Constipation, Diarrhoea & Irritable Bowel Syndrome Explained

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1. Introduction

A hypothetical model of the digestive system that can create the symptoms of Irritable Bowel Syndrome (IBS) has been published (Dobson, 2008, 2011). This paper presents that model and includes additional research.

Processes that create constipation, diarrhoea, and all other symptoms of IBS are presented. Suggestions for testing the model, treatment options, diagrams showing how the autonomic nervous system can create IBS symptoms, and photo-micrographs of the insoluble food fibres that trigger IBS symptoms, are included.

The data necessary to develop the model was collected over decades. Initially the purpose was to treat a member of the author's family, and successful treatment programs have been created. In addition, the observed symptoms of all types of IBS, have suggested the hypothesis.

2. Worldwide digestive illness

IBS is one of the most common maladies that a GP encounters. The symptoms range from mild and intermittent, to severe, continuous and incapacitating. Rates of occurrence have been measured at up to 25% in some countries. The economic burden is tens of billions of dollars annually for the USA alone (Schwetz & Chang, 2004; Drossman, 2007).

IBS is diagnosed by eliminating other digestive disorders. The symptoms demonstrate that something is wrong but there is no visible damage. There are few treatment options available and they are often ineffective. The patient goes away and tries to cope. Their days can be miserable. Constipation, bloating, cramping, borborygmii, diarrhoea, or none of these, and instead a host of other ailments may be present. They may be unable to work, afraid to eat, suffer from weight loss & malnutrition, and have fibre supplements, laxatives, & anti-diarrhoea medicines at hand. The author has also noted other symptoms such as depression, headache, hallucinations, guts ache, lack of energy, weight loss, skin infections, back pain, aching limbs, athlete's foot, ingrown nails, and other minor problems caused by malnutrition.

2.1 Types of IBS

Three types are widely recognized (Drossman 2007): IBS-C (Constipation predominant), IBS-D (Diarrhoea predominant), and IBS-A or IBS-M (Alternating or Mixed, constipation & diarrhoea).

The following definitions are based on the symptoms as observed by the author;

1. IBS-C… constipation is common but diarrhoea may also occur. Bloating is always present (but may be hard-to-detect), and it begins in the morning when breakfast is eaten. If bloating persists for many hours after breakfast, then constipation results. If bloating disappears quickly then constipation does not occur. Instead symptoms may subside, or diarrhoea containing fat (steatorrhea) may happen later in the day or next morning on arising. Borborygmii (gurgling), cramping, difficulty with fat digestion, and irritation around the anus, may be present.
2. IBS-D… diarrhoea is always present. It usually occurs on arising as the 'morning rush', but can also happen at other times. Bloating & constipation never occur. Borborygmii and irritation around the anus are always present. Cramping and difficulty with fat digestion may be present.
3. IBS-A or IBS-M… severe bloating in the upper abdomen is always present, together with either constipation or diarrhoea. If bloating persists for many hours after breakfast, constipation is the result. If bloating disappears soon after breakfast then diarrhoea may occur later in the day, or next morning on arising. Borborygmii, irritation around the anus and difficulty with fat digestion are always present. Cramping may be present.

3. The hypothesis

Digestion in the small intestine is a batch process with three sequential sections corresponding to the natural divisions of the intestine. These are the duodenum, the jejunum, and the ileum. It is governed by a brain controller divided into four sub-controllers, each with a unique neuro-transmitter. Control faults in this process cause the disorder… Irritable Bowel Syndrome

The hypothesis has been created by the author in order to explain the symptoms he has observed. When control faults occur, it creates all types and all symptoms of IBS.

3.1 Transport controllers

There are two transport control systems for the batch process;

1. The primary control system is a brain controller that is part of the autonomic nervous system (ANS). It is divided into four sub-controllers. The duodenum, the jejunum & the ileum each have a dedicated transport sub-controller. These transport sub-controllers produce output only when input is received. They obtain input from sensors in the walls of the intestine that detect food soup. Output regulates transport and mixing in the small intestine. Correct control happens regardless of the variable input caused by different foods. The food soup is moved backwards and forwards so that chemicals can be mixed in, the rate of nutrient absorption controlled, and the correct amount of water removed. It is then transferred to the next section at the correct time, and at the correct speed (slow).
2. A secondary control system called the Migratory Motor Complex (MMC) is applied when primary controller output is absent. This is a reflex action of the enteric nervous system (ENS). It is normally active only when the intestine has no food in it. However when food is present and the primary controller output is deficient or missing, the transport speed is set by the MMC. It is dependent on the types of food eaten, and the state of the ANS. There is no control of speed, mixing, or timing, and movement is in the forward direction only. When the speed set by the MMC is 'too fast', IBS symptoms occur.

3.2 Chemical controllers

Two control systems manage the addition of bile salts to the duodenum;

1. *The primary* system is the fourth sub-controller of the small intestine brain controller. When food soup containing fat is pumped in from the stomach, cells in the duodenum wall release Cholecystokinin hormone (CCK) into the bloodstream (Rehfeld, 2004). The brain detects this hormone and sends a nerve signal to the muscle that empties the gall bladder into the duodenum. If this controller is defective, then insufficient bile salts are added to the food soup.
2. *The secondary* control system is the ENS which adds bile salts when it detects; the amount and type of insoluble fibre, animal proteins (dairy, meats, fish, & egg yolks), fruit acids (alpha-hydroxy acids), and some herbs & spices (e.g. ginger). However the amount added is usually insufficient and more bile must be added by the primary control system to enable complete digestion of fats.

3.3 Primary control faults

The following defects can occur;

1. One or more of the four unique neuro-transmitters in the primary controller may be deficient or absent. This reduces or eliminates output from one or more sub-controllers of the primary controller.
2. A toxic insult may destroy intestinal sensors that provide input to the primary controller. This reduces or eliminates output from the controller.
3. Surgical procedures may sever input nerves to the primary controller from the small intestine, or output nerves from the primary controller to the intestine.
4. Misalignment of neck vertebrae may put pressure on nerves connecting the primary controller to the small intestine.
5. In infancy, development of nerve connections from the brain to the small intestine, may fail to be completed.
6. During pregnancy, pressure may be put on nerves connecting the primary controller to the small intestine.
7. Any other fault that interrupts communication between the small intestine and the brain.

3.4 IBS-B – bile deficient IBS

When output from the primary chemical sub-controller is deficient or missing, insufficient bile salts are added to the food soup. Undigested fats trigger fast speeds in the small intestine, impair nutrient uptake in the jejunum and reabsorbtion of chemicals in the ileum. Indigestion is followed by grey, fast, loose bowel movements containing fat (steatorrhea). The absence of the brown bile pigment stercobilin causes the grey colour, and when fat is present, the ENS automatically evacuates the colon. IBS-B may occur alone, but usually it accompanies one of the other three types of IBS. When it does, the symptoms of the others become severe.

3.5 The IBS Barrier – Constipation

The IBS Barrier is created when food soup is present in the small intestine, and a section under the control of the MMC precedes a section under the control of a primary transport sub-controller. When the primary sub-controller detects the 'too fast' movement of food soup, it constricts the intestine to stop the flow. It will not allow food soup to travel 'too fast'. This Barrier causes the IBS symptoms of bloating and constipation.

The Barrier is created by divisions of the ANS. Adrenal hormone levels regulate activity in this system. Soon after arising adrenal hormones are naturally high, and when breakfast is eaten the Barrier is strong. When stress releases more adrenal hormones during the day it again increases in strength. It will relax later in the day when adrenal hormones (and the ANS), return to low levels.

3.5.1 IBS-C caused by a neuro-transmitter deficiency

There are six Forms;

1. The duodenum transport sub-controller output is deficient or missing. This causes a Barrier to form at the start of the jejunum. When breakfast is eaten, immediate, severe bloating in the upper abdomen occurs. Backpressure in the duodenum keeps the valve from the gall bladder and pancreas closed, so that insufficient chemicals are added to the food soup (see Diagram 1).
2. Form 1 together with IBS-B. Symptoms become severe & diarrhoea may occur instead of constipation.
3. The jejunum transport sub-controller output is deficient or missing. This causes a Barrier to form at the start of the ileum. When breakfast is eaten, borborygmii and hard-to-detect, mild bloating in the mid-abdomen occur. Onset of bloating is delayed by a few minutes (see Diagram 2).
4. Form 3 together with IBS-B. Symptoms become severe & diarrhoea may occur instead of constipation.
5. Both the duodenum & jejunum transport sub-controller outputs are deficient or missing, causing a Barrier to form at the start of the ileum. When breakfast is eaten, borborygmii and hard-to-detect, mild bloating in the mid-abdomen occur. Onset of bloating is faster than Form 3.
6. Form 5 together with IBS-B. Symptoms become severe & diarrhoea may occur instead of constipation.

	Primary controller				
#	Chemical	Duodenum	Jejunum	Ileum	Symptoms
1.	O	X	O	O	Immediate severe bloating in the upper abdomen on eating breakfast. Cramping possible. Constipation if the Barrier persists, but if it relaxes quickly, then borborygmii may start and diarrhoea may happen next morning on arising. Steatorrhea and irritation around the anus may occur.
2.	X	X	O	O	Immediate severe bloating in the upper abdomen on eating breakfast. Cramping. Constipation if the Barrier persists, but if it relaxes quickly, borborygmii start followed by diarrhoea later in the day, or next morning on arising. Steatorrhea, irritation around the anus & severe symptoms occur.
3.	O	O	X	O	Borborygmii and hard-to-detect, mild bloating in the mid-abdomen, possibly with cramping, on eating breakfast. Constipation if the Barrier persists. If the Barrier relaxes quickly then symptoms subside.
4.	X	O	X	O	Borborygmii and hard-to-detect, mild, bloating in the mid-abdomen, with cramping, on eating breakfast. Constipation if the Barrier persists, but if it relaxes quickly, borborygmii may start followed by diarrhoea later in the day or next morning on arising. Steatorrhea, irritation around the anus & severe symptoms occur.
5.	O	X	X	O	Borborygmii and hard-to-detect, mild bloating in the mid-abdomen, possibly with cramping, on eating breakfast. Constipation if the Barrier persists. If the Barrier relaxes quickly then symptoms subside.
6.	X	X	X	O	Borborygmii and hard-to-detect, mild bloating in the mid abdomen, with cramping, on eating breakfast. Constipation if the Barrier persists but if it relaxes quickly, borborygmii start followed by diarrhoea later in the day, or next morning on arising. Steatorrhea, irritation around the anus & severe symptoms occur.

Table 1: Summary of the six forms of IBS-C Legend: X = defective and O = functioning

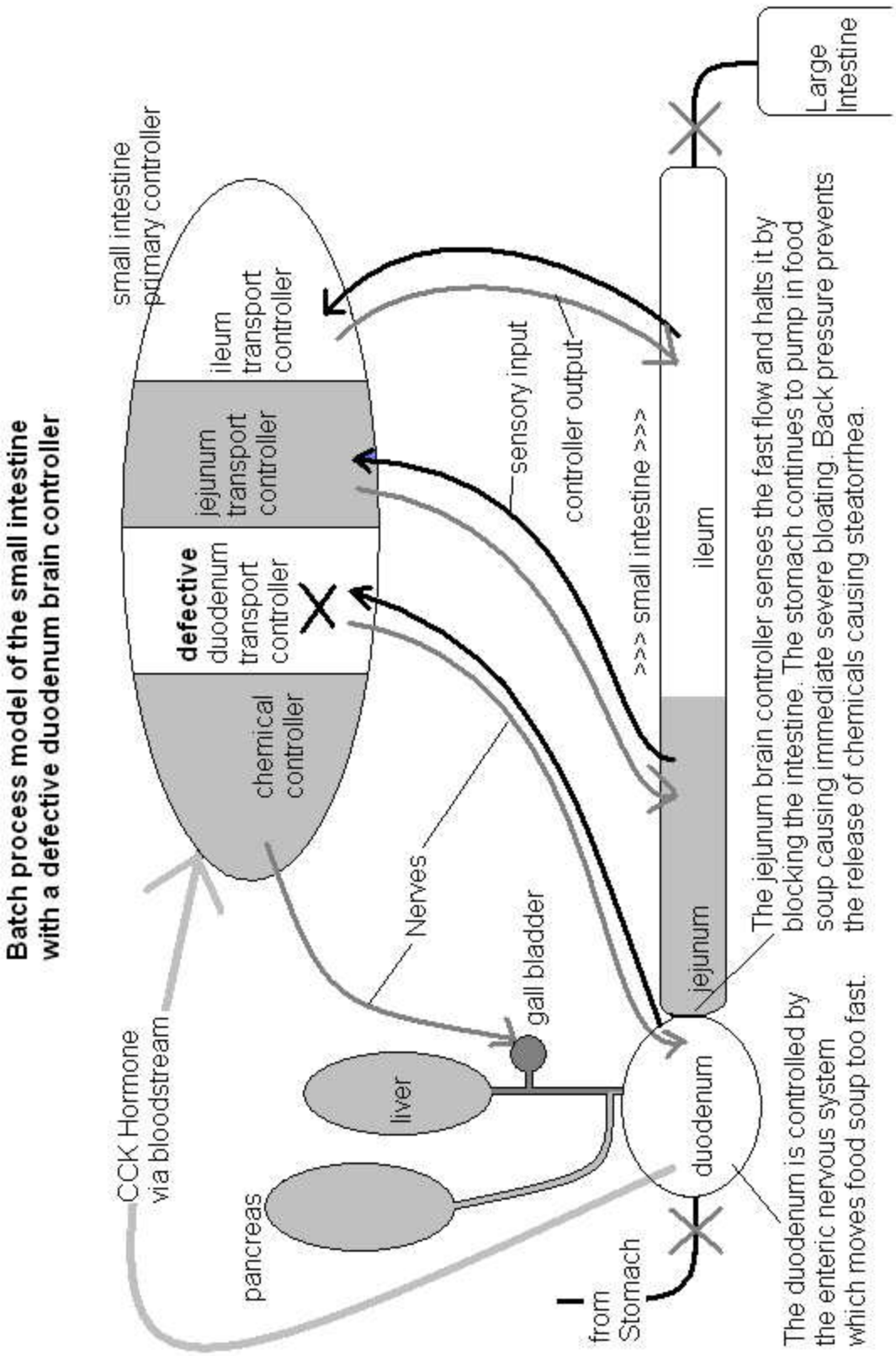


Diagram 1: Schematic showing how the model creates IBS-C Form 1

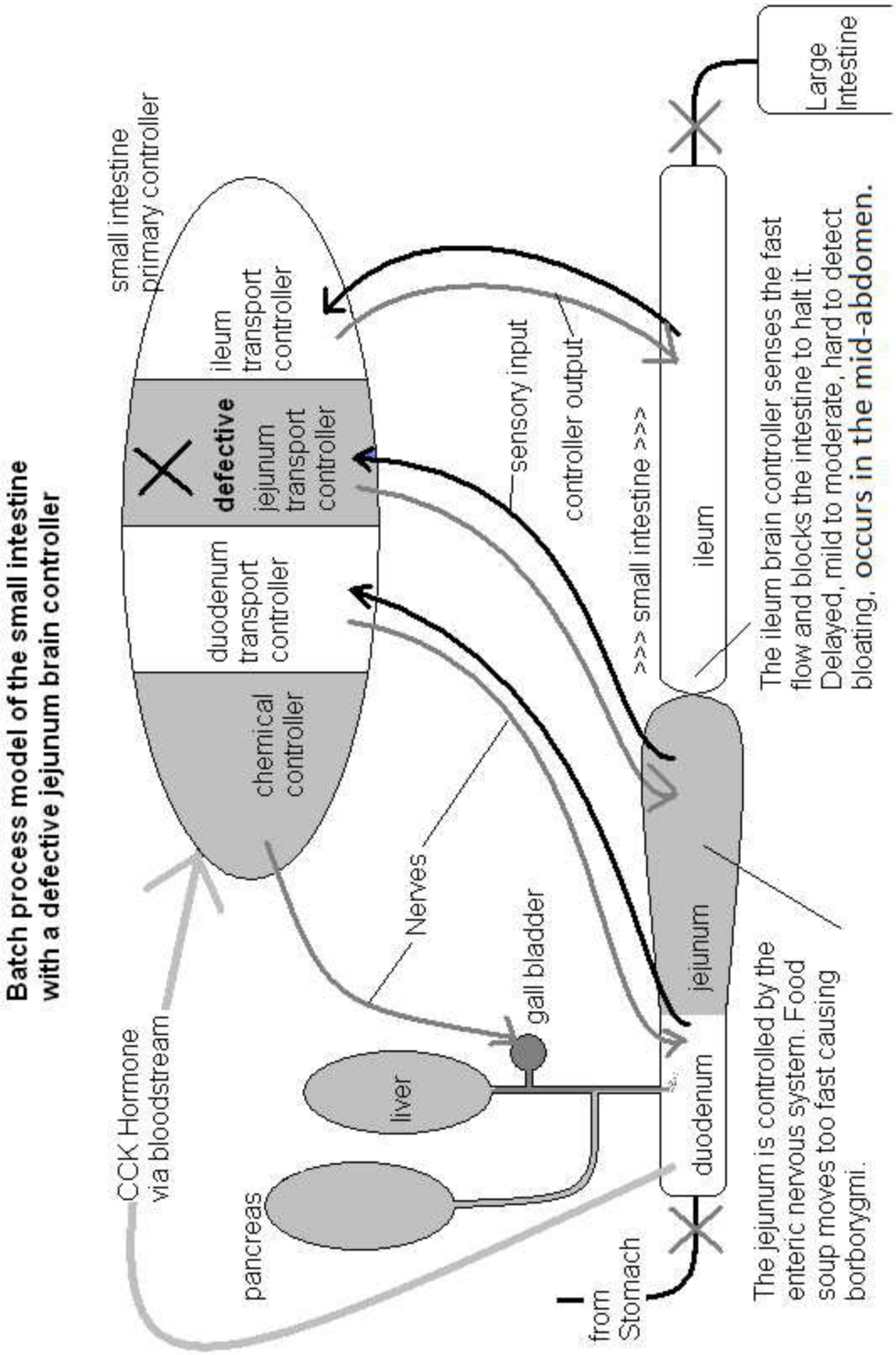


Diagram 2: Schematic showing how the model creates IBS-C Form 3

3.6 The MMC controls the ileum - Diarrhoea

When the ileum is no longer controlled by its primary transport sub-controller, the secondary transport controller (MMC) takes over and moves food soup into the colon too soon. The soup may contain high levels of digestive chemicals, acids & fats, and these will cause the ENS to automatically evacuate the colon. The level of activity in the ANS controls the ileocecal valve (ICV) at the end of the small intestine. When adrenal hormones are high on arising, the ICV is easy to open, and the ileum immediately pushes its contents into the colon (the morning rush). When stress during the day releases adrenal hormones, the ICV is again easier to open. Overnight the ICV becomes firmly closed, but when symptoms of IBS-D & A are severe, the ileum can push food soup through the valve at any time.

3.6.1 IBS-D caused by a neuro-transmitter deficiency

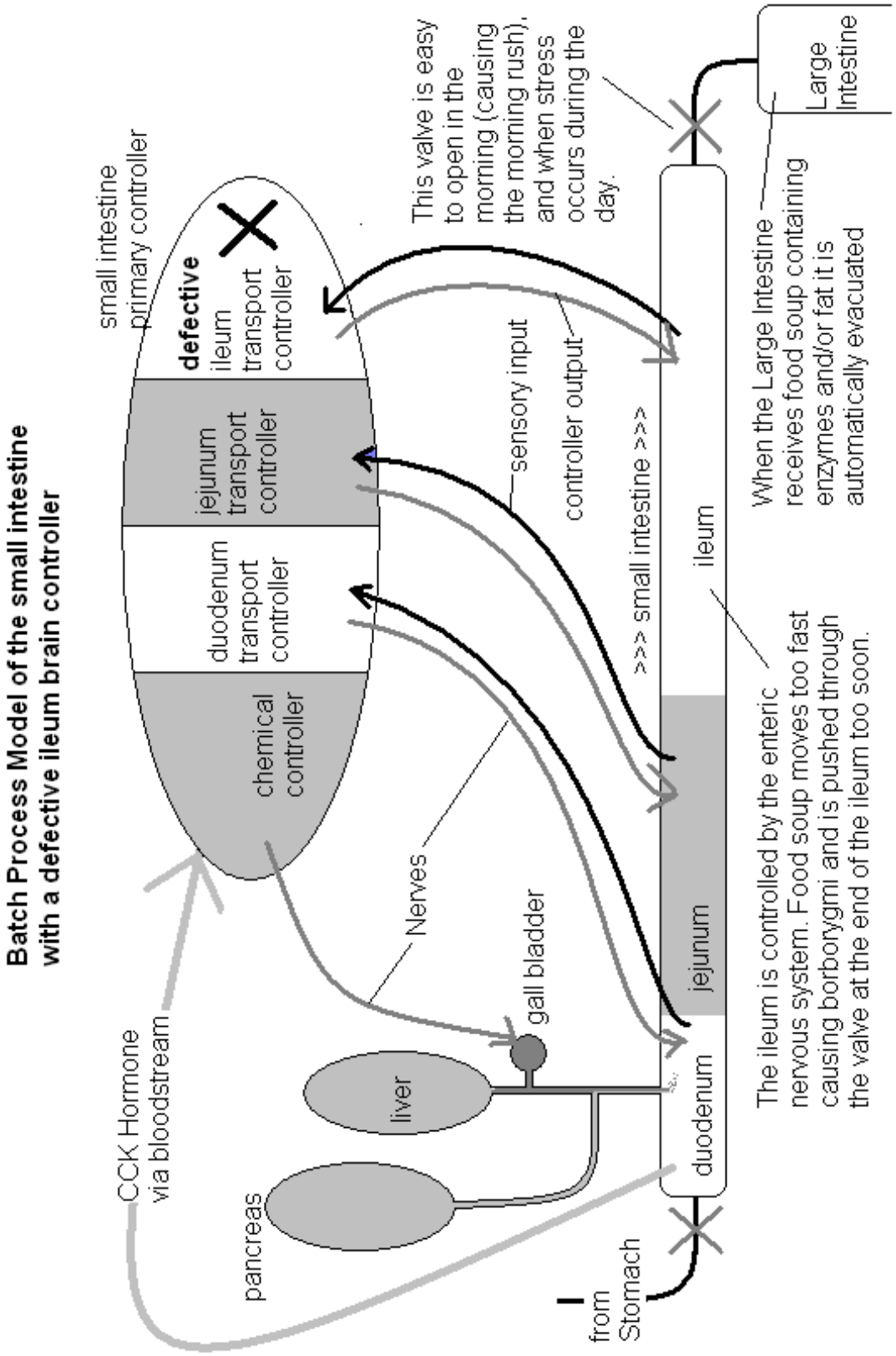
There are six Forms;

1. The ileum transport sub-controller output is deficient or missing (see Diagram 3). After breakfast is eaten, borborygmii begin when food soup reaches the ileum several hours later. Diarrhoea occurs on arising next morning (the 'morning rush').
2. Form 1 together with IBS-B. Symptoms become severe. Diarrhoea may occur immediately food reaches the end of the ileum, or next morning on arising.
3. The ileum and jejunum transport sub-controller outputs are deficient or missing. When breakfast is eaten, borborygmii begin when food soup reaches the jejunum a few minutes later. Diarrhoea occurs on arising next morning.
4. Form 3 together with IBS-B. Symptoms become severe. Diarrhoea may occur immediately food reaches the end of the ileum, or next morning on arising.
5. The ileum, jejunum and duodenum transport sub-controller outputs are deficient or missing. When breakfast is eaten, borborygmii begin immediately. Diarrhoea occurs on arising next morning.
6. Form 5 together with IBS-B. Symptoms become severe. Diarrhoea may occur immediately food reaches the end of the ileum, or next morning on arising.

	Primary controller				
#	Chemical	Duodenum	Jejunum	Ileum	Symptoms
1.	O	O	O	X	Borborygmii start several hours after breakfast is eaten. Diarrhoea occurs next morning on arising. Steatorrhea and anal irritation occur.
2.	X	O	O	X	Borborygmii may start soon after breakfast begins. Diarrhoea occurs later in the day, or next morning on arising. Steatorrhea, cramping, anal irritation, & severe symptoms occur.
3.	O	O	X	X	Borborygmii begin a few minutes after starting breakfast. Diarrhoea occurs next morning on arising. Steatorrhea and anal irritation occur.
4.	X	O	X	X	Borborygmii start soon after breakfast begins. Diarrhoea occurs later in the day, or next morning on arising. Steatorrhea, cramping, anal irritation, & severe symptoms occur.
5.	O	X	X	X	Borborygmii start immediately after breakfast begins. Diarrhoea occurs next morning on arising. Steatorrhea and anal irritation occur.
6.	X	X	X	X	Borborygmii start immediately after breakfast begins. Diarrhoea occurs later in the day or next morning on arising. Steatorrhea, cramping, anal irritation, & severe symptoms occur.

Table 2: Summary of the six forms of IBS-D Legend: X = defective and O = functioning

Diagram 3: Schematic showing how the model creates IBS-D Form 1



3.6.2 IBS-A caused by a neuro-transmitter deficiency

There are two Forms;

1. The duodenum and ileum transport sub-controller outputs are deficient or missing. This causes IBS-C (Form 1) plus IBS-D (Form1). Constipation and diarrhoea alternate irregularly. The state of the autonomic nervous system (ANS) controls the alternation.
2. Form 1 together with IBS-B. This causes IBS-C (Form 2) with IBS-D (Form 2). Symptoms become severe.

	Primary controller				
#	Chemical	Duodenum	Jejunum	Ileum	Symptoms
1.	O	X	O	X	Severe bloating in the upper abdomen starts when breakfast is eaten. Cramping is possible. Constipation occurs if the Barrier persists, but if the Barrier relaxes quickly after breakfast then borborygmii start, followed by diarrhoea next morning on arising. Steatorrhea and anal irritation are present.
2.	X	X	O	X	Severe bloating & cramping in the upper abdomen start when breakfast is eaten. Constipation results if the Barrier persists, but if it relaxes soon after breakfast, borborygmii begin. Diarrhoea then happens later in the day, or next morning on arising. Steatorrhea, anal irritation and severe symptoms occur.

Table 3: Summary of the two forms of IBS-A Legend: X = defective and O = functioning

3.7 Primary control fault summary for neuro-transmitter deficient IBS

	Primary controller				
#	Chemical	Duodenum	Jejunum	Ileum	IBS Type(s)
1	X	O	O	O	B
2	O	X	O	O	C
3	X	X	O	O	C + B
4	O	O	X	O	C
5	X	O	X	O	C + B
6	O	X	X	O	C
7	X	X	X	O	C + B
8	O	O	O	X	D
9	X	O	O	X	D + B
10	O	O	X	X	D
11	X	O	X	X	D + B
12	O	X	X	X	D
13	X	X	X	X	D + B
14	O	X	O	X	A
15	X	X	O	X	A + B

Legend: X = defective and O = functioning

Table 4: Summary of the four types and fifteen forms of IBS produced when neuro-transmitter deficiencies occur in the primary controller.

3.8 Diagnostic confusion

- If the IBS Barrier relaxes quickly after breakfast then;
    - IBS-C Forms 1 & 2 can resemble IBS-A.
    - IBS-C Forms 4 & 6 can resemble IBS-D.
- IBS-D Forms 2, 4, & 6 all have similar symptoms and are difficult to tell apart.
- At present IBS-B is not being identified as a type of IBS. It is likely being diagnosed as a gall bladder problem and treated by removing the gall bladder.

3.9 Other primary control faults

Any fault that disrupts sensory or hormonal input from the small intestine to the brain or motor output from the brain to the small intestine will cause IBS symptoms. The section(s) of the intestine that are affected will not be the same as neuro-transmitter deficient IBS. A faulty section will cause an IBS Barrier to form at the start of the following brain controlled section. Subsequent defects will have little effect, except that diarrhoea symptoms will occur when the end part of the intestine is faulty.

4 Variability of IBS symptoms

If you compare two subjects with the same type of IBS, the symptoms that they suffer from can vary in variety, intensity & timing. The following factors explain how this variation occurs.

4.1 Food variables

How food is selected, processed, and eaten, determines the speed of the small intestine when the secondary controller (MMC) is in charge.

- The insoluble fibre in most cereals and all whole legumes causes a range of 'too fast' speeds, and IBS symptoms will vary depending on the variety of cereal/legume eaten, how it has been processed, how much is eaten, and when it is eaten.
- When cereals and whole legumes are absent, cooked proteins eaten without sufficient fat and some dairy foods can cause 'too slow' speeds.
- A large meal can cause 'too fast' speeds (volume of the intestine).
- Any food that is not matched to climate and constitution can cause 'too fast' speeds. For example; a spicy (pungent) meal eaten in hot weather may cause a 'too fast' speed, and a bitter raw food meal eaten in cold weather may cause a 'too fast' speed.

More force is used to achieve faster speeds, and the brain creates a stronger Barrier to stop the flow. A strong Barrier may produce a complete transport halt for long periods, and dehydration then occurs. This causes later processes of the small intestine to take much longer. The faster the speed, the more severe constipation, diarrhoea, bloating, cramping, and all other symptoms, become.

On arising, the valve at the end of the ileum (ICV) is easy to open, and fast speeds in the ileum cause the 'morning rush'. The entire contents of the ileum are expelled into the colon. Very fast speeds move food into the colon, immediately it reaches the end of the ileum. The food soup can be acidic, contain raw enzymes, and fat. This causes the ENS to evacuate the colon. The higher the concentration of acids, fat, and enzymes, the faster the speed at which evacuation occurs. Faster speeds will also cause cramping.

Cramping can occur when the speed of food soup is 'too fast', and a Barrier is formed with its associated bloating. This is the MMC attempting to force food though the Barrier. Cramping may also occur when the intestinal wall muscles are moving food soup at speed, in any part of the intestine. This cramping is accompanied by loud borborygmii.

4.1.1 Foods that speed up the digestive system

When the MMC is in charge of transport in the small intestine, some foods stimulate 'too fast' speeds. The outer coats of legumes and most cereals contain fibres that stimulate 'too fast' speeds in the small intestine. This fibre can be classed as insoluble, but not all types of insoluble fibre stimulate fast speeds.

Food	Speed	Food	Speed
Whole cereal flours	supersonic	Vegetables	slow
Whole cereals	very fast	Fruits	slow
White cereal flours	fast	Animal foods (raw)	slow
Polished cereals	fast	Animal foods (cooked)	stopped
Whole legumes	supersonic	Gluten	stopped
Dahls (hulled split legumes)	slow	Nuts and seeds	slow
Hempseed (machine ground)	fast	Dairy foods (cold, not sour)	slow or stopped

Table 5: Speed of foods when the MMC is in charge of transport
Legend (slowest first): stopped, slow, fast, very fast, supersonic

Other factors can cause express speeds; eating too much pungent, sour & salty food in hot & wet weather, eating too much bitter or dry food in cold & dry weather, eating raw food in cold & dry weather, and eating out of season foods.

4.1.2 Examination of fibre from cereals and legumes

The Figures referred to here are published in the original book.

1. ***Whole wheat flour…*** this food causes severe IBS symptoms. Insoluble fibre was extracted from whole wheat flour (machine ground), by boiling in 3% hydrochloric acid for several hours. The fibre consisted of large quantities of 'two dimensional' flakes of bran with sharply defined edges, ranging in size from 2mm to 0.01mm (see Figure_1, Figure_2, & Figure_3).
2. ***Whole white rice…*** this food causes slight to moderate symptoms of IBS. Insoluble fibre was extracted from polished rice by cooking, then crushing and boiling in 3% hydrochloric acid for several hours. The fibre consisted of large 'two dimensional' flat sheets of bran with sharply defined edges, ranging in size from 2mm to 5mm (see Figure_4).
3. ***Corn grits…*** this food causes no IBS symptoms. Insoluble fibre was extracted by boiling coarse corn meal (machine ground) in 3% hydrochloric acid for several hours. At 40x magnification the fibre consisted of three dimensional amorphous clumps and fragments (see Figure_5). At 400x magnification (see Figure_6), the fibre is tangled clumps of soft fibrils.
4. ***Oatmeal…*** this food causes moderate symptoms of IBS. Insoluble fibre was extracted from oatmeal by boiling in 3% hydrochloric acid for several hours. The fibre consisted of moderate quantities of 'two dimensional' flat sheets of bran with sharply defined edges, ranging in size up to 1.5mm (see Figure_7).
5. ***Whole rye flour…*** this food causes severe symptoms of IBS. Insoluble fibre was extracted by boiling in 3% hydrochloric acid for several hours. The fibre consisted of large quantities of 'two dimensional' flat sheets of bran with sharply defined edges, ranging in size up to 1.5mm (see Figure_8).
6. ***White barley flour…*** this food causes mild symptoms of IBS. Insoluble fibre was extracted by boiling in 3% hydrochloric acid for several hours. The fibre consisted of small quantities of 'two dimensional' flat sheets of bran with sharply defined edges, ranging in size up to 0.5mm (see Figure_9).
7. ***White millet flour…*** this food causes mild symptoms of IBS. Insoluble fibre was extracted by boiling in 3% hydrochloric acid for several hours. The fibre consisted of small quantities of 'two dimensional' flat sheets of bran with sharply defined edges, ranging in size up to 0.5mm (see Figure_10).

8. ***Whole teff flour…*** this food causes severe symptoms of IBS. Insoluble fibre was extracted by boiling in 3% hydrochloric acid for several hours. The fibre consisted of large quantities of 'two dimensional' flat sheets of bran with sharply defined edges, ranging in size up to 0.5mm (see Figure_11).
9. ***Whole sorghum flour…*** this food causes severe symptoms of IBS. Insoluble fibre was extracted by boiling in 3% hydrochloric acid for several hours. The fibre consisted of large quantities of 'two dimensional' flat sheets of bran with sharply defined edges, ranging in size up to 0.5mm (see Figure_12).
10. ***Blue pea endosperm (internal portion)…*** this food causes no IBS symptoms. Insoluble fibre was extracted by soaking whole beans overnight, removing the external coat, and boiling the crushed endosperm in 3% hydrochloric acid for several hours. The insoluble material was obloid and spherical lumps, 0.2mm in diameter (see Figure_13). Sharp edges were not visible.
11. ***Blue pea external coat…*** this food causes severe IBS symptoms. Insoluble fibre was extracted by soaking whole beans overnight, removing the external coat, crushing it and boiling in 3% hydrochloric acid for several hours. The fibre consisted of flat two dimensional sheets composed of crystalline rods, about 0.1mm long and 0.01mm in diameter (see Figure_14), densely packed perpendicular to the surface of the pea.
12. ***Haricot bean endosperm (internal portion)…*** this food causes no IBS symptoms. Insoluble fibre was extracted by soaking whole beans overnight, removing the external coat, and boiling the crushed endosperm in 3% hydrochloric acid for several hours. The insoluble material was ovoid and spherical lumps, 0.1 to 0.2mm in diameter. Sharp edges were not visible (see Figure_15 & Figure_16).
13. ***Haricot bean external coat…*** this food causes severe IBS symptoms. Insoluble fibre was extracted by soaking whole beans overnight, removing the external coat, crushing it and boiling in 3% hydrochloric acid for several hours. The fibre consisted of flat two dimensional fragments about 1 to 5mm in size (see Figure_17). At 400x magnification the material is seen to be composed of densely packed crystalline rods, about 0.03mm long and 0.01mm in diameter (see Figure_18). The rods are orientated at 90 degrees to the surface of the endosperm.
14. ***Moong bean endosperm…*** this food causes no IBS symptoms. Insoluble fibre was extracted by soaking whole beans overnight, removing the external coat, and boiling the crushed endosperm in 3% hydrochloric acid for several hours. The fibre consisted of obloid to spherical lumps, 0.1 to 0.2mm in diameter (see Figure_19). Sharp edges were not visible.
15. ***Moong bean external coat…*** this food causes moderate IBS symptoms. Insoluble fibre was extracted by soaking beans overnight, removing the skin, crushing and then boiling it in 3% hydrochloric acid for several hours. The fibre is fragments of light coloured coat with dark veins (see Figure_20). The dark veins contain crystalline rods orientated like the sleepers on a railway track (see Figure_21). Figure_22 shows 0.05mm by 0.01mm rods removed from the dark veins.
16. ***Brown lentil endosperm (internal portion)…*** this food causes no IBS symptoms. Insoluble fibre was extracted by soaking whole beans overnight, removing the external coat, and boiling the crushed endosperm in 3% hydrochloric acid for several hours. The fibre consisted of ovoid to spherical lumps, 0.2mm in diameter (see Figure_23). Sharp edges were not visible.
17. ***Brown lentil external coat…*** this food causes severe IBS symptoms. Insoluble fibre was extracted by soaking lentils overnight, removing the external coat, crushing it and boiling in 3% hydrochloric acid for several hours. The fibre consisted of flat two dimensional sheets. At 100x magnification (see Figure_24) the material is seen to be composed of densely packed crystalline rods, about 0.2mm long and 0.02mm in diameter. The rods are orientated at 90 degrees to the surface of the endosperm. There is also a layer of 'round' crystalline plates about 0.02mm in diameter.

4.1.3 Insoluble fibre

Currently all insoluble fibre is treated the same, but this research has identified three distinct types of insoluble fibre;

1. ***Cereal bran…*** sharp edged, 'two dimensional' flakes present in wheat, barley, oats, rye, millet, teff, sorghum, & rice. It causes severe IBS symptoms when present in large quantities in machine ground wholemeal flours. White flours with less fragments of bran cause milder symptoms. Notes; *Fonio was not tested. Corn does not contain bran and caused no symptoms.*
2. ***Legume micro-crystalline fibre...*** these tiny, hard, sharp edged crystalline rods and plates are found in the external coats of mature beans, peas and lentils. In high numbers they trigger severe IBS symptoms. Note; *Moong bean external coat contains less crystalline fibre and causes milder symptoms.*
3. ***Soft insoluble fibre…*** Soft amorphous material from corn, legume endosperm, fruits, vegetables, nuts, seeds & animal foods, does not cause IBS symptoms.

4.1.4 Foods that slow the digestive system

Some foods reduce the speed of the digestive system. This allows more time for dehydration to occur. The slowing effects are not seen when fibre from cereals and whole legumes, is eaten.

- ***Cooked animal protein foods***; chemicals called heterocyclic amines (HCAs) are formed when most animal proteins are heated to 40 degrees Centigrade or more. They have an anaesthetic action in the digestive system. Proteins cooked at high temperatures (fried/seared), and cooked red meats have the strongest effect. Cooked white meats & cooked egg yolks have less effect. Cooked egg white has no effect.
- ***Some dairy foods;*** have 'refrigerant properties' and/or contain 'opioid' peptides that slow the digestive system. These are sweet & cold dairy foods. Other dairy such as well fermented cheeses and yoghurts (sour & salty) may speed up the digestion.
- ***Gluten;*** is a protein found in some cereals. It contains 'opioid' peptides that can slow the digestive system.

4.1.5 Micro-minerals, depression and malnutrition

When a high starch, low fat diet containing cooked animal proteins is eaten, most starch & protein cannot be digested in the small intestine. Instead they are digested by bacteria in the colon. These bacteria supply vital micro-minerals by transforming indigestible inorganic micro-minerals into absorbable organic micro-mineral complexes. However IBS often causes colonic bacteria to be expelled before they can transform the minerals. Lack of these minerals causes depression and many symptoms of malnutrition.

4.2 Cholesterol management

The human body manages circulating free cholesterol with the ileum. The liver makes bile salts from cholesterol and stores them in the gall bladder. This process removes cholesterol from circulation. Bile salts are used to emulsify fats in the first and second sections of the small intestine and later on they can be recycled in the third section (ileum). The ileum brain controller manages this recycling process. When the body's cholesterol level is low, most bile salts are recycled. When the cholesterol level is high, bile salts are allowed to escape via the stool;

- ***IBS-A, IBS-D & some types of IBS-C***; the ileum brain controller's ability to manage the recycling of bile salts may be compromised and large amounts can be lost. The liver has priority over cholesterol supplies (for bile salt manufacture), and a cholesterol deficit will occur in the rest of the body.
- ***IBS-B;*** here the chemical sub-controller can no longer empty the gall bladder, and it becomes full. Excess cholesterol can no longer be reduced by making bile salts.

4.2.1 Symptoms of cholesterol deficit & excess

1. When excessive amounts of bile salts are lost, the liver demands extra cholesterol to make more. The brain has to supply most of this and it displays characteristic symptoms. These are visual hallucinations; kaleidoscopic moving patterns of colour that start near the centre of the visual field and radiate outwards. They can be followed by headaches and impaired brain function.
2. When the ability to eliminate excess cholesterol via the digestive process is compromised (IBS-B), it must instead be moved into organs such as the brain, and again visual hallucinations are caused. These are not as bad as those caused by a cholesterol deficit.

4.3 Glucose management

Brain activity is powered by glucose. So when the brain needs glucose the jejunum transport sub-controller is instructed to absorb it at a faster rate. However a defective sub-controller cannot do this, so a lack of glucose causes the brain to output visual hallucinations. These are similar to, but not as bad as, those caused by a cholesterol deficit.

Other parts of the body can also require extra glucose;

1. Leg muscles for fast running. When the jejunum transport sub-controller is unable to provide it, muscles will 'hit the wall' and only slow walking will be possible.
2. Extremities of the body are subjected to a severe temperature drop. Now there will be a demand for extra glucose to generate heat, but if the jejunum transport sub-controller cannot supply it then Raynaud's disorder will occur. The fingers, toes & face go white and numb.

4.4 Variable level of the autonomic nervous system

The activity level of the autonomic nervous system (ANS) is high on arising in the morning, and whenever environmental stress occurs. It usually declines as the day progresses and is lowest during sleep at night. The small intestine is controlled by five divisions of the ANS, so variation in its level affects transport speed in the small intestine, when the MMC is in charge.

- IBS symptoms are worst early in the morning. The characteristic symptom of the 'morning rush' occurs when the ANS relaxes the valve (ICV) terminating the ileum, the entire contents of the ileum move prematurely into the colon, and the colon is evacuated by the ENS in response to the presence of acids, raw enzymes and/or fat.
- The characteristic IBS-C & A symptom of bloating is worst on eating breakfast. The transport speed set by the MMC is higher, and so the strength of the Barrier erected by the primary controller is stronger.
- Other symptoms such as cramping and borborygmii are worst in the morning. Later in the day they diminish and may disappear overnight.
- If a stressful event occurs later in the day, causing the release of adrenal hormones, symptoms will intensify.

4.5 Climate, age & constitution.

- Living at arctic latitudes or high altitudes (cold & dry), worsens symptoms. At tropical latitudes (hot & wet), they improve.
- IBS is less severe in young people and more severe in old age.
- Some constitutions suffer more from IBS. Those that suffer most are thin and underweight. Substantial constitutions cope better.

4.6 Progression of the illness

A neuro-transmitter deficiency (or deficiencies) in the small intestine brain controller, may take decades to develop. IBS symptoms can be mild and irregular at first, then become more frequent, then continuous and possibly severe.

4.7 Other causes of IBS

For these types of IBS, the onset of symptoms will be expressed differently;

- Damage to the intestine from a toxic insult will cause symptoms immediately.
- Damage to intestinal nerves from abdominal surgery, will result in immediate symptoms.
- Pressure on nerves in the neck area from misaligned vertebrae, will cause intermittent symptoms.
- Damage to intestinal nerves from pregnancy or childbirth, will result in immediate symptoms that may be intermittent and may disappear once a period of healing is complete.
- Failure of nervous system development as an infant will cause symptoms to appear as soon as solid foods are fed.

5 Evidence for the model

5.1 No visible damage

Internal examination of IBS patients usually shows no damage that can account for the symptoms. The automated controls of the digestive system are where the problem(s) are likely to be.

5.2 Cereal and legume fibre

When consumption of cereals (not corn) and whole legumes is stopped, IBS symptoms are dramatically improved (Dobson, 2011; Sinclair, 2003). The insoluble fibre from these foods stimulates 'too fast' speeds when the MMC regulates transport in the small intestine.

5.3 Difficulty digesting fats

The model identifies these possible causes of fat in the stool (steatorrhea);

1. When severe bloating is a symptom, backpressure prevents the release of sufficient bile into the duodenum to digest all fats.
2. When a defective ileum causes continual diarrhoea, large amounts of bile can be lost. The gall bladder may no longer contain enough bile to digest all fat in the next meal.
3. When the chemical sub-controller is defective or there is damage to duodenal sensors that release CCK hormone, then IBS-B is caused, and insufficient bile is added to the duodenum to digest all fats.
4. Damage to duodenal sensors that release Secretin hormone, causes insufficient bicarbonate to be added to the small intestine. It becomes acidic, and fats are not digested.

5.4 Irritation around the anus

Diarrhoea is often accompanied by irritation of the skin around the anus. When the ileum no longer efficiently recycles digestive chemicals, bowel movements will contain raw protease enzymes. These attack the area around the anus.

5.5 Intestinal bloating

IBS bloating starts on arising when breakfast is eaten. Stress during the day increases it again. Overnight it can disappear. The autonomic nervous system is at a high level in the morning, high in response to stress and low overnight. It is likely to be causing the bloating.

The symptom of bloating displays two degrees. It is either severe in the upper abdomen, or slight to moderate in the mid-abdomen and hard-to-detect. The duodenum is short (25 cm). When the 'IBS Barrier' is at the start of the jejunum and the stomach continues to pump in food, bloating is severe (see Diagram_1). The jejunum is 2–3m long. When the Barrier is at the start of the ileum, it causes only slight to moderate bloating that is hard-to-detect (see Diagram_2).

5.6 Intestinal cramping

1. Cramping associated with bloating, is the MMC trying to move food soup through an 'IBS Barrier' created by a primary transport sub-controller. It pushes in one direction only (forward). The strength of the pushing depends on the types of food eaten, and the state of the autonomic nervous system.
2. Cramping associated with loud borborygmii is the MMC moving food soup 'too fast' in the intestine.
3. Cramping followed by diarrhoea, occurs when food soup moves prematurely into the colon. The soup may contain acids, enzymes & fats, and this insult causes the ENS to rapidly evacuate the colon, possibly with cramping.

6 Suggestions for testing the model

6.1 Two 'IBS Barriers' for IBS-C & IBS-A

Clinicians may be able to confirm the existence of the two 'IBS Barriers' predicted by the hypothesis for neuro-transmitter deficient IBS-C & IBS-A;

1. *'IBS Barrier' at the start of the jejunum;* the key symptom is immediate severe bloating in the upper abdomen on eating breakfast. If the Barrier persists, constipation results. If the Barrier relaxes quickly after breakfast, there is no constipation, and instead borborygmii & diarrhoea can occur (IBS-C Forms 1 & 2 and IBS-A Forms 1 & 2).
2. *'IBS Barrier' at the start of the ileum;* key symptoms are borborygmii soon after starting breakfast, then slight to moderate bloating in the mid-abdomen that is hard-to-detect. If the Barrier persists then constipation results. If the Barrier relaxes quickly after breakfast, symptoms may subside (IBS-C Forms 3 & 5), or borborygmii & diarrhoea may occur (IBS-C Forms 4 & 6).

Notes:

- IBS-C Forms 1 & 2 resemble IBS-A when the 'IBS Barrier' relaxes soon after breakfast and diarrhoea occurs instead of constipation.
- IBS-C Forms 4 & 6 resemble IBS-D when the 'IBS Barrier' is not detected, it relaxes soon after breakfast, and diarrhoea occurs instead of constipation. Diagnoses of IBS-D should be checked for the presence of a Barrier at the start of the ileum, by looking for mid-abdominal cramping, and measuring mid-abdominal diameter before and after breakfast.
- The two 'IBS Barriers' may be able to be detected by X-ray scanning the abdomen after a low fat breakfast that contains cereal fibre (not corn) and a signaling compound.

6.2 Three variations of borborygmii for IBS-D

Neuro-transmitter deficient IBS-D may display three variations of the symptom of borborygmii.

1. *The ileum transport sub-controller is defective;* borborygmii start several hours after breakfast (IBS-D Form 1).
2. *Both the ileum and jejunum transport sub-controllers are defective*; borborygmii will begin a short time after starting breakfast (IBS-D Form 3).
3. *All transport sub-controllers are defective or IBS-B is present;* borborygmii will begin almost immediately after starting breakfast (IBS-D Forms 2, 4, 5, & 6).

Notes:

- If digestive chemicals have been exhausted by continual diarrhoea, this test will not be possible.
- IBS-D Forms 2, 4, 5 & 6 will not be able to be individually identified, as their symptoms are so similar.
- IBS-C Forms 4 & 6 can resemble IBS-D. Diagnoses of IBS-D should be checked for a Barrier at the start of the ileum. If mid-abdominal cramping and/or increased mid-abdominal diameter are present after breakfast, then IBS-C is indicated instead of IBS-D.

6.3 Ratio of neurotransmitter deficient IBS types = 2 : 1 : 6 : 6

The hypothesis predicts that the ratio of cases of neurotransmitter deficient IBS-A: IBS-B: IBS-C: IBS-D will be 2 : 1 : 6 : 6. However if misdiagnosis of IBS-C as IBS-A or D occurs, then the number of cases of IBS-A & D will be more, and the number of cases of IBS-C will be less. IBS-B is not yet recognized by the medical profession as a type of IBS.

7. Coping with IBS symptoms

7.1 Stopping the symptoms

IBS symptoms are dramatically reduced by removing cereals & whole legumes from the diet, and making other commonsense adjustments (Dobson, 2011; Sinclair, 2003). Remaining symptoms can be substantially reduced with Relaxation Therapies (Blanchard, 1993, 2001; Dobson, 2011). When stress releases adrenal hormones, the autonomic nervous system moves to a higher level of activity, and IBS symptoms become worse. A cascade occurs…

Stress → IBS → more Stress → severe IBS etc.

Relaxation Therapies keep the level of adrenal hormones low, and the autonomic nervous system operates at a lower level of activity. The secondary controller (MMC) then moves food soup at a slower speed, the Barrier diminishes in strength, and the valve into the colon (ICV) is harder to open.

8. Future research

The author is currently developing a range of treatment programs for IBS. These programs are based on a change of diet, and the practice of a relaxation therapy. Together they remove most IBS symptoms. The hypothesis and the treatment programs will eventually be published in a more formal way.

Additional research;

- Further clinical observation of symptoms to confirm the hypothesis.
- Further refining of treatment programs.
- Location of the small intestine controller in the brain.
- Identification of the four unique neuro-transmitters in the small intestine brain controller.
- Identification of the receptor for the hormone Cholecystokinin (CCK) in the small intestine chemical sub-controller.

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