The higher/lower the intended level of CO, the lower/higher the %HR and the lower/higher the $\%HR_{MP}$. See SA 2-1.
2. Changing the duration of the collaborative project has an effect on both outcome variables. The longer/shorter the duration of the project, the lower/higher the %HR and the lower/higher the $\%HR_{MP}$. See SA 2-2.
3. Changing the voluntariness of the CO has an effect on both outcome variables. The more voluntary the project, the higher the %HR and the higher the $\%HR_{MP}$. See also SA 2-3.
4. Changing the responsiveness of $\%HR_{MP \to H}$ to changes in CO has an effect on both outcome variables. The more/less responsive the relation, the lower/higher the %HR and the lower/higher the $\%HR_{MP}$. See SA 2-4.
5. Changing the responsiveness of $\%LR_{H \to MP}$ to changes in CO has an effect on both outcome variables. The more responsive the relation, the lower the %HR and the lower the $\%HR_{MP}$. Note that there is hardly any effect for a less responsive relation. See SA 2-5.
6. Changing the responsiveness of QoC_{MP} to changes in CO has no effect on the outcome variables. See SA 2-6.
7. Changing the responsiveness of QoC_{H} to changes in CO has no effect on the outcome variables. See SA 2-7.
8. Changing the responsiveness of outsourcing consultations by MP's to changes in CO has an effect on one outcome variable. The more responsive the relation, the lower the %HR in the system. See SA 2-8.
9. Changing the responsiveness of outsourcing consultations by H's to changes in CO has no effect on the outcome variables. See SA 2-9.
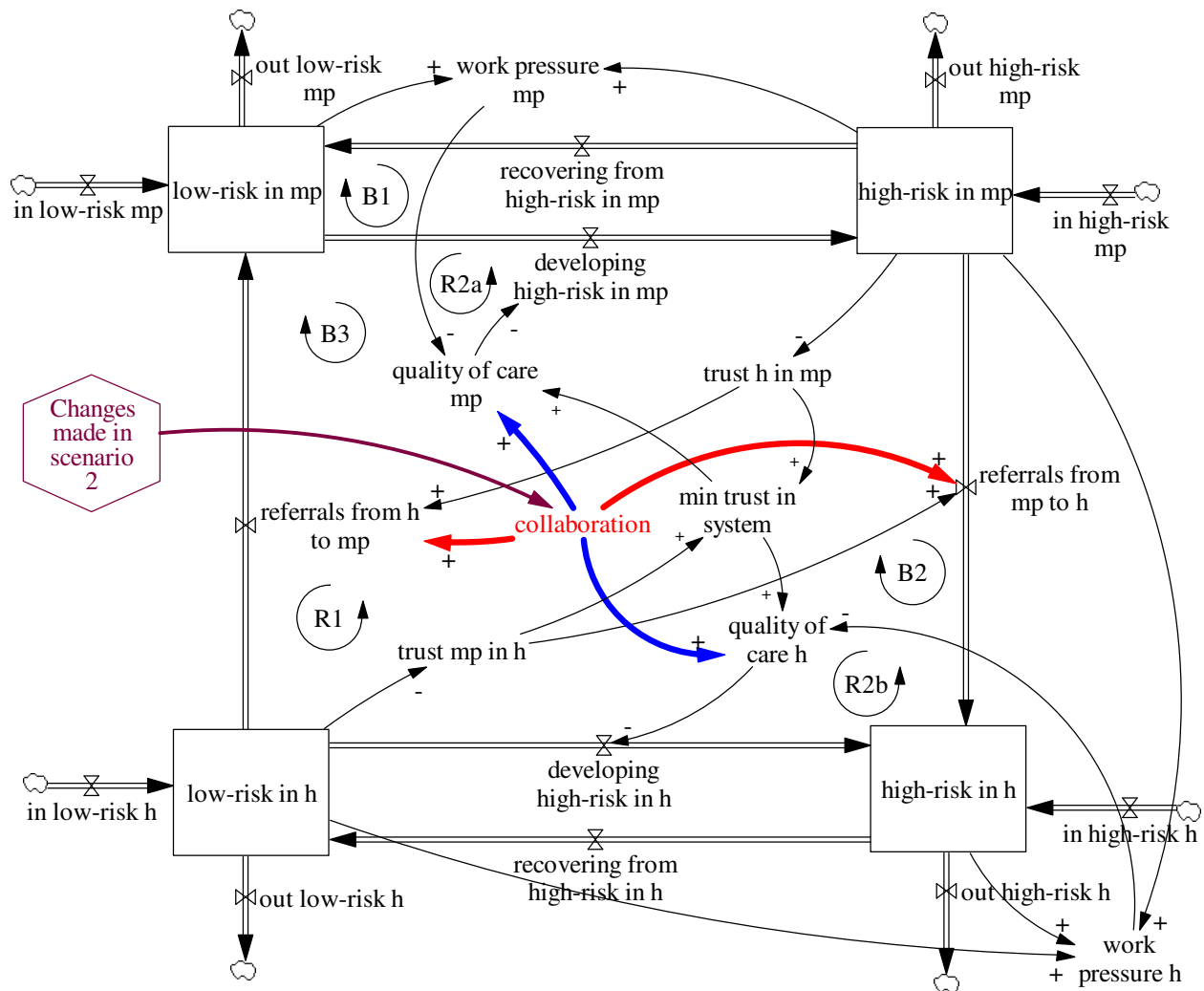
Figure 57 High level stock and flow diagram with results of sensitivity analysis scenario 2

SA 3-1: Percentage of integration

Questioning
In the third scenario, the integrated care model, 10% of the MP's integrate with the H's. What if this percentage would be higher?
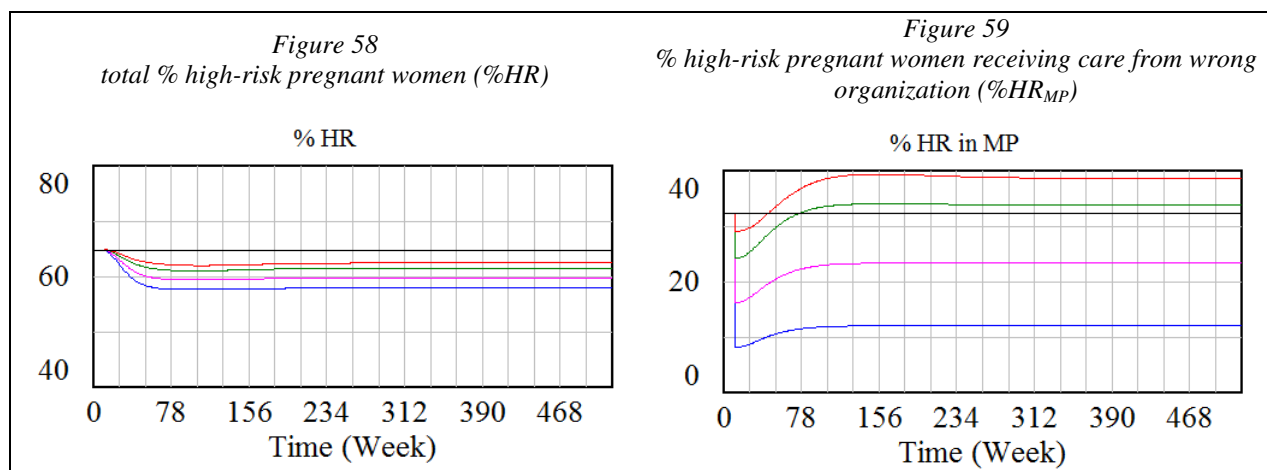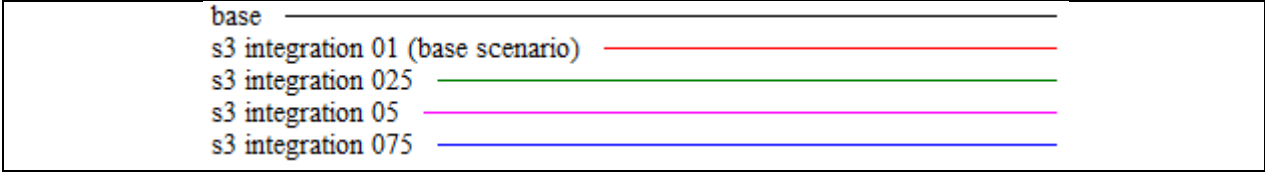
Variations

The percentage of integration is set at the following values: 0.10, 0.25, 0.5, 0.75. Note that a scenario of 100% integrated care is a bit of a "boring" scenario, for as all professionals will be working in one organization, with a maximum quality of care of 1, assuming the different type of professionals collaborating well. It seems obvious that this scenario will deliver the best performance. In the Netherlands, however, is it unrealistic that all organizations in a region merge into one, so the dynamics of competition and distrusting each other will always be present.

Results

Increasing the percentage of MP's that integrate with H's results in a lower %HR (Figure 58). The integrated H's are able to deliver a higher CoQ, and because the PW_H increases when the percentage of MP's that integrate with H's increases, HR decreases. Note that the QoC_{MP} does not change substantially in these tests.

Regarding the $\%HR_{MP}$, integration is not always a good way to go. Integration of 25% still worsens the results, but integration of a higher percentage results in increased performance compared to the current situation (base) (Figure 59). For the scenarios of 10% and 25% of integration, the increase in $\%HR_{MP}$ is caused by the fact that $TR_{MP \to H}$ decreases and that there are, as a result, less $HR_{MP \to H}$. The decrease in the $\%HR_{MP}$ for the scenarios 50% and 75% is caused by the following. $TR_{MP \to H}$ decreases in all scenarios, but it decreases so much, that in the scenarios of 25%, 50% and 75% it decreases to 0. This implies that $\%HR_{MP \to H}$ also decreases to its minimum (which is not 0% but 7%). Therefore, the decrease in $\%HR_{MP}$ when the percentage of integration increases more than 25%, is caused by the calculation of $\%HR_{MP}$: the total number of HR_{MP} is divided by the total number of PW in the whole system. The total number of HR_{MP} decreases, not because of delivering better care in midwifery practices, or because of referring more $HR_{MP \to H}$, but because there are less PW_{MP}, (more MP's have integrated with H's).

Figure 58
total % high-risk pregnant women (%HR)

Figure 59
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

39

base ————————————————
s3 integration 01 (base scenario) ————————————————
s3 integration 025 ————————————————
s3 integration 05 ————————————————
s3 integration 075 ————————————————

Conclusion

Changing the percentage of integration has a substantial effect on the outcomes. Integration is advisable when the percentage of integration is more than 25%.

SA 3-2: Maximum quality of care in hospitals

Questioning

In the third scenario, the maximum QoC in H's increases from 0.8 to 1. Reason for this is that H's are now able to deliver both the care and the cure to PW (midwives are good at delivering care, whereas obstetricians are good at delivering cure). Further, it is expected that midwives and obstetricians work perfectly well together. What if this isn't the case? What if the maximum QoC is lower than 1? And what if it will be lower than the current setting?

Variations

The max QoC_H takes on the following values: 1, 0.9, 0.8, and 0.7.

Results

A change in the maximum QoC_H results in a change in the outcomes also. The lower the max QoC_H, the higher the %HR (Figure 60), and the lower the $\%HR_{MP}$ (Figure 61).

Firstly, regarding the %HR, the %HR is determined by the degree to which PW develop a HR-pregnancy. This, in turn, is determined by the delivered QoC_H and QoC_{MP}. The QoC_{MP} does not change substantially, the QoC_H does differ in the tests conducted here. Accordingly, the %HR changes: the higher the QoC_H, the lower the $LR_H \rightarrow HR_H$ and because the performance of MP's remains the same, the lower the total %HR.

Secondly, regarding the $\%HR_{MP}$, the $\%HR_{MP}$ is determined by the $TR_{MP \rightarrow H}$. This is determined by the relative number of LR_H. The more $\%LR_H \rightarrow HR_H$ decreases, the more LR_H increases. As a result the more $TR_{MP \rightarrow H}$ decreases and thus the more $HR_{MP \rightarrow H}$ decreases.

Figure 60 *total % high-risk pregnant women (%HR)*	*Figure 61* *% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)*

% HR	% HR in MP

base ———
s3 max qoc 07 ———
s3 max qoc 08 ———
s3 max qoc 09 ———
s3 max qoc 1 (base scenario) ———
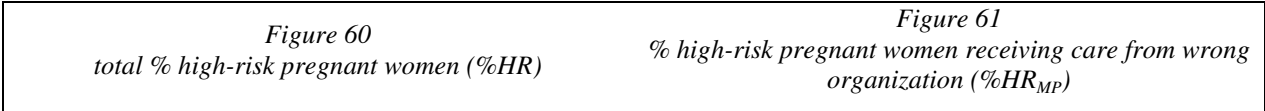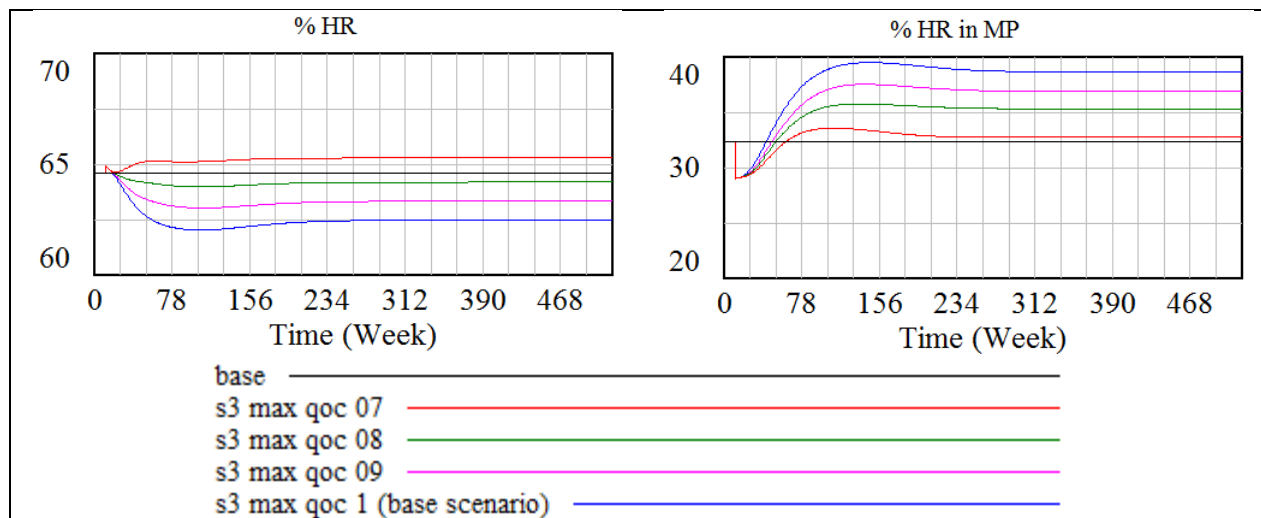
Conclusion

The QoC_H is of importance to both outcome variables: % HR and $\%HR_{MP}$.

SA 3-3: Referrals from hospitals to midwifery practices

Questioning

In the third scenario, the percentage $LR_{H \to MP}$ decreases to 0%. Reason for this is that there is no need to send LR to the MP's, for as there are midwives in the hospital who can perfectly take care of these LR. But what if these midwives are only employed to provide care to HR and to "their own" population of LR.

Variations

Let's assume that the integrated H's are willing to refer a certain percentage of the LR to the independent MP's, but that H's are also likely to still hold on to some LR. Let's assume that the regular dynamics of the systems, in terms of trust and collaboration, are still in place. Let's multiply the percentage $LR_{H \to MP}$ by 0, 0.25, 0.5, 0.75 and 1 (0 representing H's do not refer any LR to MP's, 1 representing H's will do as the dynamics of the system subscribe, thus based on trust and collaboration).

Results

The results for the two main outcome variables are given in Figure 62 and Figure 63. It appears that the degree to which H's are reluctant in referring LR to MP's when they employ midwives themselves doesn't really affect the outcome in the system as a whole. Reason for this is that in the base case they refer 5% of the LR back to MP. Making this percentage lower doesn't have as much of an impact.

Figure 62	Figure 63
total % high-risk pregnant women (%HR)	% high-risk pregnant women receiving care from wrong organization ($\%HR_{MP}$)

41

Conclusion

Changing the assumption that the percentage of $LR_{H \to MP}$ decreases to 0% does not have a substantial effect on the outcomes.

SA 3-4 Trust midwifery practices have in hospitals

Questioning

The scenario of x% integrated care is attractive from the perspective of %HR. However, there are some problems when seen from $\%HR_{MP}$, which is caused amongst others by the $TR_{MP \to H}$. What would happen if the relation between the LR_H and $TR_{MP \to H}$ would change? What if it would be more or less responsive to changes?

Variations

Three different relations between the LR_H and $TR_{MP \to H}$ are modeled: one being the base scenario (Figure 65), one being more responsive in the area of the base case value (BCV) (Figure 64) and one being less responsive in the area of the BCV (Figure 66). The BCV here is around 2.8 (x-scale of figures is defined 0-4 and the y-scale is defined on 0-1). Note that that the minimum and maximum values of the relation do not change.

Figure 64
TfE LR_H on $TR_{MP \to H}$
(more responsive)

Figure 65
TfE LR_H on $TR_{MP \to H}$
(base scenario)

Figure 66
TfE LR_H on $TR_{MP \to H}$
(less responsive)

BCV

42
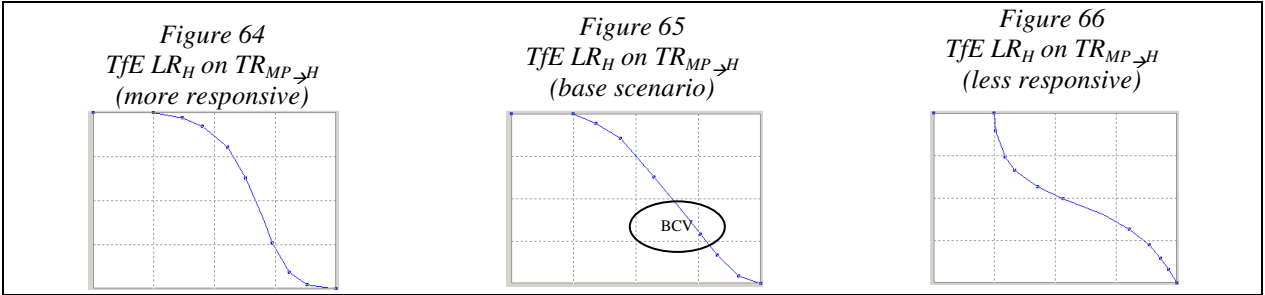
Results

The $\%HR_{MP}$ changes according to changes in the responsiveness of $TR_{MP\to H}$ to the number of LR_H: the more responsive, the higher the $\%H_{MP}$ (Figure 68). In this third scenario, the QoC_H improves due to MP's integrating with H's. As a result, and because the $LR_{H\to MP}$ decreases to 0, the LR_H increases. With a more responsive relation between LR_H and $TR_{MP\to H}$, the $TR_{MP\to H}$ decreases more, and the less the $HR_{MP\to H}$ and thus the higher the $\%HR_{MP}$.

However, making this ratio more or less responsive doesn't really affect the $\%HR$; the $\%HR$ in the system is for all three degrees of responsiveness about the same (Figure 67). The $\%HR$ is mainly determined by the QoC_H and the QoC_{MP}. For all these sub-scenarios the max QoC_H increases to 1 and the max QoC_{MP} remains the same and because the effects of TR, CO and WP on the QoC (resulting in the delivered QoC) are about the same in the three sub-scenarios, the $\%HR$ will remain about the same.

Figure 67
total % high-risk pregnant women (%HR)

Figure 68
% high-risk pregnant women receiving care from wrong organization (%HR_MP)

Conclusion

The responsiveness of $TR_{MP\to H}$ to LR_H is of importance to one of the outcome variables: $\%HR_{MP}$.

SA 3-5: Percentage low-risk pregnant women to high-risk pregnant women in hospital

Questioning

In the third scenario, the max QoC_H is increased from 0.8 to 1 (out of 1). QoC_H has a direct effect on the percentage pregnant women that develop a high-risk pregnancy in H's. What if the percentage LR_H to HR_H is more responsive to changes in the QoC_H?
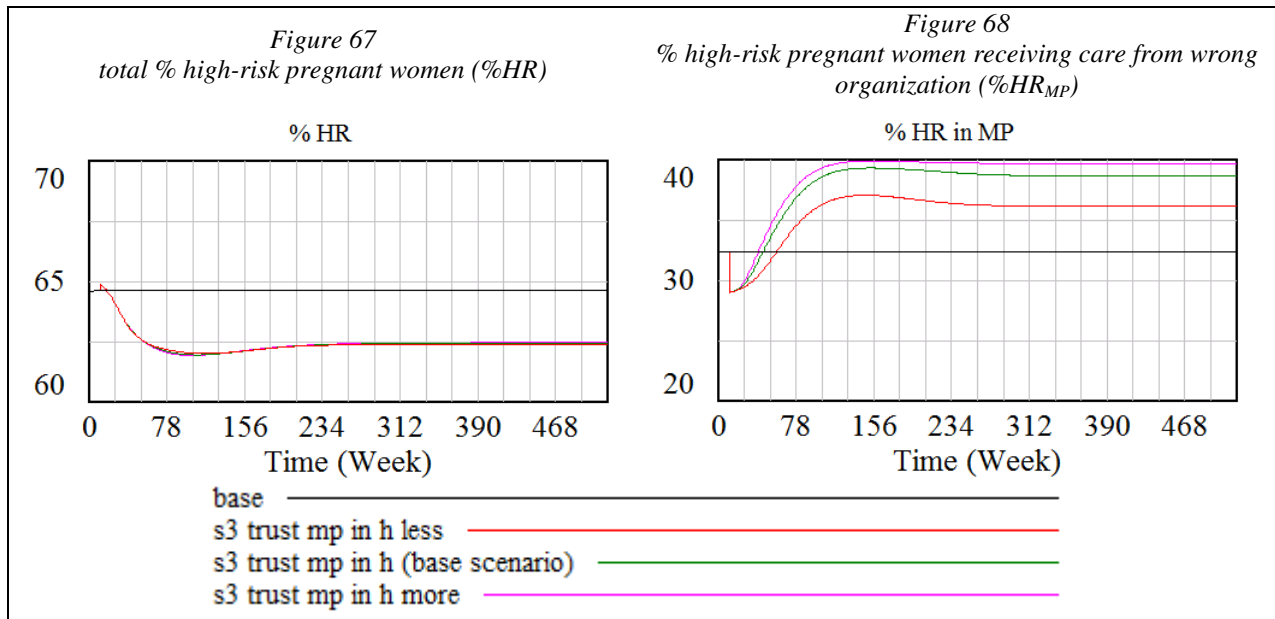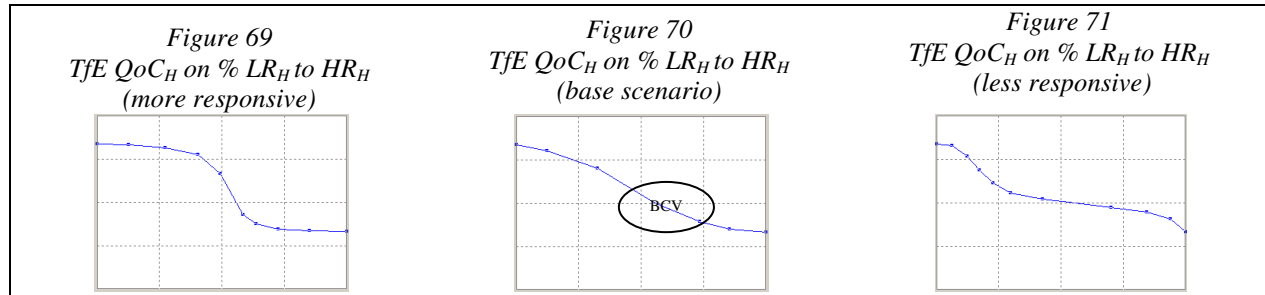
Variations

Three different relations between the percentage LR_H and HR_H are modeled: one being the base scenario (Figure 70), one being more responsive in the area of the base case value (BCV) (Figure 69) and one being less responsive in the area of the BCV (Figure 71). The BCV here is around 0.55 (x-scale of figures is defined 0-1 and the y-scale is defined on 0-3). Note that that the minimum and maximum values of the relation do not change.

Figure 69
TfE QoC$_H$ on % LR$_H$ to HR$_H$
(more responsive)

Figure 70
TfE QoC$_H$ on % LR$_H$ to HR$_H$
(base scenario)

Figure 71
TfE QoC$_H$ on % LR$_H$ to HR$_H$
(less responsive)

Results

Making the percentage LR_H to HR_H more/less responsive to changes in the QoC_H results in a lower/higher %HR (Figure 72) and in a higher/lower %HR$_{MP}$ (Figure 73).

Firstly, regarding the %HR, the %HR determined by the degree to which PW develop a high-risk pregnancy, which is directly determined by the QoC_H and QoC_{MP}. Changing the responsiveness of the degree to which LR in H's develop into HR to changes in QoC_H results therefore directly into a larger or smaller effect (for as the QoC_{MP} remains the same in this scenario).

Secondly, regarding the %HR$_{MP}$, the %HR$_{MP}$ is determined by $TR_{MP\rightarrow H}$, which is determined by the relative number of LR_H. A change in responsiveness of %HR$_H$ to QoC_H (as described above) has also an effect on the percentage LR_H, and thus on $TR_{MP\rightarrow H}$.

Figure 72
total % high-risk pregnant women (%HR)

Figure 73
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

44

Conclusion

The responsiveness of the percentage $LR_H \rightarrow HR_H$ to QoC_H is of importance to both outcome variables: %HR and %HR$_{MP}$.

SA in summary: scenario 3

The results of the tests are given below. The first three concern assumptions of the scenario, the others assumptions made in the model.

1. Changing the percentage of integration has an effect on both outcomes. The higher the percentage of integration, the lower %HR and the lower the %HR$_{MP}$. Regarding the latter, integration of more than 25% is beneficial. See 3-1.
2. Changing the assumption that max QoC_H will increase to 1 does change the outcomes. The lower the QoC_H, the higher %HR and the lower %HR$_{MP}$. See SA 3-2.
3. Changing the assumption that the percentage of $LR_{H \rightarrow MP}$ decreases to 0% does not have a substantial effect on the outcomes. See SA 3-3.
4. Changing the responsiveness of $TR_{MP \rightarrow H}$ to changes in LR_H has an effect on one outcome variable. The more responsive the relation, the larger the effect on the %HR$_{MP}$. See SA 3-4.
5. Changing the responsiveness of $\%LR_H \rightarrow HR_H$ to changes in QoC_H has an effect on both outcome variables. The more responsive the relation, the larger the effect on $\%LR_H \rightarrow HR_H$, and the larger the effect on %HR$_{MP}$. See SA 3-5.

SA 4-1: Maximum quality of care hospitals

Questioning

In the fourth scenario, just as in the first scenario, the maximum QoC in H's increases from 0.8 to 1. Reason for this is that H's are now able to deliver both the care and the cure to PW (midwives are good at delivering care, whereas obstetricians are good at delivering cure). Further, it is expected that midwives and obstetricians work perfectly well together. What if this isn't the case? What if the maximum QoC is lower than 1? And what if it will be lower than the current setting?

Variations

The max QoC_H takes on the following values: 1, 0.9, 0.8, and 0.7.

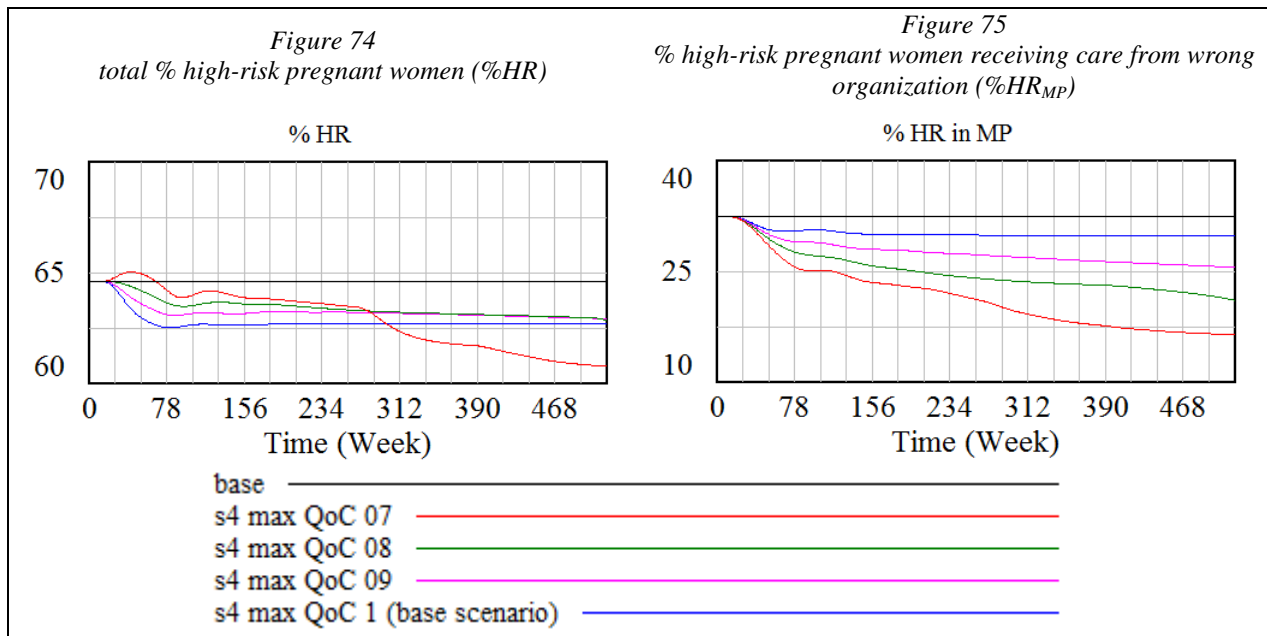*Results*

Firstly, regarding the %HR (Figure 74), the %HR is determined by the degree to which PW develop a HR-pregnancy. This, in turn, is determined by the delivered QoC_H and QoC_{MP}. A few comments here. Lowering the QoC_H exogenously in this test, results in a higher %HR (compared to the base scenario). Note that even a QoC_H lower than in the base case (QoC_H=0.8) results in a

better performance in terms of %HR. This is due to the fact that CO is also improved in this scenario. Increasing CO increases both QoC_H and QoC_{MP}. In addition, increasing CO has a reinforcing effect on the reinforcing trust loop (R1): increasing the referral percentages results in higher trust levels and thus in higher referral percentages. And the increase in trust has a positive effect on the QoC levels. And so increasing CO reduces the %HR compared to the base case.

Interestingly, the test with a QoC_H of 0.7 results in very dynamic graph. Having a QoC_H lower than the base case (<0.8) results in a higher $\%LR_H \rightarrow HR_H$ and thus in less LR_H. This, together with the increase in CO, boosts $TR_{MP \rightarrow H}$. As a result, the threshold for when organizations outsource consultations is met earlier, which boosts the QoC and thus reduces the %HR, as can be seen in Figure 74 (red line).

Secondly, regarding the $\%HR_{MP}$ (Figure 75), the lower the QoC_H, the lower the $\%HR_{MP}$. The $\%HR_{MP}$ is determined by $TR_{MP \rightarrow H}$. This is determined by the LR_H. In this test LR_H is decreased because of two effects: firstly, the increase in CO results in more $LR_{H \rightarrow MP}$, and secondly, QoC_H is varied and decreasing it, compared to the base scenario, results in more $LR_H \rightarrow HR_H$. Note the difference here with scenario 1, the improved hospital model, where $\%HR_{MP}$ increases compared to the base case. Here, due to the improvement of CO, $\%HR_{MP}$ only decreases.

Figure 74
total % high-risk pregnant women (%HR)

Figure 75
% high-risk pregnant women receiving care from wrong organization (%HR_MP)

Conclusion
The QoC_H is of importance to both outcome variables: % HR and $\%HR_{MP}$.

SA 4-2: Intended level of collaboration

Questioning

The level of collaboration in the base case is 0.4 (out of 1). In the fourth scenario, the intended level of collaboration is increased to 0.8. What would happen if the intended level of collaboration is set lower than 0.8, or even higher?

Variation

The intended level of collaboration after the start of the improvement project is set at the following values: 1, 0.9, 0.8, 0.7, 0.6, and 0.5.
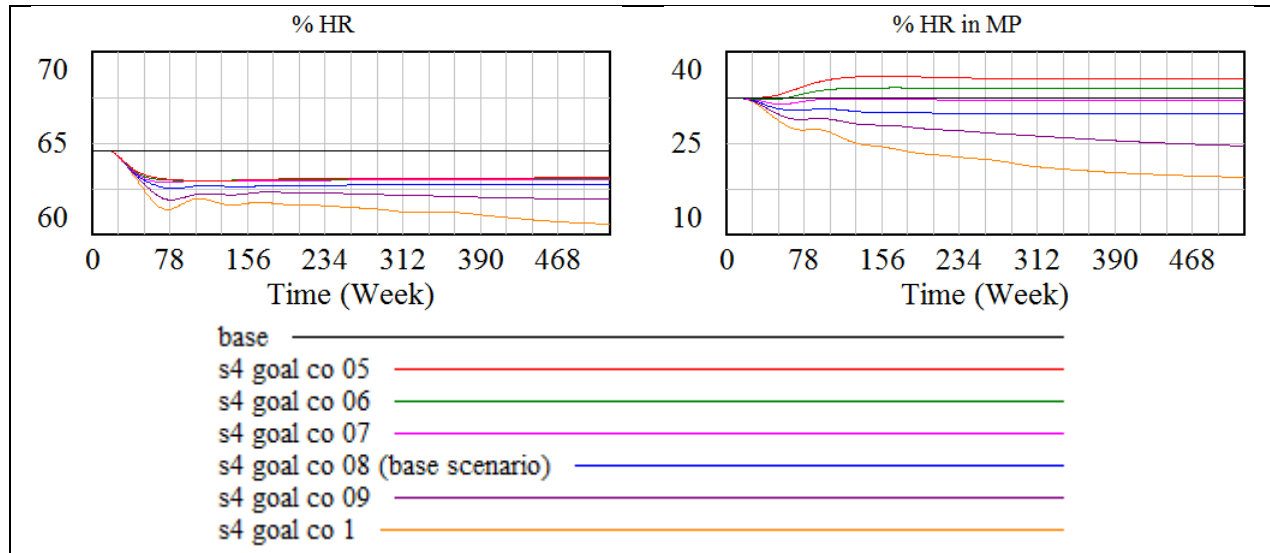
Results

Changing the intended level of CO compared to the base scenario results in changes in the outcomes: the %HR is lower/higher as the intended level of CO is higher/lower compared to the base scenario (Figure 76) and the %HR$_{MP}$ is higher/lower when the intended level of CO is lower/higher compared to the base scenario (Figure 77).

Firstly, regarding %HR, CO has a positive effect on the QoC and this has a negative effect on the percentage of LR→HR. Thus the less increase in CO, the less decrease in this percentage. When comparing the results to SA 2-1, where the same test is conducted in the collaborative model, the decrease in %HR is higher here in the combined scenario. This is due to the fact that the QoC$_H$ is increased because of the improved hospital model that is applied here also.

Secondly, regarding the %HR$_{MP}$, the less increase in CO, the higher the %HR$_{MP}$, compared to the base scenario. Increasing the level of CO makes firstly that more PW are referred between H's and MP's and secondly that the QoC increases, which results in less HR. As a result, a higher CO than 0.4 improves outcomes, one would think. However, it appears that an increase in the intended level of CO to 0.5 or 0.6 in this scenario results in a higher %HR$_{MP}$ compared to the base case. Note that this is not the case in scenario 2, the collaborative model. What happens here is the following. An increase in CO (compared to the base case) results in an increase in QoC and thus in less HR$_H$. In addition, it results in an increase in LR$_{H\rightarrow MP}$. However, the increase in LR$_{H\rightarrow MP}$ is less than the decrease of LR$_H$→HR$_H$, which results in a net increase of LR$_H$. As a result, TR$_{MP\rightarrow H}$ decreases and thus HR$_{MP\rightarrow H}$ decreases. The increase in HR$_{MP}$ due to changes in trust is greater than the decrease in HR$_{MP}$ due to increased QoC$_{MP}$ (due to increased CO). And thus, the %HR$_{MP}$ rises.

Figure 76 *total % high-risk pregnant women (%HR)*	*Figure 77* *% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)*

% HR	% HR in MP

base
s4 goal co 05
s4 goal co 06
s4 goal co 07
s4 goal co 08 (base scenario)
s4 goal co 09
s4 goal co 1

Conclusion

The intended level of CO is of importance to both outcome variables: %HR and %HR$_{MP}$. In fact, when the intended level of CO is below 0.7, the results regarding %HR$_{MP}$ worsens.

SA 4-3: Voluntariness of collaboration

Questioning

In the fourth scenario, the improved hospital model combined with the collaborative model, CO changes. The effect of CO on the system depends among others on the degree of voluntariness. The current degree of voluntariness is set at 0.8 (out of 1). What if the CO is less voluntary and stricter?

Variation

The degree of voluntariness takes on the following values: 0.9, 0.8, 0.7, 0.5 and 0.25. Note that the value 1 is not included in this list for as setting the voluntariness at 1 implies that CO does not have an effect; all behavior is based on TR only. Also note that the value 0 is not included in this list for as setting the voluntariness at 0 implies that TR does not have an effect; all behavior is based on CO only. In addition, a voluntariness of 0 basically equals being tied together so closely that one kind of did integrate into 1.

Results

Changing the degree of voluntariness has an effect on the %HR (Figure 78) and on the %HR$_{MP}$ (Figure 79): the lower the voluntariness of the CO, the lower the %HR and the lower the %HR$_{MP}$.

To gain insight into this, one has to understand the relation between the reinforcing trust loop (R1) and the effect CO has on it. R1 states that the higher the TR, the more referrals between organizations, the more PW are being cared for by the right organization, and thus the

higher the TR. CO is an external stimulus on this loop: increasing CO forces more referrals between H's and MP's. The degree to which CO has this effect depends on the voluntariness of the CO: the lower the voluntariness, the more effect. However, just as in SA 4-2, due to the improved hospital model $LR_H \rightarrow HR_H$ decreases, which results in a decrease in $TR_{MP \rightarrow H}$ and thus the decrease in $\%HR_{MP}$ is less than in scenario 2, the collaborative model, and the test with a voluntariness of 0.9 results in a worse outcome than the base case. <explain>
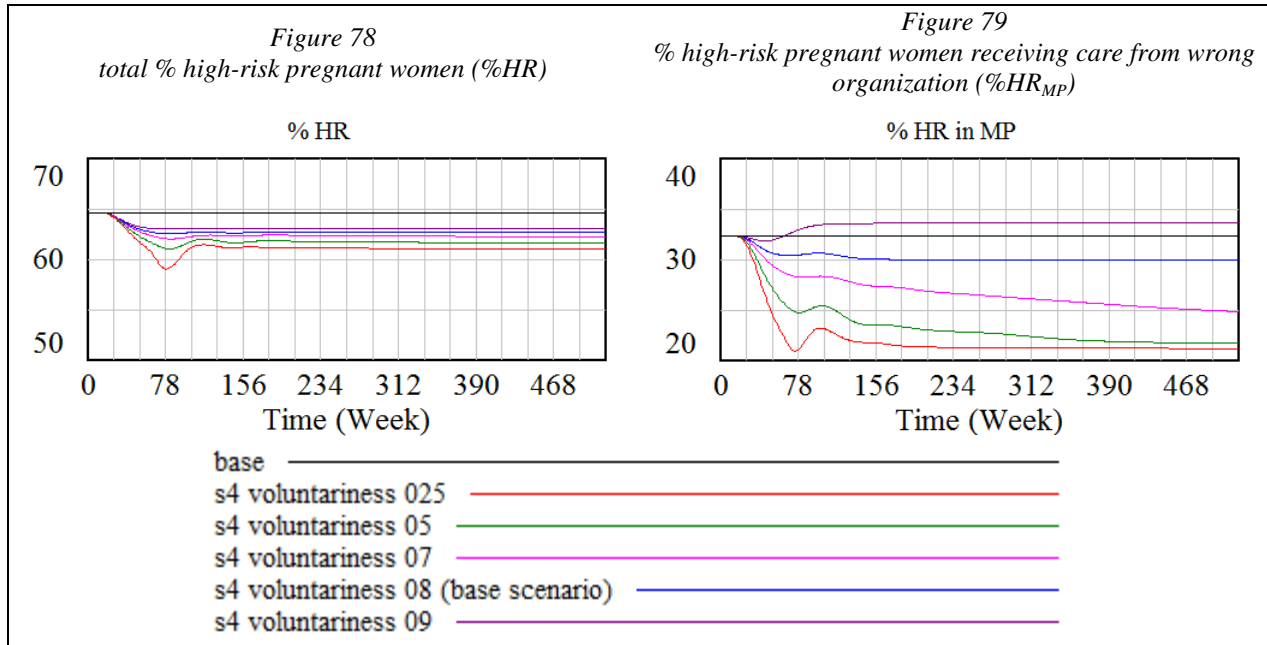
Figure 78
total % high-risk pregnant women (%HR)

Figure 79
% high-risk pregnant women receiving care from wrong organization (%HR_MP)

base
s4 voluntariness 025
s4 voluntariness 05
s4 voluntariness 07
s4 voluntariness 08 (base scenario)
s4 voluntariness 09

Conclusion

The voluntariness of CO is of importance to both outcome variables: $\%HR$ and $\%HR_{MP}$. In fact, a level of voluntariness of 0.9 worsens the $\%HR_{MP}$ when compared to the base case.

SA 4-4: Referrals from midwifery practices to hospitals

Questioning

The first effect of CO is on the referral rates between H's and MP's. One can question the chosen relation between CO and the $\%HR_{MP \rightarrow H}$. What would happen when this rate would be more or less responsive to changes in CO?

Variation

Three different relations between CO and $\%HR_{MP \rightarrow H}$ are modeled: one being the base scenario (Figure 81), one being less responsive in the area of the BCV (Figure 80) and one being more responsive in the area of the BCV (Figure 82). The BCV is on 0.4 (x-scale of figures is defined 0-1 and the y-scale is defined on 0-1). Note that that the minimum and maximum values of the relation do not change.
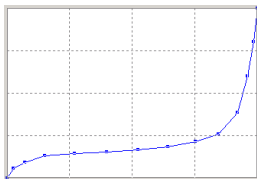
Figure 80
TfE CO on %HR$_{MP \to H}$
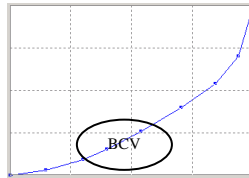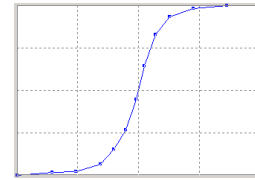*(less responsive)*

Figure 81
TfE CO on %HR$_{MP \to H}$
(base scenario)

Figure 82
TfE CO on %HR$_{MP \to H}$
(more responsive)

BCV

Results

The two main outcome variables do change when the responsiveness of %HR$_{MP \to H}$ to changes in CO varies (Figure 83 and Figure 84). One would expect that making the relation more/less responsive would increase/decrease system's performance. CO is an exogenous variable which is increased in this scenario. The reinforcing loop R1 is one of the main loops in the model, and making this loop directly more responsive to changes in the CO is expected to have a real impact on the outcomes (see also SA 2-4). However, this combined scenario results in something different. The two outcome variables are determined by the distribution of the PW over the four different stocks (LR$_{MP}$, LR$_H$, HR$_{MP}$, HR$_H$). This distribution is determined by the referral percentages and by the QoC.

Regarding the first outcome variable, the %HR, there only is an effect when %HR$_{MP \to H}$ is more responsive to changes in CO. In the case that it is less responsive, there is no substantial difference in outcome. Both CO and TR have an effect on %HR$_{MP \to H}$, and in case of a less responsive relation, CO still causes the %HR$_{MP \to H}$ to increase, however, due to a decrease in TR$_{MP \to H}$, %HR$_{MP \to H}$ decreases slightly, resulting in about the same referral percentages as in the base scenario. So how come that TR$_{MP \to H}$ decreases when %HR$_{MP \to H}$ is less responsive to CO? An increase in CO, as is the case in this scenario, results in an increase in QoC and thus in a decrease of LR→HR, both in H's and in MP's. As a result, the LR$_H$ increases. This decreases TR$_{MP \to H}$ and thus increases HR$_{MP}$ and thus decreases TR$_{H \to MP}$. The fact that QoC is increased in this scenario results in less %HR, but due to the dynamics as presented here, the base scenario and the less responsive scenario do not differ regarding the %HR.

Regarding the second outcome variable, the %HR$_{MP}$, when the relation is more responsive, the %HR$_{MP}$ decreases further. However, when the relation is made less responsive, the %HR$_{MP}$ increases even compared to the base case. This is due to the dynamics as described above where the TR$_{MP \to H}$ decreases, which increases HR$_{MP}$.

Note that the sudden decrease in the outcome variables (after t=156) in the more responsive scenario is due to the fact that TR increases to a level where consultations will be outsourced, which results in an increase in the max QoC$_{MP}$ (the max QoC$_H$ was already set at 1 due to the improved hospital model).

Figure 83
total % high-risk pregnant women (%HR)

Figure 84
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)
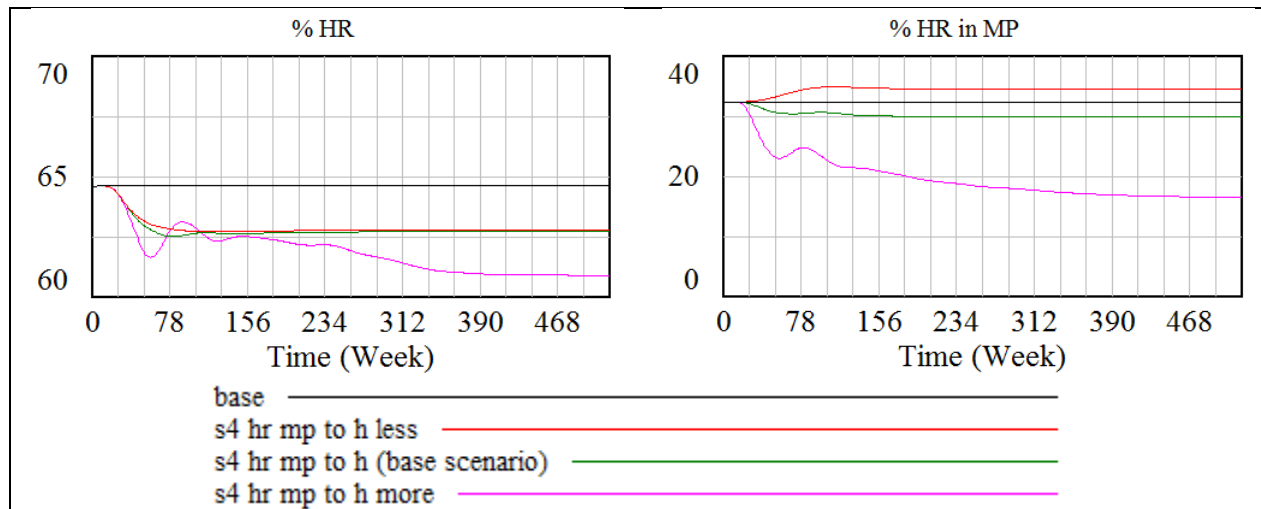
% HR | % HR in MP

base
s4 hr mp to h less
s4 hr mp to h (base scenario)
s4 hr mp to h more

Conclusion

The responsiveness $\%HR_{MP \to H}$ to changes in CO has an effect on both outcome variables: $\%HR$ and $\%HR_{MP}$.

SA 4-5: Referrals from hospitals to midwifery practices

Questioning

The first effect of CO is on the referral rates between H's and MP's. One can question the chosen relation between CO and $LR_{H \to MP}$. What would happen when this rate would be more or less responsive to changes in CO?

Variation

Three different relations between CO and $LR_{H \to MP}$ are modeled: one being the base scenario (Figure 86), one being less responsive in the area of the BCV (Figure 85) and one being more responsive in the area of the BCV (Figure 87). The BCV is on 0.4 (x-scale of figures is defined 0-1 and the y-scale is defined on 0-1). Note that that the minimum and maximum values of the relation do not change.

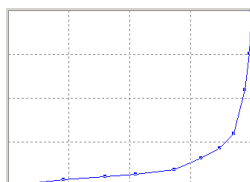
Figure 85
TfE CO on $LR_{H \to MP}$
(less responsive)

Figure 86
TfE CO on $LR_{H \to MP}$
(base scenario)

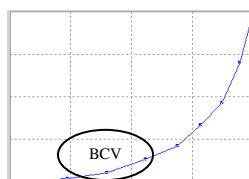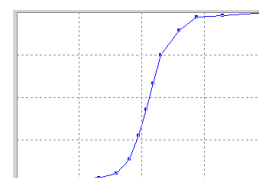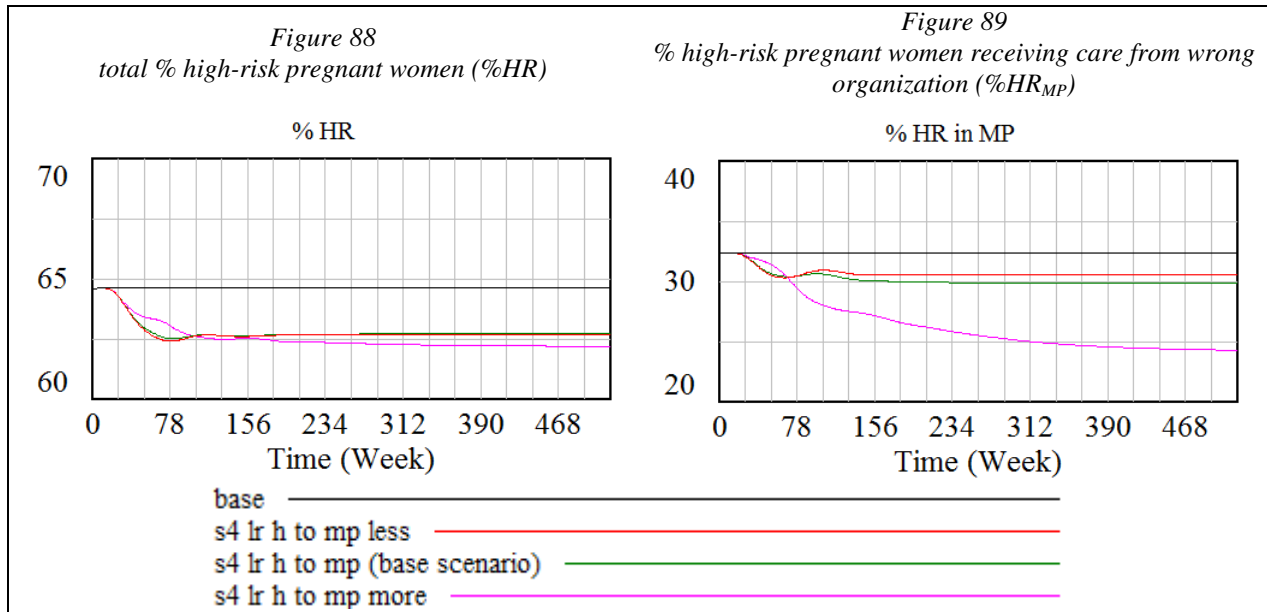*Figure 87*
TfE CO on $LR_{H \to MP}$
(more responsive)

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Results

Firstly, changing the responsiveness of $LR_{H \to MP}$ to changes in CO does not result in different outcomes regarding the %HR (Figure 88). Changing the response of $LR_{H \to MP}$ to changes in CO has an effect on the reinforcing trust-loop (R1). However, the impact on changing QoC, which determines %HR, is minimal when changing the responsiveness.

Secondly, changing the responsiveness of $LR_{H \to MP}$ to changes in CO does result in different outcomes regarding the $\%HR_{MP}$, although this only holds for when the relation is set more responsive. The more $LR_{H \to MP}$, the lower the LR_H and the higher $TR_{MP \to H}$, which results in more $HR_{MP \to H}$. The fact that the outcomes differ more when having a more responsive relation instead of a less responsive relation is caused by the graphs of the relation itself. Comparing Figure 85, Figure 86 and Figure 87, when the intended level of CO rises from 0.5 to 0.8 (with the actual CO rising from 0.4 to 0.75), one can see that the difference between the "less responsive"-graph and the "base scenario"-graph is less than the difference between the "more responsive"-graph and the "base scenario"-graph.

Figure 88
total % high-risk pregnant women (%HR)

Figure 89
% high-risk pregnant women receiving care from wrong organization ($\%HR_{MP}$)

Conclusion

The responsiveness of the referral percentages between organizations to CO has only an effect on one of the outcome variables: $\%HR_{MP}$.
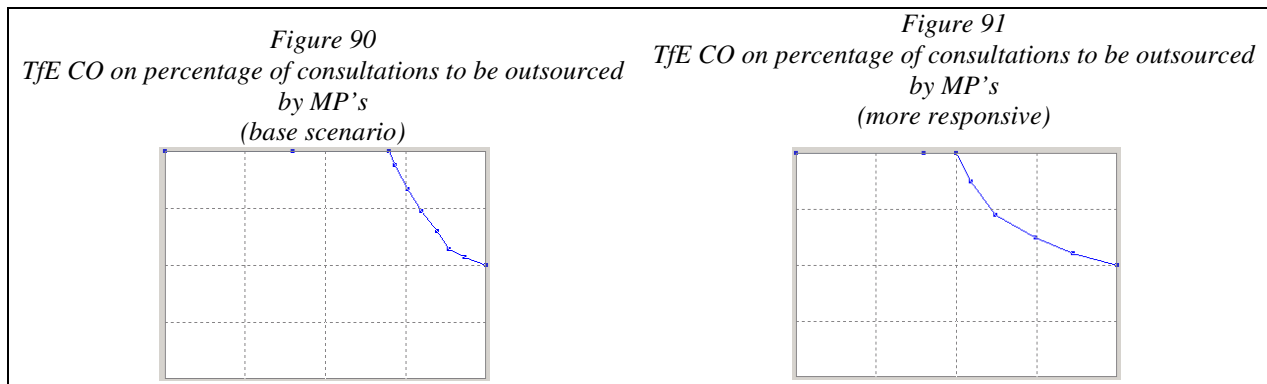
SA 4-6: Outsourcing consultations in midwifery practices

Questioning

The third effect of CO is on the degree to which organizations outsource consultations. What would happen when the number of consultations that will be outsourced by MP's is set more responsive to changes in CO?

Variation

CO has an effect on the percentage of consultations that MP's will outsource. Figure 90 presents the base scenario for the table which determines the effect of CO on the percentage of consultations that has to be outsourced for both MP's and H's. Figure 91 shows the more responsive relation. The BCV is on 0.4 (x-scale of figures is defined 0-1 and the y-scale is defined on 0-100). Note that in the base scenario, CO has to be 0.7 before any effect occurs. In the analysis, this is changed to 0.5.

Figure 90
TfE CO on percentage of consultations to be outsourced by MP's
(base scenario)

Figure 91
TfE CO on percentage of consultations to be outsourced by MP's
(more responsive)

Results

The increased responsiveness of the percentage of consultations outsourced by MP to CO results in a slightly lower %HR (Figure 92), and it hardly has any effect on the $\%HR_{MP}$ (Figure 93). Firstly, regarding the %HR, the outsourcing of consultations by MP has an effect on the QoC_{MP}. A higher QoC_{MP} results in less $LR_{MP} \rightarrow HR_{MP}$, which is expressed in the total %HR.

Secondly, regarding the $\%HR_{MP}$, the $\%HR_{MP}$ is determined by the LR_H. Having MP outsource more consultations does increase QoC_{MP}, but it does not have any effect on the LR_H, and thus it has no effect on the $\%HR_{MP}$.

Figure 92
total % high-risk pregnant women (%HR)

Figure 93
% high-risk pregnant women receiving care from wrong organization ($\%HR_{MP}$)

base
s4 outsource co mp (base scenario)
s4 outsource co mp more

Conclusion

Changing the responsiveness of outsourcing consultations by MP to CO does have a very small effect on one of the outcome variables (%HR), but has no substantial effect on the other outcome variable (%HR$_{MP}$).

SA 4-7: Outsourcing consultations in hospitals

Questioning

The third effect of CO is on the degree to which organizations outsource consultations. What would happen when the number of consultations that will be 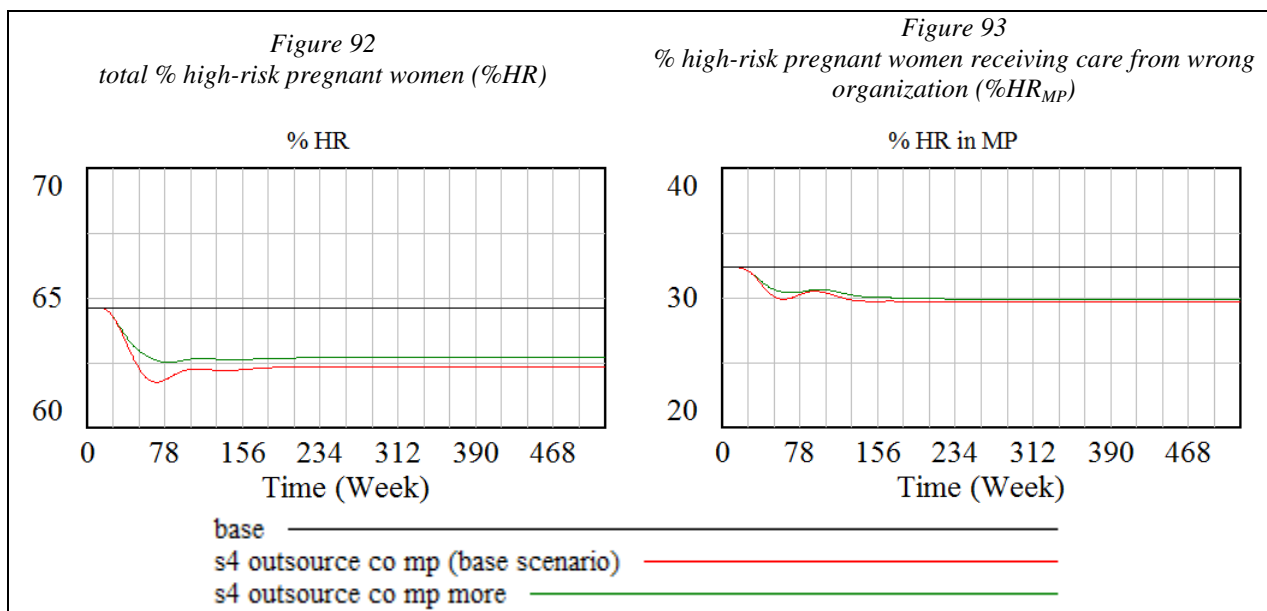outsourced by H's is set more responsive to changes in CO? Note that in this fourth scenario, the improved hospital model combined with the collaborative model, H's will not outsource consultations because they have employed midwives to meet the care needs of PW.

SA 4-8: Percentage low-risk pregnant women to high-risk pregnant women in hospital

Questioning

In the fourth scenario, the max QoC$_H$ is increased from 0.8 to 1 (out of 1). QoC$_H$ has a direct effect on the percentage pregnant women that develop a high-risk pregnancy in H's. What if the percentage LR$_H$ to HR$_H$ is more responsive to changes in the QoC$_H$?

Variation

Three different relations between the percentage LR$_H$ and HR$_H$ are modeled: one being the base scenario (Figure 95), one being more responsive in the area of the base case value (BCV) (Figure 94) and one being less responsive in the area of the BCV (Figure 96). The BCV here is around 0.55 (x-scale of figures is defined 0-1 and the y-scale is defined on 0-3). Note that that the minimum and maximum values of the relation do not change.

Figure 94
TfE QoC$_H$ on % LR$_H$ to HR$_H$
(more responsive)

Figure 95
TfE QoC$_H$ on % LR$_H$ to HR$_H$
(base scenario)

Figure 96
TfE QoC$_H$ on % LR$_H$ to HR$_H$
(less responsive)

Results

Making the percentage LR$_H$ to HR$_H$ more/less responsive to changes in the QoC$_H$ results in a lower/higher %HR (Figure 97) and in a higher/lower %HR$_{MP}$ (Figure 98).

Firstly, regarding the %HR, the %HR is determined by the degree to which PW develop a high-risk pregnancy, which is directly determined by the QoC$_H$ and QoC$_{MP}$. Changing the

54

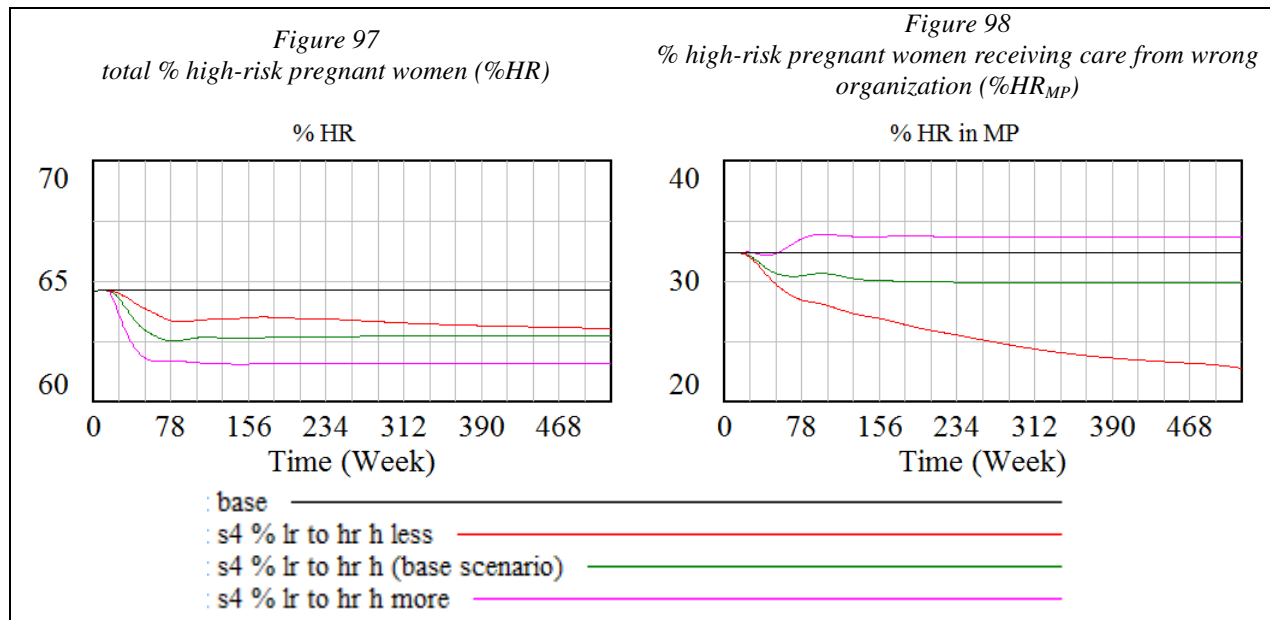responsiveness of the degree to which LR_H develop into HR_H to changes in QoC_H results therefore directly into a larger or smaller effect.

Secondly, regarding the $\%HR_{MP}$, the $\%HR_{MP}$ is determined by $TR_{MP \to H}$, which is determined by the relative number of LR_H. A change in responsiveness of the percentage of PW in H's that develop a high-risk to QoC_H (as described above) has thus also an effect on the percentage LR_H, and thus on $TR_{MP \to H}$. Note that, compared to SA 1-4 and SA 3-5, in this scenario the $\%HR_{MP}$ decreases compared to the base case. Reason for this is that the negative effect of having more LR_H on $TR_{MP \to H}$ (due to the increased QoC_H) is compensated by an improvement in QoC_{MP} due to increased CO. However, which effect dominates depends here on the relation between QoC_H and $LR_H \to HR_H$.

In addition, the fast decrease in $\%HR_{MP}$ when there is a less responsive relation is explained by the effect on the reinforcing trust-loop (R1). A less responsive relation results in a higher $TR_{MP \to H}$ and thus in a faster developing R1. As a result, MP's will outsource consultations, which results in an increased QoC_{MP} and thus in less HR_{MP}.

Figure 97
total % high-risk pregnant women (%HR)

Figure 98
% high-risk pregnant women receiving care from wrong organization (%HR_MP)

Conclusion
The responsiveness of the percentage $LR_H \to HR_H$ to QoC_H is of importance to both outcome variables: $\%HR$ and $\%HR_{MP}$.
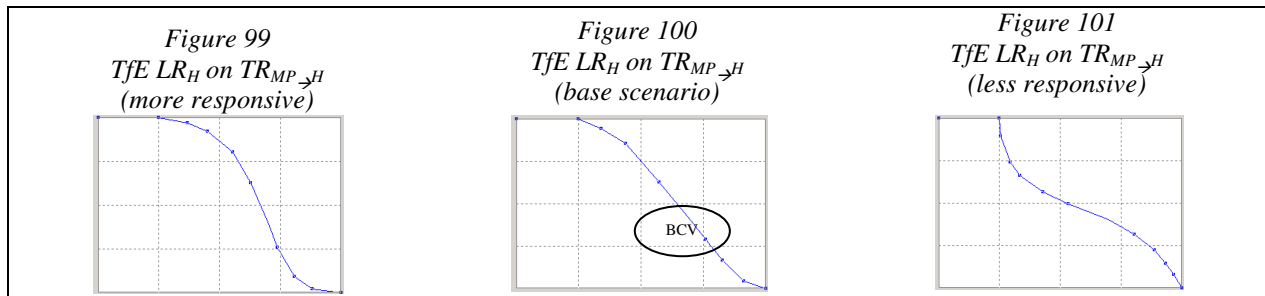
SA 4-9: Trust midwifery practices have in hospitals

Questioning
The fourth scenario, that of combining the improved hospital model with the collaborative model, is attractive. However, in the sensitivity analysis for this scenario, the relation between $TR_{MP \to H}$ and LR_H seems often to be an important variable in the explanation on the behavior that

the sensitivity analysis show. But what would happen if the relation between the LR_H and $TR_{MP \to H}$ would change? What if it would be more or less responsive to changes?

Variation

Three different relations between the LR_H and $TR_{MP \to H}$ are modeled: one being the base scenario (Figure 100), one being more responsive in the area of the base case value (BCV) (Figure 99) and one being less responsive in the area of the BCV (Figure 101). The BCV here is around 2.8 (x-scale of figures is defined 0-4 and the y-scale is defined on 0-1). Note that that the minimum and maximum values of the relation do not change.

Figure 99
TfE LR_H on $TR_{MP \to H}$
(more responsive)

Figure 100
TfE LR_H on $TR_{MP \to H}$
(base scenario)

Figure 101
TfE LR_H on $TR_{MP \to H}$
(less responsive)

BCV

Results

The $\%HR_{MP}$ changes according to changes in the responsiveness of $TR_{MP \to H}$ to the number of LR_H: the more responsive, the higher the $\%H_{MP}$ (Figure 103). In this fourth scenario, the QoC_H improves and as a result, the LR_H increases. With a more responsive relation between LR_H and $TR_{MP \to H}$, the $TR_{MP \to H}$ decreases more, and the less the $HR_{MP \to H}$ and thus the higher the $\%HR_{MP}$. However, when making the relation less responsive, there is hardly any effect on $\%HR_{MP}$ compared to the base scenario. <explain>

Regarding the %HR, making this ratio more or less responsive doesn't really has an effect (Figure 102). The %HR is mainly determined by the QoC_H and the QoC_{MP}. For all these sub-scenarios the max QoC_H increases to 1 and the QoC_{MP} increases equally due to improved collaboration. In addition, the effects of TR, CO and WP on the QoC (resulting in the delivered QoC) are about the same in the three sub-scenarios, and thus the %HR will remain about the same.

Figure 102
total % high-risk pregnant women (%HR)

Figure 103
% high-risk pregnant women receiving care from wrong organization (%HR_{MP})

56

Conclusion

The responsiveness of $TR_{MP \to H}$ to LR_H is of hardly any importance to the outcome variables.

SA 4-10: Percentage low-risk pregnant women to high-risk pregnant women in midwifery practices

Questioning

In the previous scenarios where the relation between QoC_H and $LR_H \to HR_H$ is tested (scenario 1 and scenario 3), the relation between QoC_{MP} and $LR_{MP} \to HR_{MP}$ is not tested because the QoC_{MP} in those scenarios has been rather constant. However, in this fourth scenario, QoC_{MP} is improved because CO is increased. Therefore, if this relation within the H's is tested, the relation within MP's should be tested also.

Variation

Three different relations between the percentage LR_{MP} and HR_{MP} are modeled: one being the base scenario (Figure 105), one being more responsive in the area of the base case value (BCV) (Figure 104) and one being less responsive in the area of the BCV (Figure 106). The BCV here is around 0.50 (x-scale of figures is defined 0-1 and the y-scale is defined on 1-2.5). Note that that the minimum and maximum values of the relation do not change.
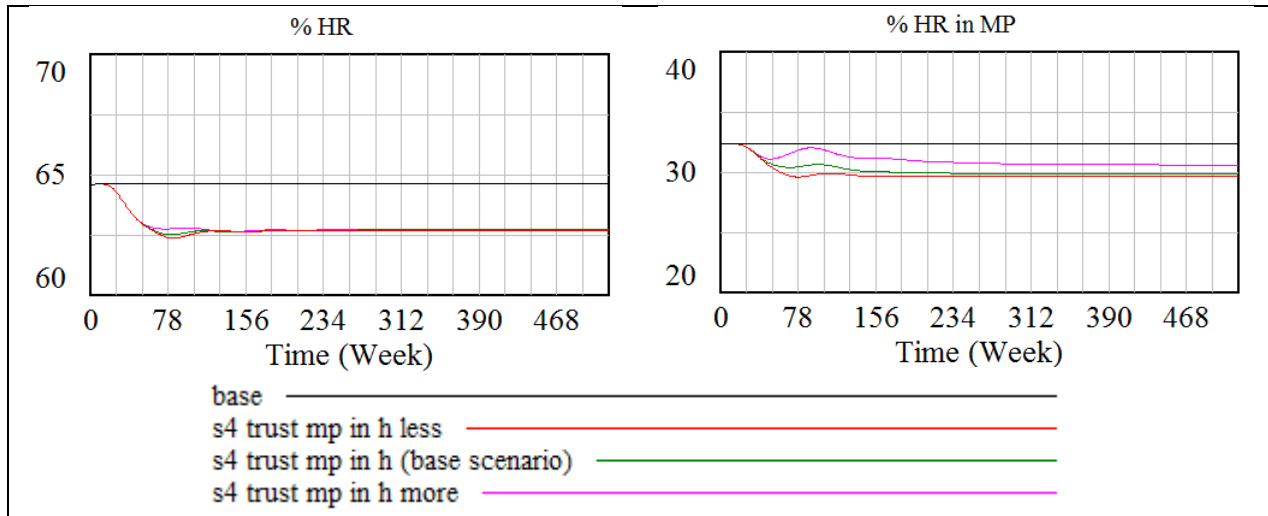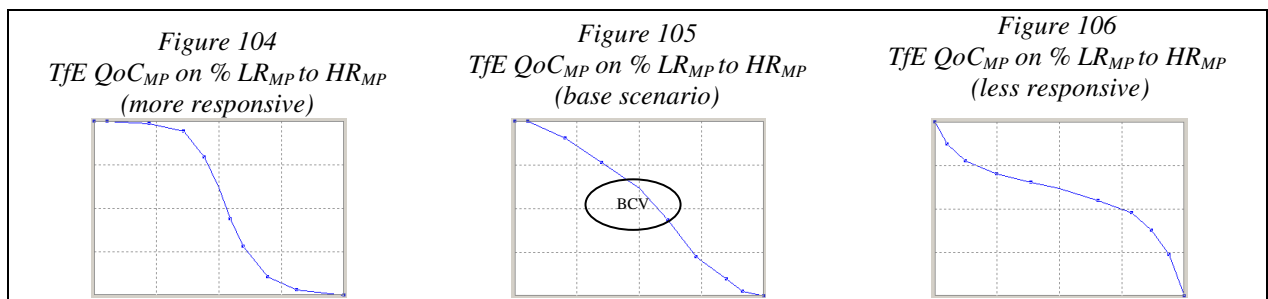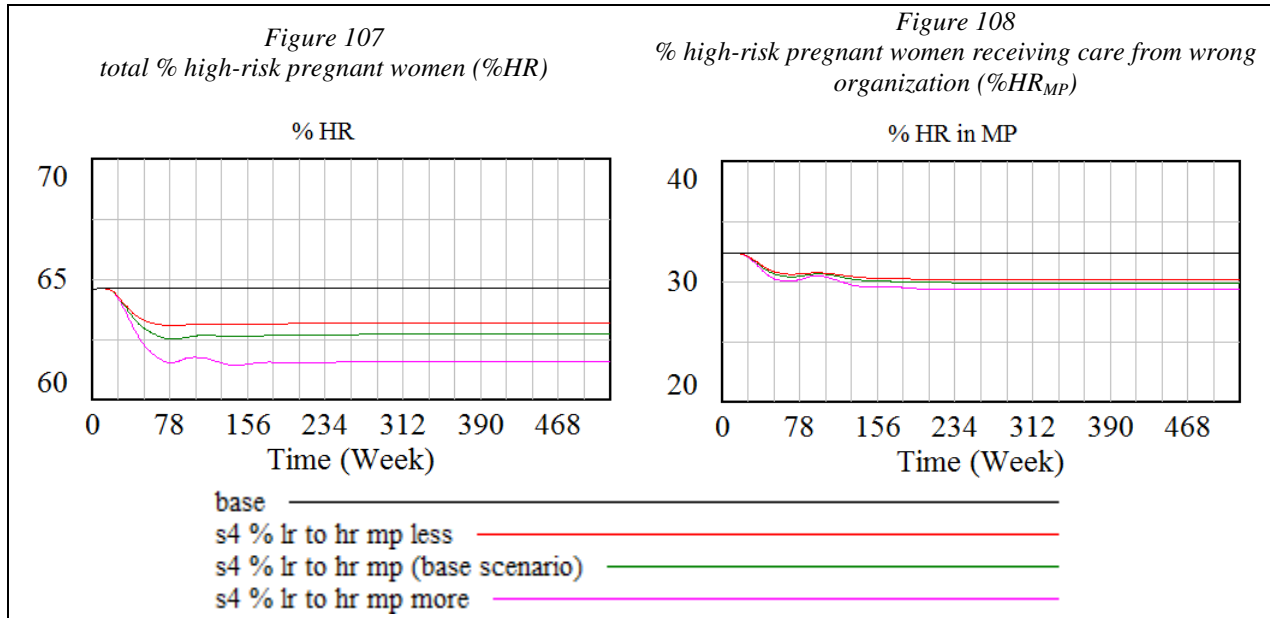

Figure 104
TfE QoC_{MP} on % LR_{MP} to HR_{MP}
(more responsive)

Figure 105
TfE QoC_{MP} on % LR_{MP} to HR_{MP}
(base scenario)

Figure 106
TfE QoC_{MP} on % LR_{MP} to HR_{MP}
(less responsive)

57

Results

Figure 107
total % high-risk pregnant women (%HR)

Figure 108
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

Conclusion

The responsiveness of the percentage $LR_{MP} \rightarrow HR_{MP}$ to QoC_{MP} is of importance to one outcome variable (%HR) and it has hardly any effect on the other outcome variable (%HR$_{MP}$).

SA 4-11: Trust hospitals have in midwifery practices

Questioning

Improving QoC_H and improving CO in this scenario has an effect on the reinforcing trust-loop. The responsiveness of $TR_{MP \rightarrow H}$ to changes in LR_H is tested (SA 4-9). So let's tests the sister-relation too: the responsiveness of $TR_{H \rightarrow MP}$ to HR_{MP}.

Variations

Three different relations between HR_{MP} and $TR_{H \rightarrow MP}$ are modeled: one being the base scenario (Figure 110), one being more responsive in the area of the BCV (Figure 109) and one being less responsive in the area of the BCV (Figure 111). The BCV here is around 2.0 (x-scale of figures is defined 0-4 and the y-scale is defined on 0-1). Note that that the minimum and maximum values of the relation do not change.

Figure 109 *TfE HR$_{MP}$ on TR$_{H \rightarrow MP}$ (more responsive)*	Figure 110 *TfE HR$_{MP}$ on TR$_{H \rightarrow MP}$ (base scenario)*	Figure 111 *TfE HR$_{MP}$ on TR$_{H \rightarrow MP}$ (less responsive)*
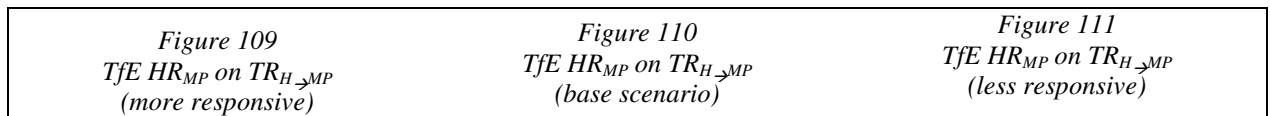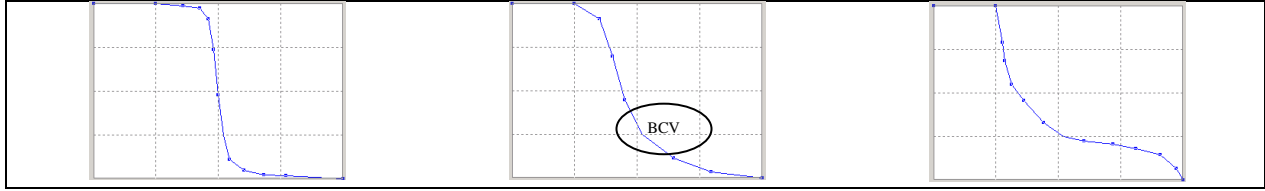
Results

The effect of HR_{MP} on $TR_{H \to MP}$ does initially not change the outcome variables %HR and %HR_{MP} substantially when its responsiveness changes (Figure 112 and Figure 113). The reason why the more responsive scenario performs better than the base scenario is because from about t=170 TR in the system is increased to the level that extra consultations will be outsourced by MP because of the increased TR. This boosts the performance of the system.
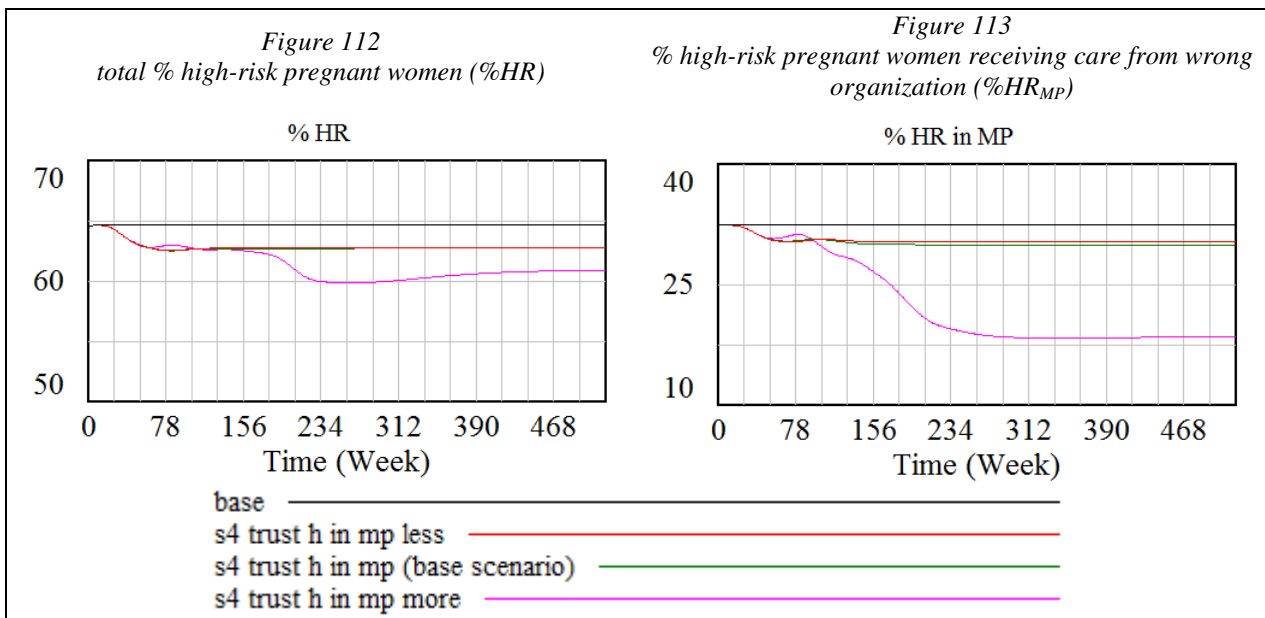
Figure 112
total % high-risk pregnant women (%HR)

Figure 113
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

Conclusion

Changing the responsiveness of $TR_{H \to MP}$ to HR_{MP} and does have a substantial effect on the outcomes, although only when the relation is defined more responsive.

SA in summary: scenario 4

The results of the tests are given below. The first three concern assumptions of the scenario, the others assumptions made in the model.

1. Changing the assumption that max QoC_H will increase to 1 does change the outcomes. The lower the QoC_H, the higher %HR and the lower %HR_{MP}. See SA 4-1.
2. Changing the intended level of CO has an effect on both outcome variables. The higher/lower the intended level of CO, the lower/higher the %HR and the lower/higher

the $\%HR_{MP}$. See SA 4-2. Specifically, an intended level of CO below 0.7 makes the performance regarding $\%HR_{MP}$ worse than the base case.

3. Changing the voluntariness of the CO has an effect on both outcome variables. The more voluntary the project, the higher the $\%HR$ and the higher the $\%HR_{MP}$. See also SA 4-3. Specifically, a voluntariness of 0.9 results in a worse performance regarding the $\%HR_{MP}$ than in the base case.

4. Changing the responsiveness of $\%HR_{MP \rightarrow H}$ to changes in CO has an effect on both outcome variables. The more/less responsive the relation, the lower/higher the $\%HR$ and the lower/higher the $\%HR_{MP}$. See SA 4-4. Specifically, making the relation less responsive results in a worse $\%HR_{MP}$ than in the base case.

5. Changing the responsiveness of $\%LR_{H \rightarrow MP}$ to changes in CO has an effect one outcome variable. The more responsive the relation, the lower the $\%HR_{MP}$. Note that there is hardly any effect for a less responsive relation. See SA 4-5.

6. Changing the responsiveness of outsourcing consultations by MP's to changes in CO does have a very small effect on one outcome variable. The more responsive the relation, the lower the $\%HR$ in the system. See SA 4-6.

7. Changing the responsiveness of outsourcing consultations by H's to changes in CO is not logical to test in this scenario. See SA 4-7.

8. Changing the responsiveness of $\%LR_H \rightarrow HR_H$ to changes in QoC_H has an effect on both outcome variables. The more responsive the relation, the lower the $\%HR$, and the higher the $\%HR_{MP}$. Specifically, making the relation more responsive results in a worse $\%HR_{MP}$ compared to the base case. See SA 4-8.

9. Changing the responsiveness of $TR_{MP \rightarrow H}$ to changes in LR_H has no effect on the outcome variables. See SA 4-9.

10. The responsiveness of the percentage $LR_{MP} \rightarrow HR_{MP}$ to QoC_{MP} is of importance to one outcome variable ($\%HR$) and it has hardly any effect on the other outcome variable ($\%HR_{MP}$). See SA 4-10.

11. Changing the responsiveness of $TR_{H \rightarrow MP}$ to HR_{MP} and does have a substantial effect on the outcomes, but only when the relation is more responsive. There is hardly any effect if the relation is defined less responsive. See SA 4-11.

SA 5-1: Percentage of integration

Questioning
In the fifth scenario, where the integrated care model and the collaborative model are combined, 20% of the MP's integrate with the H's. What if this percentage would be higher?
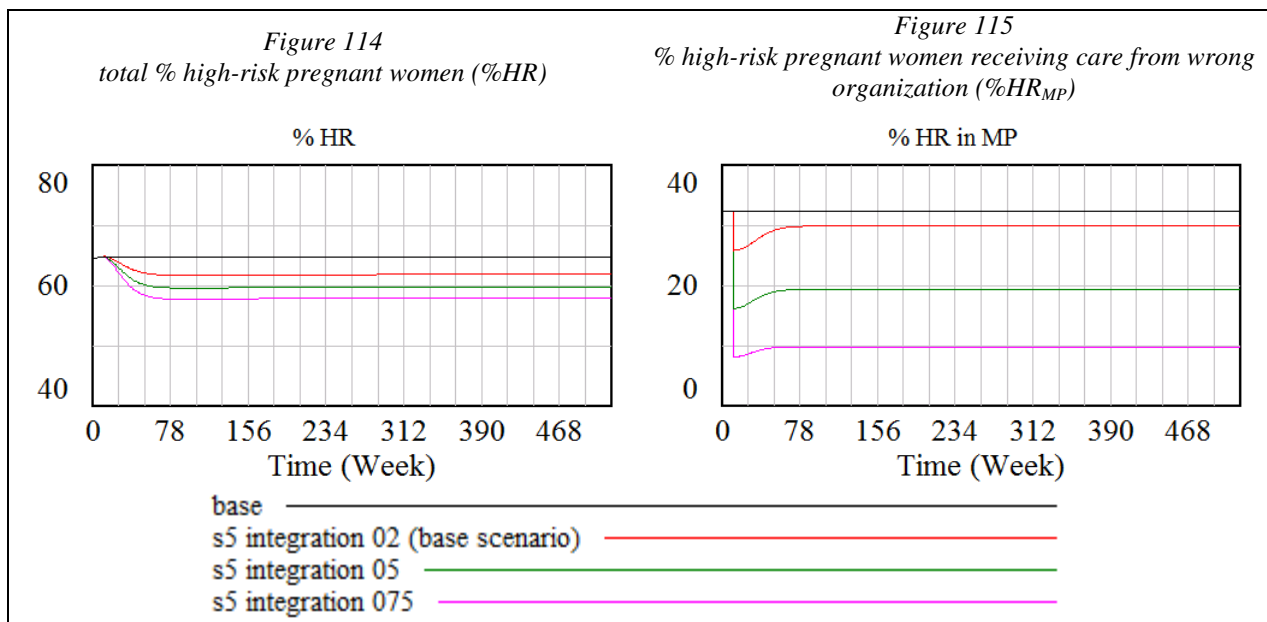
Variations
The percentage of integration is set at the following values: 0.20, 0.5, 0.75. Note that a scenario of 100% integrated care is a bit of a "boring" scenario, for as all professionals will be working in

one organization, with a maximum quality of care of 1, assuming the different type of professionals collaborating well. It seems obvious that this scenario will deliver the best performance. In the Netherlands, however, is it unrealistic that all organizations in a region merge into one, so the dynamics of competition and distrusting each other will always be present.

Results

Increasing the percentage of MP's that integrate with H's results in a lower %HR (Figure 114) and in a lower $\%HR_{MP}$ (Figure 115). The integrated H's are able to deliver a higher CoQ, and because the PW_H increases when the percentage of MP's that integrate with H's increases, HR decreases. Note that, compared to scenario 3, the 10% integrated care model, the QoC_{MP} does change slightly because CO is improved also. However, the consequences of this increase in CO are not that visible in the graphs because the voluntariness of CO is high (0.8). Note also that the total number of HR_{MP} decreases, not because of delivering better care in midwifery practices, or because of referring more $HR_{MP \to H}$, but because there are less PW_{MP}, (more MP's have integrated with H's).

Figure 114
total % high-risk pregnant women (%HR)

Figure 115
% high-risk pregnant women receiving care from wrong organization ($\%HR_{MP}$)

Conclusion

Changing the percentage of integration has a substantial effect on the outcomes.

SA 5-2: Maximum quality of care in hospitals

Questioning

Because of MP's integrating with H's, the maximum QoC in H's increases from 0.8 to 1. Reason for this is that H's are now able to deliver both the care and the cure to PW (midwives are good at delivering care, whereas obstetricians are good at delivering cure). Further, it is expected that

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midwives and obstetricians work perfectly well together. What if this isn't the case? What if the maximum QoC is lower than 1? And what if it is even lower than the current setting?
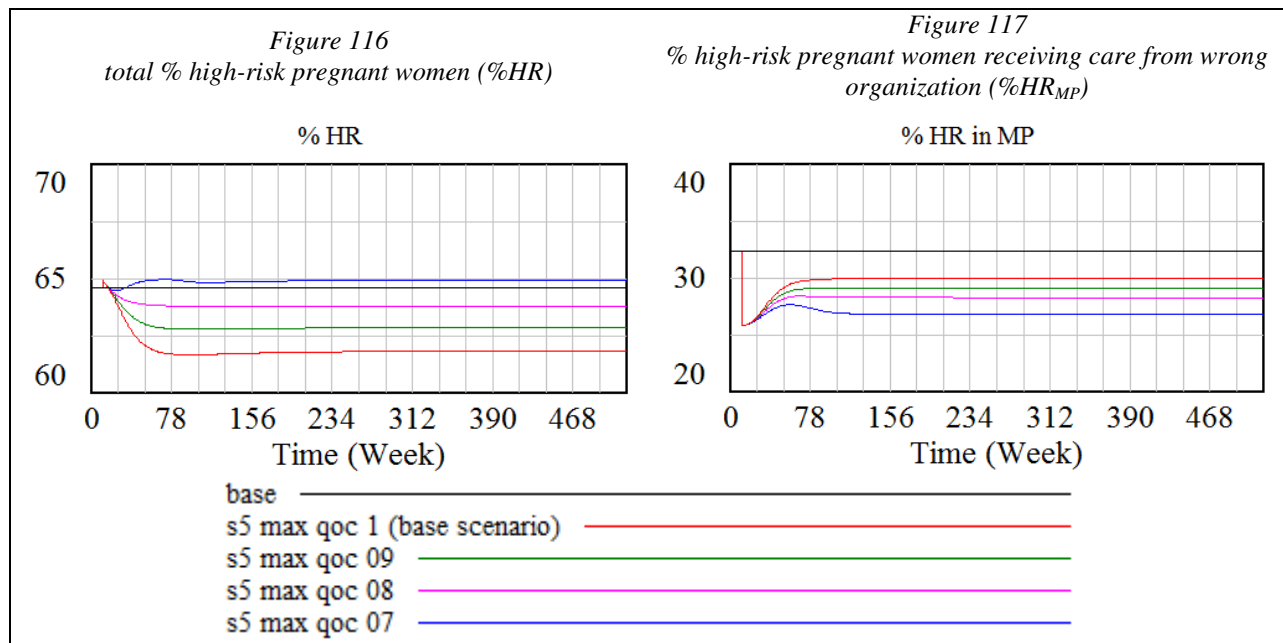
Variations

The max QoC_H due to the integrated care model takes on the following values: 1, 0.9, 0.8, and 0.7.

Results

A change in the maximum QoC_H results in a change in the outcomes also. The lower the max QoC_H, the higher the %HR (Figure 116), and the lower the $\%HR_{MP}$ (Figure 117).

Firstly, regarding the %HR, the %HR is determined by the degree to which PW develop a HR-pregnancy. This, in turn, is determined by the delivered QoC_H and QoC_{MP}. The QoC_{MP} does not change substantially, the QoC_H does differ in the tests conducted here. Accordingly, the %HR changes: the higher the QoC_H, the lower the degree to which PW develop a HR-pregnancy in H's and because the performance of MP's remains the same, the lower the total %HR.

Secondly, regarding the $\%HR_{MP}$, the lower the QoC_H, the lower the $\%HR_{MP}$. The $\%HR_{MP}$ is determined by $TR_{MP \rightarrow H}$. This is determined by the LR_H. In this test LR_H is decreased because of two effects: firstly, the increase in CO results in more $LR_{H \rightarrow MP}$, and secondly, QoC_H is varied and decreasing it, compared to the base scenario, results in more $LR_H \rightarrow HR_H$. Note the difference here with scenario 3, the integrated care model, where $\%HR_{MP}$ increases compared to the base case. Here, due to the improvement of CO, $\%HR_{MP}$ only decreases.

Figure 116
total % high-risk pregnant women (%HR)

Figure 117
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

Conclusion

The maximum QoC_H is of importance to both outcome variables: % HR and $\%HR_{MP}$.

SA 5-3: Intended level of collaboration

Questioning
The level of collaboration in the base case is 0.4 (out of 1). In the fifth scenario, the intended level of collaboration is increased to 0.8. What would happen if the intended level of collaboration is set lower than 0.8, or even higher?
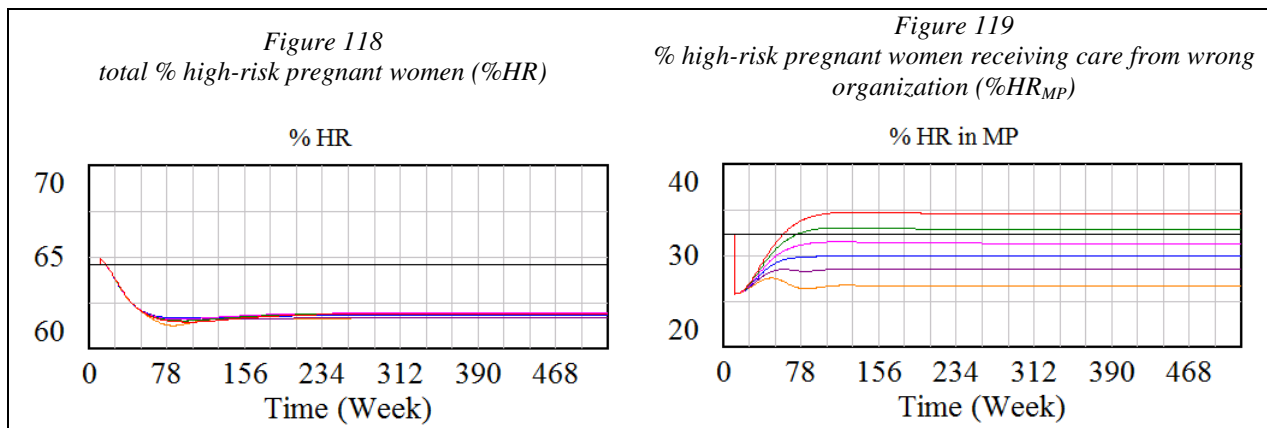
Variation
The intended level of collaboration after the start of the improvement project is set at the following values: 1, 0.9, 0.8, 0.7, 0.6, and 0.5.
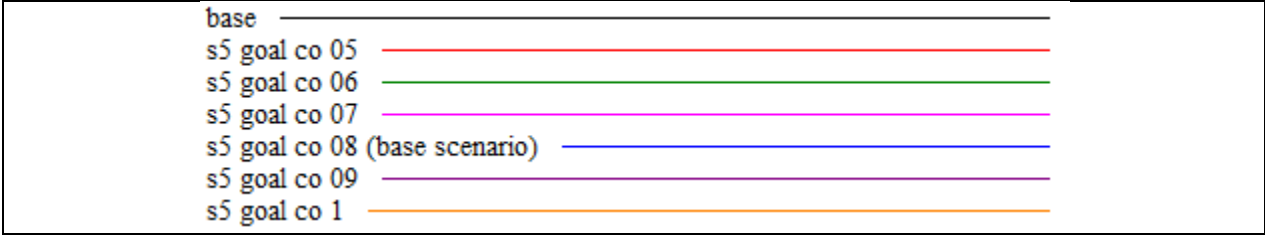
Results
Changing the intended level of collaboration compared to the base scenario results in changes in %HR$_{MP}$ (Figure 119) but it does not have any effect on %HR (Figure 118).

Firstly, regarding the %HR, changing the intended level of CO does not affect the %HR, however the end result does not show the internal dynamics. Firstly, the lower the CO, the lower the QoC$_{MP}$ and thus the higher the %LR→HR in MP's (note that the QoC$_H$ remains more or less the same because the maximum value is set at 1). One would expect this to result in a higher %HR. However, the lower the intended level of CO, the lower the LR$_{H→MP}$, and thus the lower the LR$_{MP}$. As a result, the actual number of LR→HR in MP's remains the same (a higher percentage over less actual PW).

Secondly, regarding the %HR$_{MP}$, the higher the intended level of CO, the more PW are referred between organizations and thus the less %HR$_{MP}$. However, in this scenario, an intended level of CO of 0.5 or 0.6 results in a worse outcome than the base case. How come? Well, the in that case, the positive effect CO has on increasing LR$_{H→MP}$ is cancelled out by the negative effect of the following. Due to the increase in QoC$_H$, the %LR$_H$→HR$_H$ decreases, which results in more LR$_H$. As a result TR$_{MP→H}$ decreases and the HR$_{MP→H}$ decreases and %HR$_{MP}$ increases.

Figure 118
total % high-risk pregnant women (%HR)

Figure 119
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

63

base
s5 goal co 05
s5 goal co 06
s5 goal co 07
s5 goal co 08 (base scenario)
s5 goal co 09
s5 goal co 1

Conclusion

The intended level of CO is of importance to one outcome variables: $\%HR_{MP}$. In fact, an intended level of CO of 0.5 or 0.6 worsens the performance compared to the base case.

SA 5-4: Voluntariness of collaboration

Questioning

In the fifth scenario, the 20% integrated care model combined with the collaborative model, CO changes. The effect of CO on the system depends among others on the degree of voluntariness. The current degree of voluntariness is set at 0.8 (out of 1). What if the CO is less voluntary and stricter?

Variation

The degree of voluntariness takes on the following values: 0.9, 0.8, 0.7, 0.5 and 0.25. Note that the value 1 is not included in this list for as setting the voluntariness at 1 implies that CO does not have an effect; all behavior is based on TR only. Also note that the value 0 is not included in this list for as setting the voluntariness at 0 implies that TR does not have an effect; all behavior is based on CO only. In addition, a voluntariness of 0 basically equals being tied together so closely that one kind of did integrate into 1.
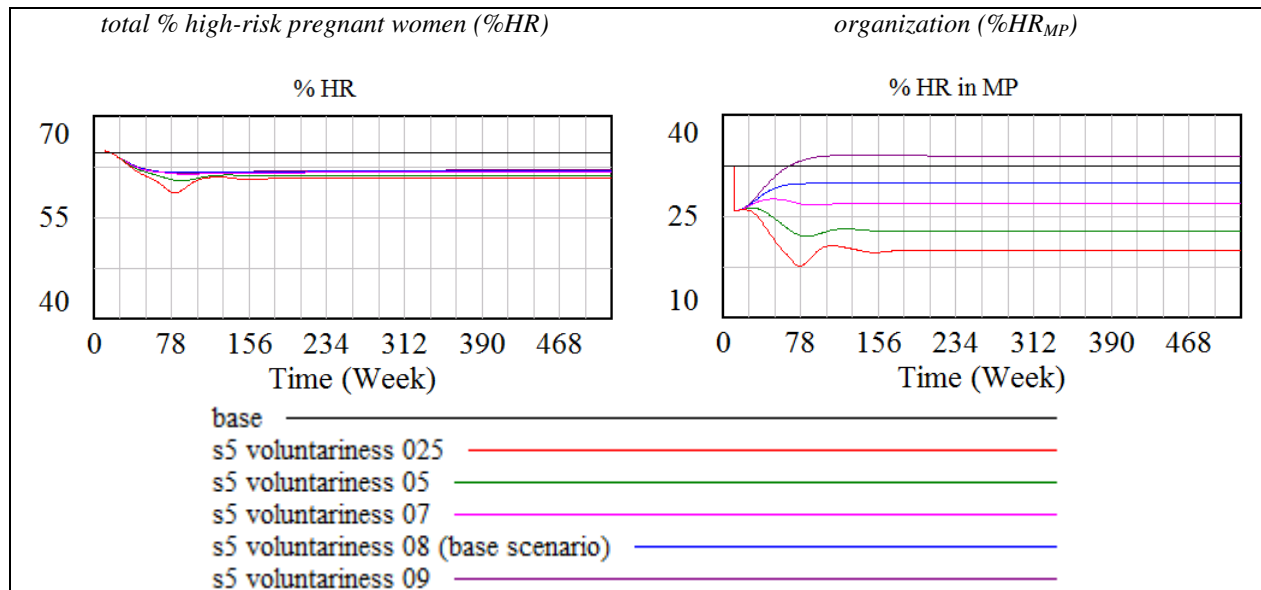
Results

Changing the degree of voluntariness has hardly any effect on the %HR (Figure 120) but it has an effect on the $\%HR_{MP}$ (Figure 121): the lower the voluntariness of the CO, the lower the $\%HR_{MP}$.

Firstly, regarding the %HR, this percentage remains fairly constant in the different tests and this variable does not reflect the dynamics well. Firstly, the lower the voluntariness of CO, the higher the QoC, and the lower the %LR→HR, in both organizations. This should have made the %HR lower. However, in addition to this, the lower the voluntariness of CO, the higher the $LR_{H\to MP}$, and the higher the LR_{MP}. Because the $\%LR_{MP}\to HR_{MP}$ is greater than the $\%LR_{H}\to HR_{H}$ the actual number of LR→HR increases. As a result, the %HR remains about the same in all scenarios.

Secondly, regarding the $\%HR_{MP}$, the lower the voluntariness, the higher the referral rates. As a result, the $\%HR_{MP}$ decreases.

Figure 120	*Figure 121* *% high-risk pregnant women receiving care from wrong*

total % high-risk pregnant women (%HR)   organization (%HR_MP)

% HR

% HR in MP

base
s5 voluntariness 025
s5 voluntariness 05
s5 voluntariness 07
s5 voluntariness 08 (base scenario)
s5 voluntariness 09

Conclusion

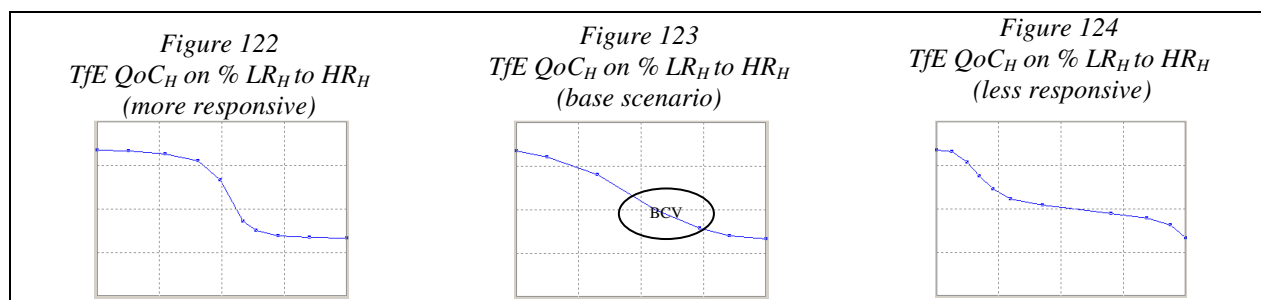The voluntariness of CO is of importance to $\%HR_{MP}$, but it rarely has an effect on %HR.

SA 5-5: Percentage low-risk pregnant women to high-risk pregnant women in hospitals

Questioning

In the fifth scenario, the max QoC_H is increased from 0.8 to 1 (out of 1). QoC_H has a direct effect on the percentage pregnant women that develop a high-risk pregnancy in H's. What if the percentage LR_H to HR_H is more responsive to changes in the QoC_H?

Variation

Three different relations between the percentage LR_H and HR_H are modeled: one being the base scenario (Figure 95), one being more responsive in the area of the base case value (BCV) (Figure 94) and one being less responsive in the area of the BCV (Figure 96). The BCV here is around 0.55 (x-scale of figures is defined 0-1 and the y-scale is defined on 0-3). Note that that the minimum and maximum values of the relation do not change.
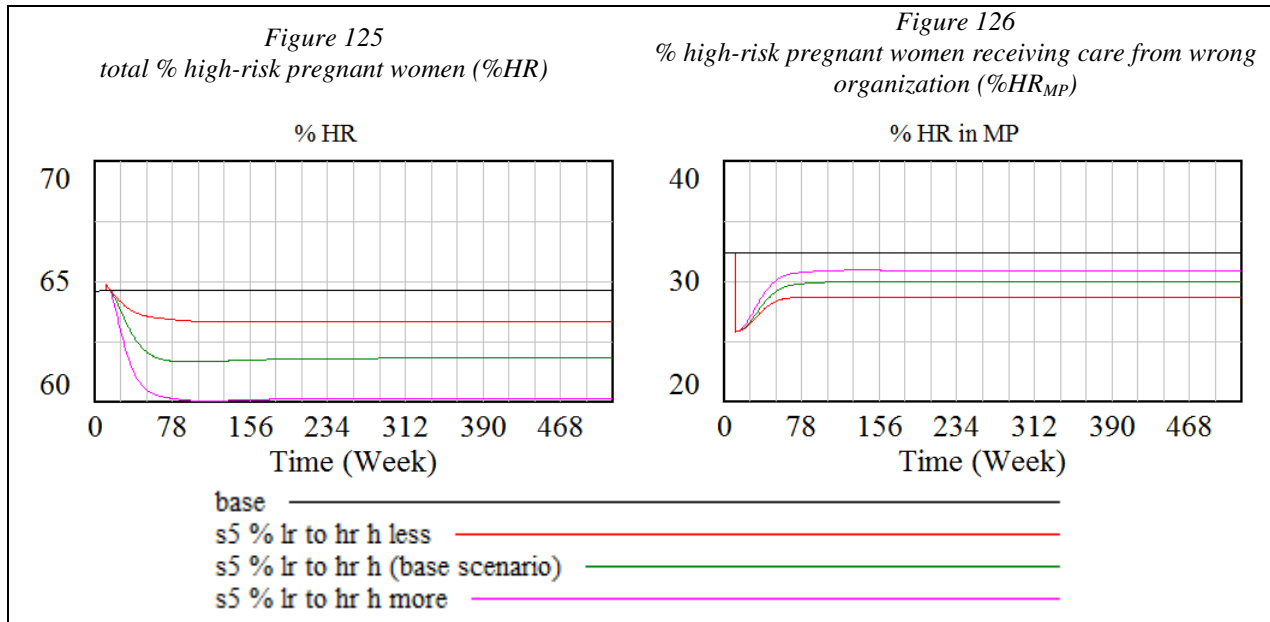

Figure 122
TfE QoC_H on % LR_H to HR_H
(more responsive)

Figure 123
TfE QoC_H on % LR_H to HR_H
(base scenario)

BCV

Figure 124
TfE QoC_H on % LR_H to HR_H
(less responsive)

65

Results

Making the percentage LR_H to HR_H more/less responsive to changes in the QoC_H results in a lower/higher %HR (Figure 125) and in a higher/lower $\%HR_{MP}$ (Figure 126).

Firstly, regarding the %HR, the %HR is determined by the degree to which PW develop a high-risk pregnancy, which is directly determined by the QoC_H and QoC_{MP}. Changing the responsiveness of the degree to which LR_H develop into HR_H to changes in QoC_H results therefore directly into a larger or smaller effect.

Secondly, regarding the $\%HR_{MP}$, the $\%HR_{MP}$ is determined by $TR_{MP \to H}$, which is determined by the relative number of LR_H. A change in responsiveness of the percentage of PW in H's that develop a high-risk to QoC_H (as described above) has thus also an effect on the percentage LR_H, and thus on $TR_{MP \to H}$. Note that, compared to SA 1-4 and SA 3-5, in this scenario the $\%HR_{MP}$ decreases compared to the base case. Reason for this is that the negative effect of having more LR_H on $TR_{MP \to H}$ (due to the increased QoC_H) is compensated by an improvement in QoC_{MP} due to increased CO.

Figure 125
total % high-risk pregnant women (%HR)

Figure 126
% high-risk pregnant women receiving care from wrong organization (%HR_MP)

Conclusion

The responsiveness of the percentage $LR_H \to HR_H$ to QoC_H is of importance to both outcome variables: %HR and $\%HR_{MP}$.
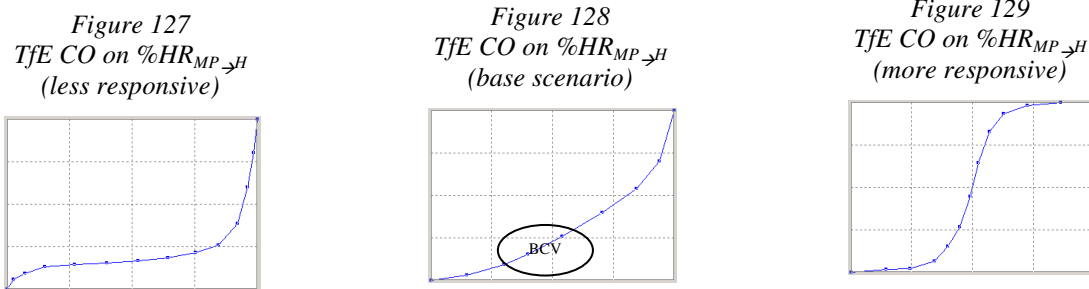
SA 5-6: Referrals from midwifery practices to hospitals

Questioning

One of the effects of CO is on the referral rates between H's and MP's. One can question the chosen relation between CO and the $\%HR_{MP \to H}$. What would happen when this rate would be more or less responsive to changes in CO?

Variation

Three different relations between CO and $\%HR_{MP\to H}$ are modeled: one being the base scenario (Figure 128), one being less responsive in the area of the BCV (Figure 127) and one being more responsive in the area of the BCV (Figure 129). The BCV is on 0.4 (x-scale of figures is defined 0-1 and the y-scale is defined on 0-1). Note that that the minimum and maximum values of the relation do not change.

Figure 127
TfE CO on $\%HR_{MP\to H}$
(less responsive)

Figure 128
TfE CO on $\%HR_{MP\to H}$
(base scenario)

BCV

Figure 129
TfE CO on $\%HR_{MP\to H}$
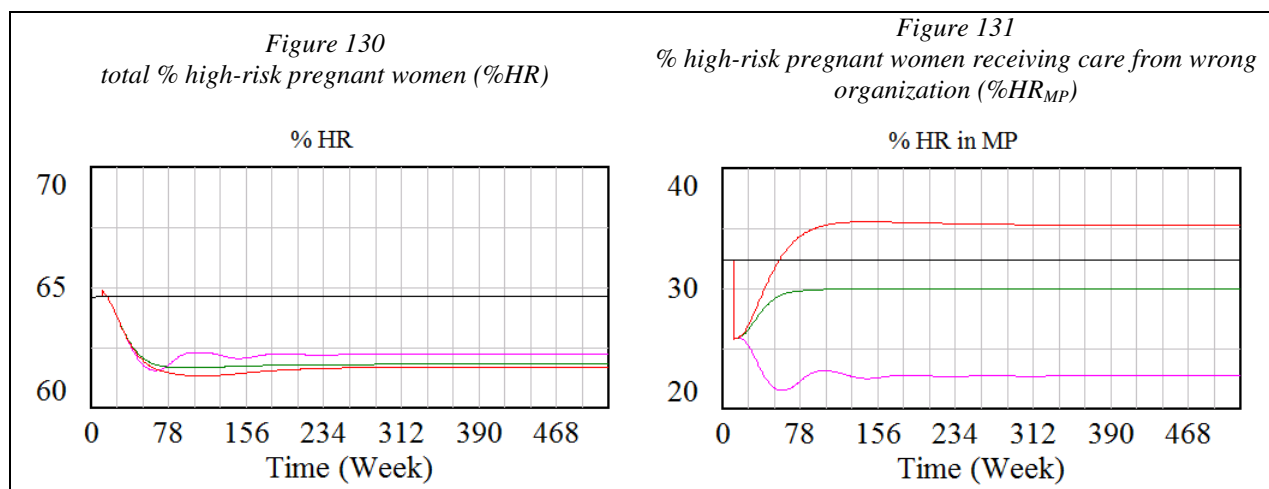*(more responsive)*

Results

Only one of the outcomes variables changes substantially when changing the responsiveness (Figure 130 and Figure 131).

Firstly, regarding the first outcome variable, the $\%HR$, there only is hardly any effect when $\%HR_{MP\to H}$ is more responsive to changes in CO. The main reason why the $\%HR$ would change is when QoC changes. In all tests, the QoC do not change substantially for H's and MP's.

Secondly, regarding the $\%HR_{MP}$, when the relation is more responsive, the $\%HR_{MP}$ decreases further. However, when the relation is made less responsive, the $\%HR_{MP}$ increases even compared to the base case. This is due to the following dynamics. Because of the integrated care model, the LR_H increases, resulting in a decrease in $TR_{MP\to H}$. In addition, both CO and TR have an effect on $\%HR_{MP\to H}$, and in case of a less responsive relation, CO still causes the $\%HR_{MP\to H}$ to increase, however, due to a decrease in $TR_{MP\to H}$, $\%HR_{MP\to H}$ decreases slightly, resulting in a higher referral percentage as in the base scenario, and thus in a higher $\%HR_{MP}$.

Figure 130
total % high-risk pregnant women (%HR)

Figure 131
% high-risk pregnant women receiving care from wrong organization (%HRMP)

67

base
s5 hr mp to h less
s5 hr mp to h (base scenario)
s5 hr mp to h more

Conclusion

The responsiveness $\%HR_{MP \to H}$ to changes in CO has an effect on one outcome variable: $\%HR_{MP}$. More specifically, when the relation is less responsive than in the base scenario, the $\%HR_{MP}$ even worsens compared to the base case.

SA 5-7: Referrals from hospitals to midwifery practices

Questioning

One of the effects of CO is the effect on the referral rates between H's and MP's. One can question the chosen relation between CO and $LR_{H \to MP}$. What would happen when this rate would be more or less responsive to changes in CO?

Variation

Three different relations between CO and $LR_{H \to MP}$ are modeled: one being the base scenario (Figure 133), one being less responsive in the area of the BCV (Figure 132) and one being more responsive in the area of the BCV (Figure 134). The BCV is on 0.4 (x-scale of figures is defined 0-1 and the y-scale is defined on 0-1). Note that that the minimum and maximum values of the relation do not change.

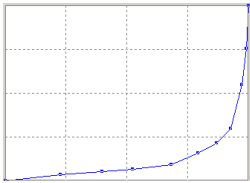*Figure 132*
TfE CO on $LR_{H \to MP}$
(less responsive)
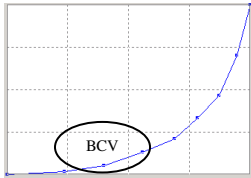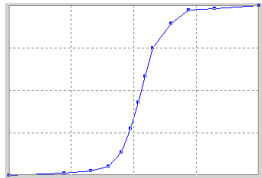
Figure 133
TfE CO on $LR_{H \to MP}$
(base scenario)
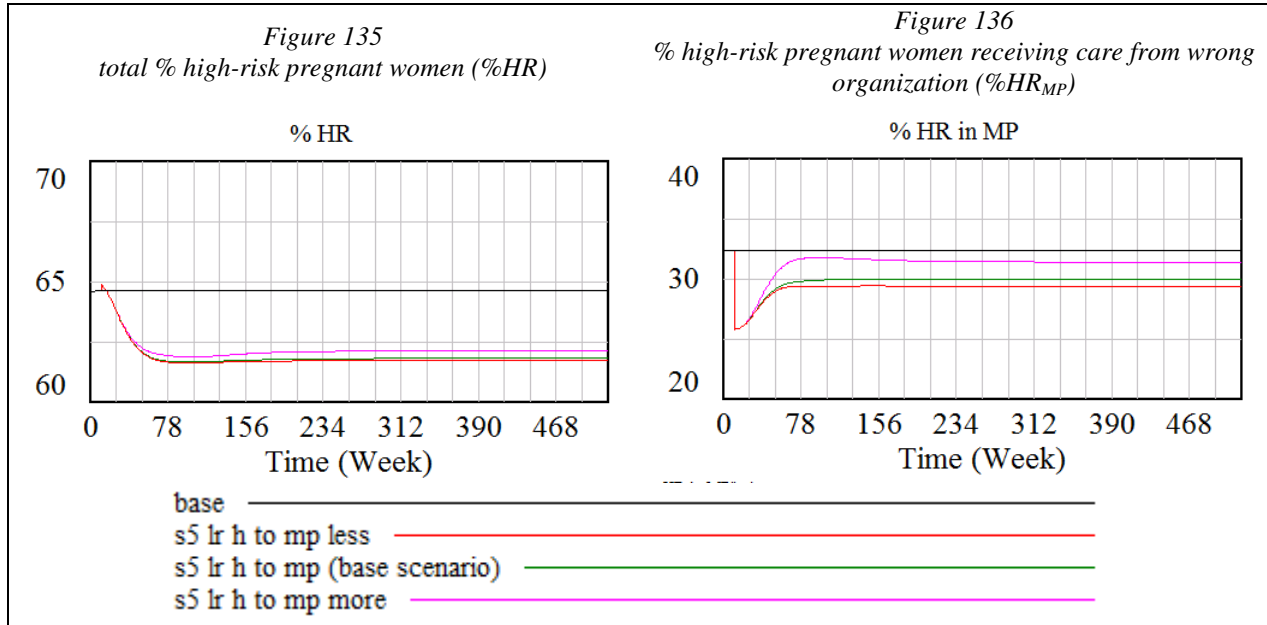
Figure 134
TfE CO on $LR_{H \to MP}$
(more responsive)

Results

Firstly, changing the responsiveness of $LR_{H \to MP}$ to changes in CO does not result in different outcomes regarding the %HR (Figure 135). Changing the response of $LR_{H \to MP}$ to changes in CO has an effect on the reinforcing trust-loop (R1). However, the impact on changing QoC, which determines %HR, is minimal when changing the responsiveness.

Secondly, changing the responsiveness of $LR_{H \to MP}$ to changes in CO does result in different outcomes regarding the $\%HR_{MP}$ (Figure 136), although this only holds for when the relation is set more responsive. The more $LR_{H \to MP}$, the lower the LR_H and the higher $TR_{MP \to H}$, which results in more $HR_{MP \to H}$. The fact that the outcomes differ more when having a more responsive relation instead of a less responsive relation is caused by the graphs of the relation

itself. Comparing Figure 132 with Figure 133 and Figure 134, when the intended level of CO rises from 0.5 to 0.8 (with the actual CO rising from 0.4 to 0.75), one can see that the difference between the "less responsive"-graph and the "base scenario"-graph is less than the difference between the "more responsive"-graph and the "base scenario"-graph.

Figure 135
total % high-risk pregnant women (%HR)

Figure 136
% high-risk pregnant women receiving care from wrong organization ($\%HR_{MP}$)

Conclusion

The responsiveness of the referral percentage of H's to MP's to changes in CO has only an effect on one of the outcome variables: $\%HR_{MP}$.
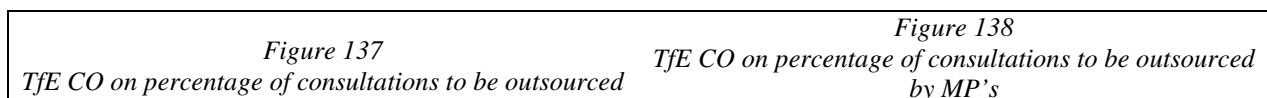
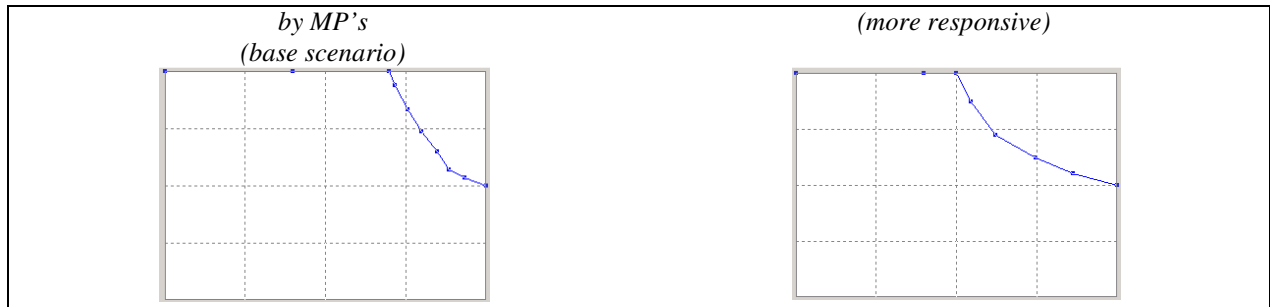## SA 5-8: Outsourcing consultations in midwifery practices

Questioning

One of the effects of CO is on the degree to which organizations outsource consultations. What would happen when the number of consultations that will be outsourced by MP's is set more responsive to changes in CO?

Variation

CO has an effect on the percentage of consultations that MP's will outsource. Figure 90 presents the base scenario for the table which determines the effect of CO on the percentage of consultations that has to be outsourced for both MP's and H's. Figure 91 shows the more responsive relation. The BCV is on 0.4 (x-scale of figures is defined 0-1 and the y-scale is defined on 0-100). Note that in the base scenario, CO has to be 0.7 before any effect occurs. In the analysis, this is changed to 0.5.

Figure 137
TfE CO on percentage of consultations to be outsourced

Figure 138
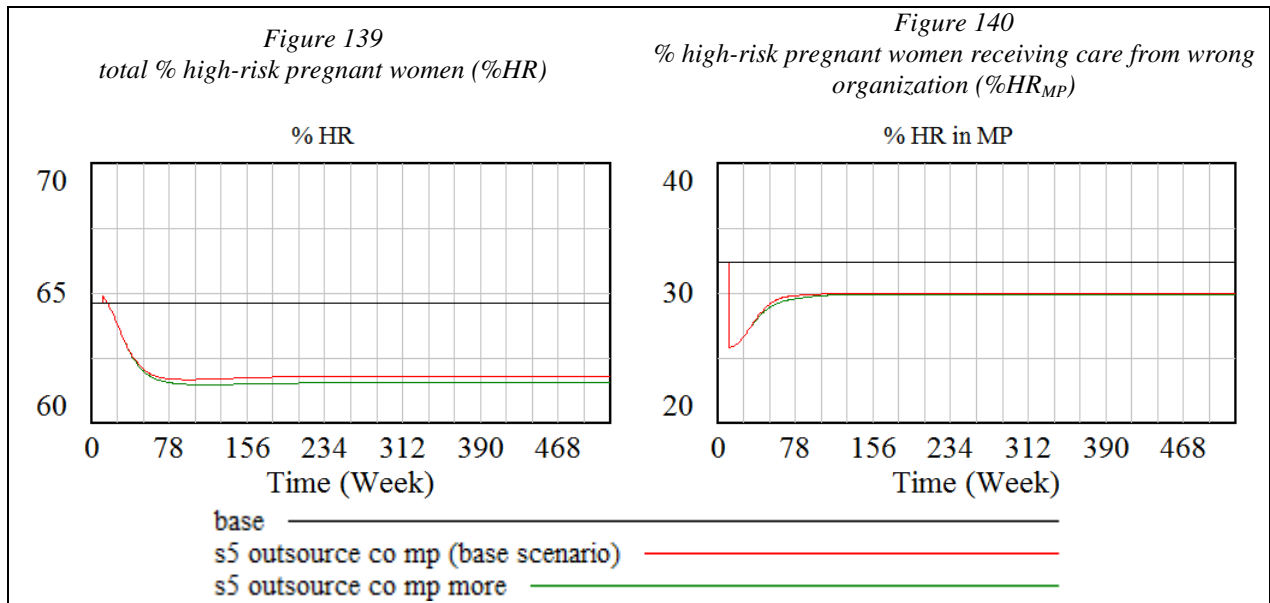TfE CO on percentage of consultations to be outsourced by MP's

Results

The increased responsiveness of the percentage of consultations outsourced by MP to CO has no effect on the outcome variables (Figure 139 and Figure 140).

Firstly, regarding the %HR, the outsourcing of consultations by MP has an effect on the QoC_{MP}. A higher QoC_{MP} results in a decrease in $\%LR_{MP} \rightarrow HR_{MP}$. However, because there are slightly more LR_{MP}, the actual number of $LR \rightarrow HR$ in MP's does not change much. Because the QoC_H remains the same, the %HR remains the same also.

Secondly, regarding the $\%HR_{MP}$, the $\%HR_{MP}$ is determined by the LR_H. Having MP outsource more consultations does increase QoC_{MP}, but it does not have any effect on the LR_H, and thus it has no effect on the $\%HR_{MP}$.

Figure 139
total % high-risk pregnant women (%HR)

Figure 140
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

Conclusion

Changing the responsiveness of outsourcing consultations by MP to CO does not have an effect on the outcome variables.
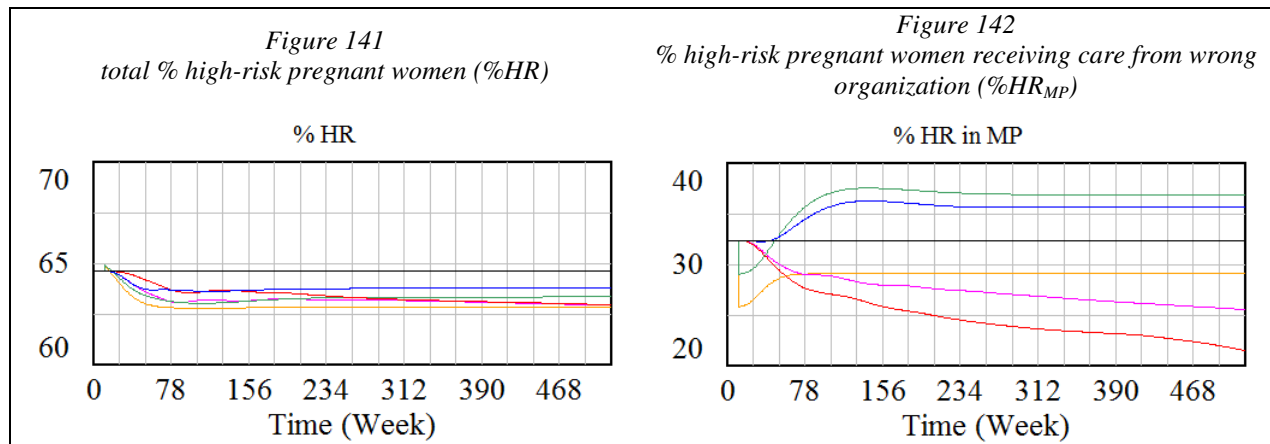
SA in summary: scenario 5

The results of the tests are given below. The first four concern assumptions of the scenario, the others assumptions made in the model.

1. Changing the percentage of integration has a substantial effect on the outcomes. See SA 5-1.
2. The maximum QoC_H is of importance to both outcome variables: % HR and %HR_{MP}. See SA 5-2.
3. The intended level of CO is of importance to one outcome variables: %HR_{MP}. In fact, an intended level of CO of 0.5 or 0.6 worsens the performance compared to the base case. See SA 5-3.
4. The voluntariness of CO is of importance to %HR_{MP}, but it rarely has an effect on %HR. See SA 5-4.
5. The responsiveness of the percentage $LR_H \rightarrow HR_H$ to QoC_H is of importance to both outcome variables: %HR and %HR_{MP}. See SA 5-5.
6. The responsiveness %$HR_{MP \rightarrow H}$ to changes in CO has an effect on one outcome variable: %HR_{MP}. More specifically, when the relation is less responsive than in the base scenario, the %HR_{MP} even worsens compared to the base case. See SA 5-6.
7. The responsiveness of the referral percentage of H's to MP's to changes in CO has only an effect on one of the outcome variables: %HR_{MP}. See SA 5-7.
8. Changing the responsiveness of outsourcing consultations by MP to CO does not have an effect on the outcome variables. See SA 5-8.

SA 6-1: Maximum quality of care hospitals

Scenario 1, 3, 4 and 5 all use the assumption that QoC_H will increase from 0.8 to 1. Reason for this is that H's are able to deliver both the care and the cure to PW (midwives are good at delivering care, whereas obstetricians are good at delivering cure). Further, it is expected that midwives and obstetricians work perfectly well together. What if this isn't the case? What if the maximum QoC_H will only become 0.9? 0.9 is chosen because it is likely that the quality of care will improve although it is arguable that this it will increase to 1.

Changing the max QoC_H results in a different order (Figure 142). Especially scenario 4 improves regarding the %HR_{MP} compared to the base case. <explain>

Figure 141
total % high-risk pregnant women (%HR)

Figure 142
% high-risk pregnant women receiving care from wrong organization (%HR_{MP})
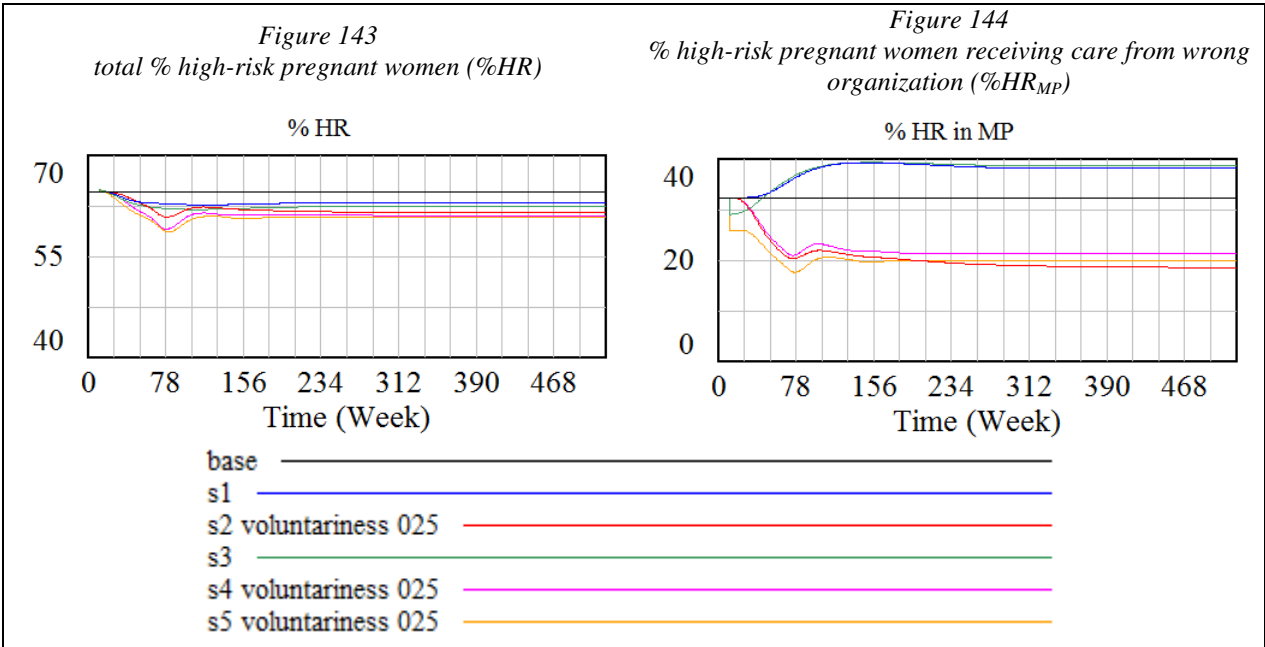

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SA 6-2: Voluntariness of collaboration

Scenario 2, 4 and 5 all use the assumption that the voluntariness of collaboration after the improvement project remains 0.8. But what if it is changed to 0.25? CO at the moment is not very formal and strict, but what if one would agree otherwise?
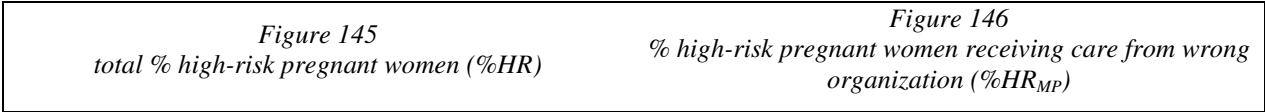
Making the collaboration more formal and strict results in an improvement in outcomes all scenarios where collaboration is improved. Interestingly, performance of these scenarios does not differ much amongst each other. <explain>

Figure 143
total % high-risk pregnant women (%HR)

Figure 144
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

% HR

% HR in MP

base
s1
s2 voluntariness 025
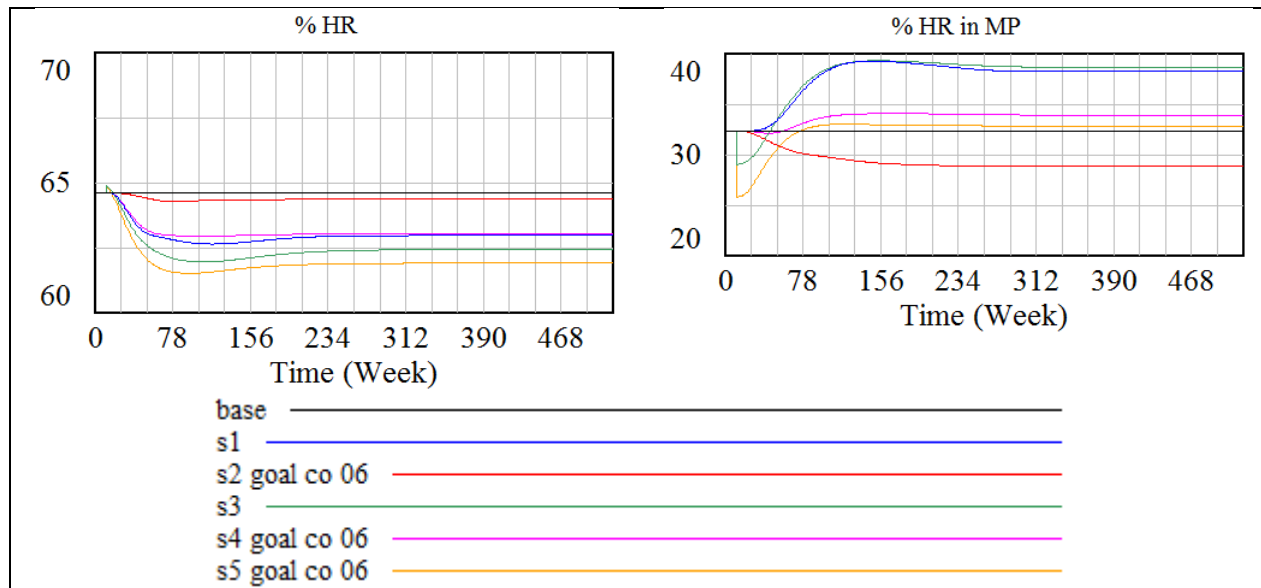s3
s4 voluntariness 025
s5 voluntariness 025

SA 6-3: Intended level of collaboration

Scenario 2, 4 and 5 all use the assumption that the intended level of collaboration is 0.8. What if we would lower the ambition and make it 0.6? So there will still be an improvement in CO, but just a more slight one.

Setting the intended level of CO at 0.6 results in worse performance regarding %HR$_{MP}$ than the base case. Only the collaborative model performs better. <explain>

Figure 145
total % high-risk pregnant women (%HR)

Figure 146
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

72

% HR

% HR in MP

base
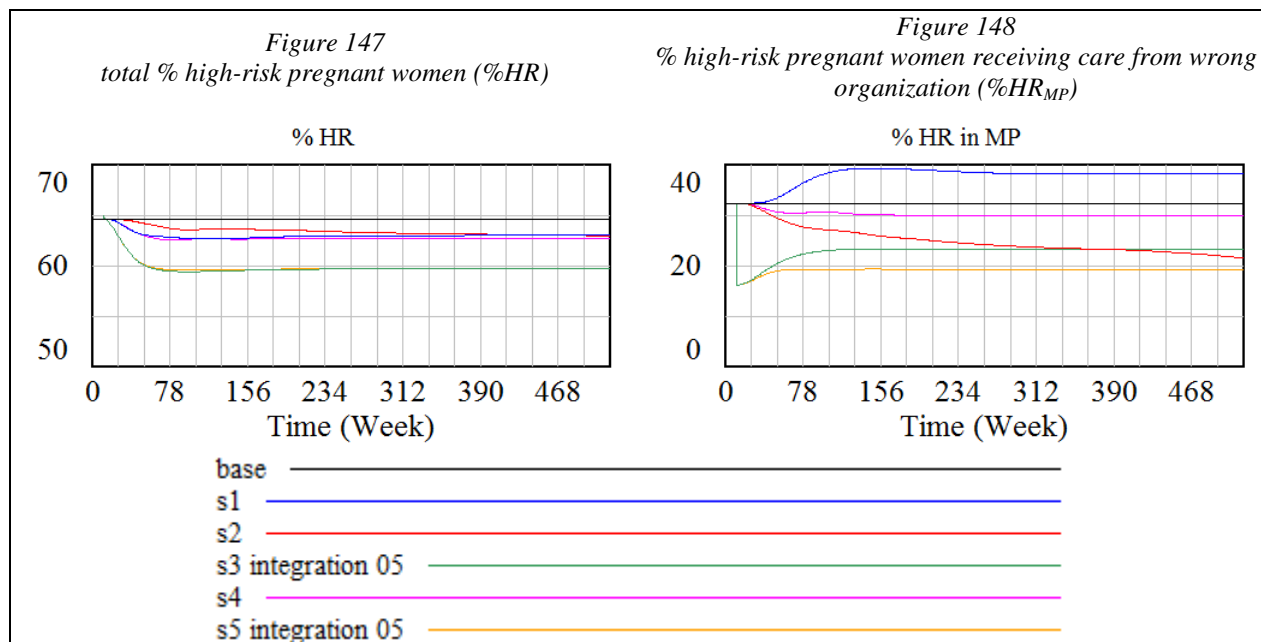s1
s2 goal co 06
s3
s4 goal co 06
s5 goal co 06

SA 6-4: Percentage of integration

In scenario 3 10% of the MP's integrate with the H's, and in scenario 5 this percentage is set at 20%. What if 50% of midwifery practices would integrate? Note that is unrealistic that 100% of all MP's would integrate with H's.

Figure 147
total % high-risk pregnant women (%HR)

% HR

Figure 148
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

% HR in MP
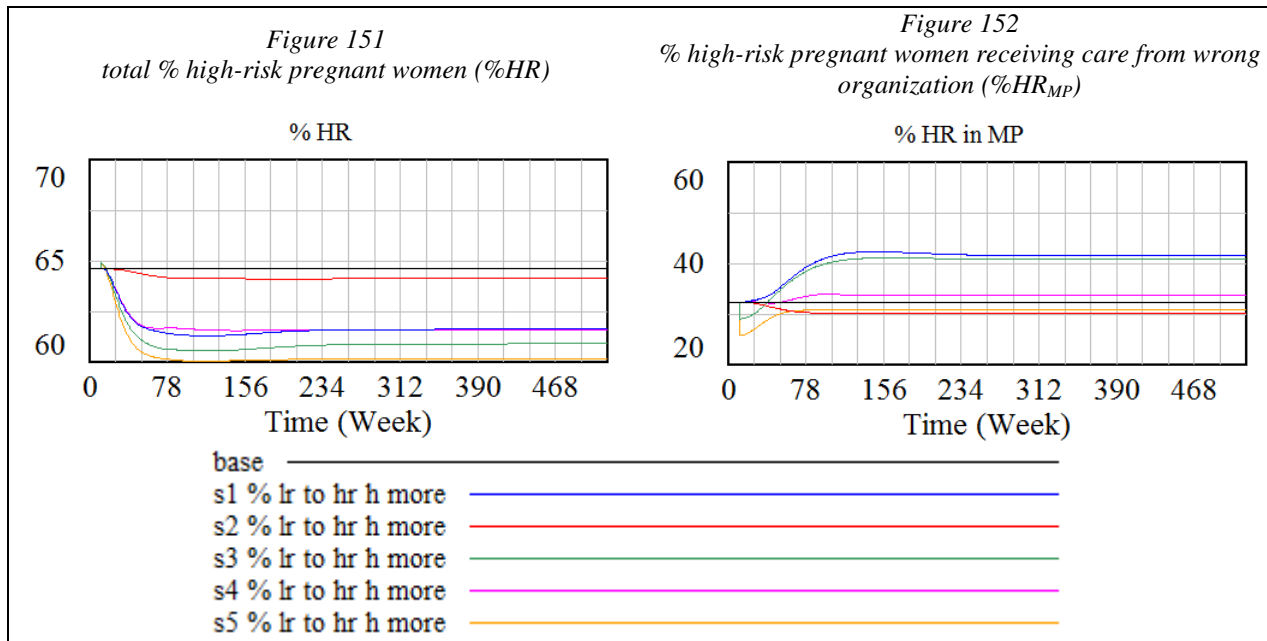
base
s1
s2
s3 integration 05
s4
s5 integration 05

SA 6-5: Percentage low-risk pregnant women to high-risk pregnant women in hospital

In the scenarios 1, 3, 4 and 5, the maximum quality of care is increased to 1. What if the effect of increasing that this causes is more responsive than in the base case? Thus What if the effect of

the percentage $LR_H \rightarrow HR_H$ would be more responsive to changes in QoC_H? Figure 150 presents the base scenario and Figure 149 presents a more responsive relation in the area of the base case value (BCV). The BCV here is around 0.55 (x-scale of figures is defined 0-1 and the y-scale is defined on 0-3). Note that that the minimum and maximum values of the relation do not change.

Figure 149
TfE QoC_H on % LR_H to HR_H
(more responsive)

Figure 150
TfE QoC_H on % LR_H to HR_H
(base scenario)

Figure 151
total % high-risk pregnant women (%HR)

Figure 152
% high-risk pregnant women receiving care from wrong organization (%HR_MP)
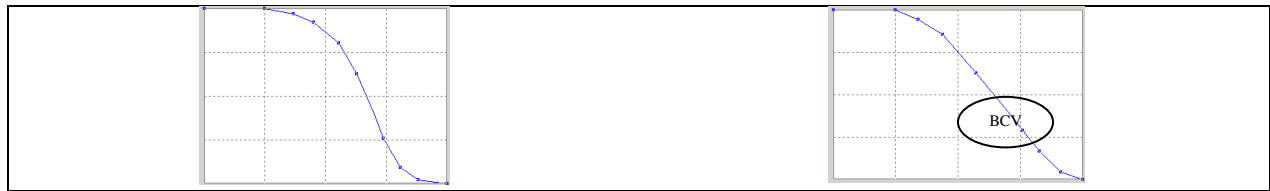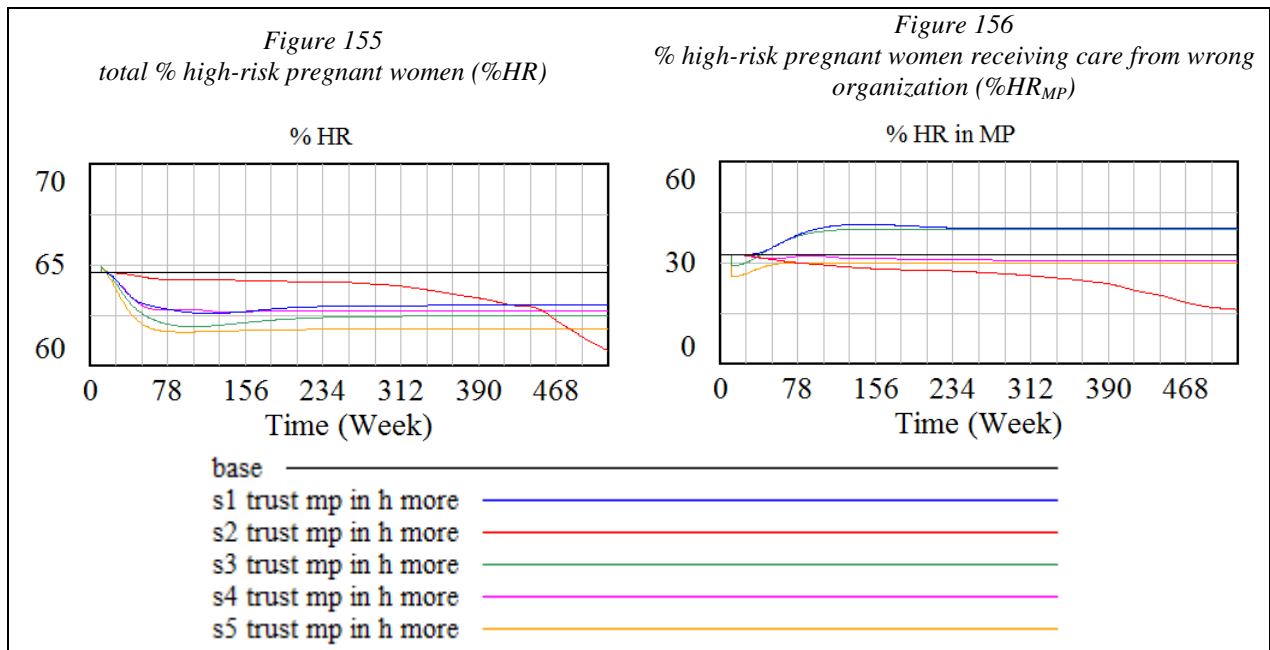
SA 6-6: Trust midwifery practices have in hospitals

What if MP's react more responsive to the behavior of H's than in the base case? What if the $TR_{MP \rightarrow H}$ is more responsive to the LR_H? Figure 153 presents the base scenario and Figure 154 presents the more responsive relation in the area of the base case value (BCV). The BCV here is around 2.8 (x-scale of figures is defined 0-4 and the y-scale is defined on 0-1). Note that that the minimum and maximum values of the relation do not change.

Figure 153
TfE LR_H on TR_{MP \rightarrow H}
(more responsive)

Figure 154
TfE LR_H on TR_{MP \rightarrow H}
(base scenario)

<mark><results and explain></mark>

Figure 155
total % high-risk pregnant women (%HR)

Figure 156
% high-risk pregnant women receiving care from wrong organization (%HR$_{MP}$)

SA in summary: all scenarios

The mutual order of the scenarios is given in Table 4. The order is determined by looking at the %HR$_{MP}$.

Table 4 Mutual order of the scenarios

SA	description	scenario 1	scenario 2	scenario 3	scenario 4	scenario 5
base scenarios	scenarios as defined	3	1	3	2	2
6-1	max QoC$_H$ of 0.9 (instead of 1)	4	1	5	2	3
6-2	voluntariness of CO of 0.25 (instead of 0.8)	2	1	2	1	1
6-3	intended level of CO of 0.6 (instead of 0.8)	4	1	4	3	2
6-4	percentage of integration of 60% (instead of 10% or 20%)	5	2	3	4	1

Some findings from these analyses:

1. When the quality of care in the hospitals (or in the integrated care organizations) would not increase to 1 but to 0.9, the collaborative model still has the best performance, but the improved hospital + model improves substantially, whereas the performance of the integrated care + model remains about the same.
2. When the CO is made less voluntary, the performance of the scenarios where CO is involved all move very close to each other. So in terms of performance, there is not much difference between the collaborative model, the hospital + model, and the integrated care + model.
3. When the intended level of collaboration, and thus the actual level of collaboration that is reached, is not set as high as in the base scenarios (0.6 instead of 0.8), only the collaborative model has an improved outcome in terms of percentage high-risk pregnant women taken care of by the wrong organization. All other scenarios perform worse than the base case regarding this outcome variable. However, all scenarios still show an improvement regarding the overall percentage of high-risk pregnant women, with the collaborative model showing the least improvement.
4. When the percentage of integration is set at 50% the integrated care model and the integrated care + model have better performance than the other models. Thus, the higher the percentage of midwifery practices that integrates with hospitals, the better the outcomes, both regarding the total percentage of high-risk pregnant women in the system as well as regarding the percentage of high-risk pregnant women being taken care of by the wrong organization. However, one comment has to be made. It is rather obvious that the latter improves, for as more pregnant women are being taken care of by the integrated care organization. Actually, when analyzing the integrated care model and the integrated care + model one should maybe also look to the number of high risk pregnant women being taken care of by midwifery practices compared to the total number of pregnant women in midwifery practices (instead of comparing it to all pregnant women in the system). Then, one can see that the midwifery practices who did not integrate with the hospitals are more reluctant to send high-risk pregnant women to the integrated care organizations.