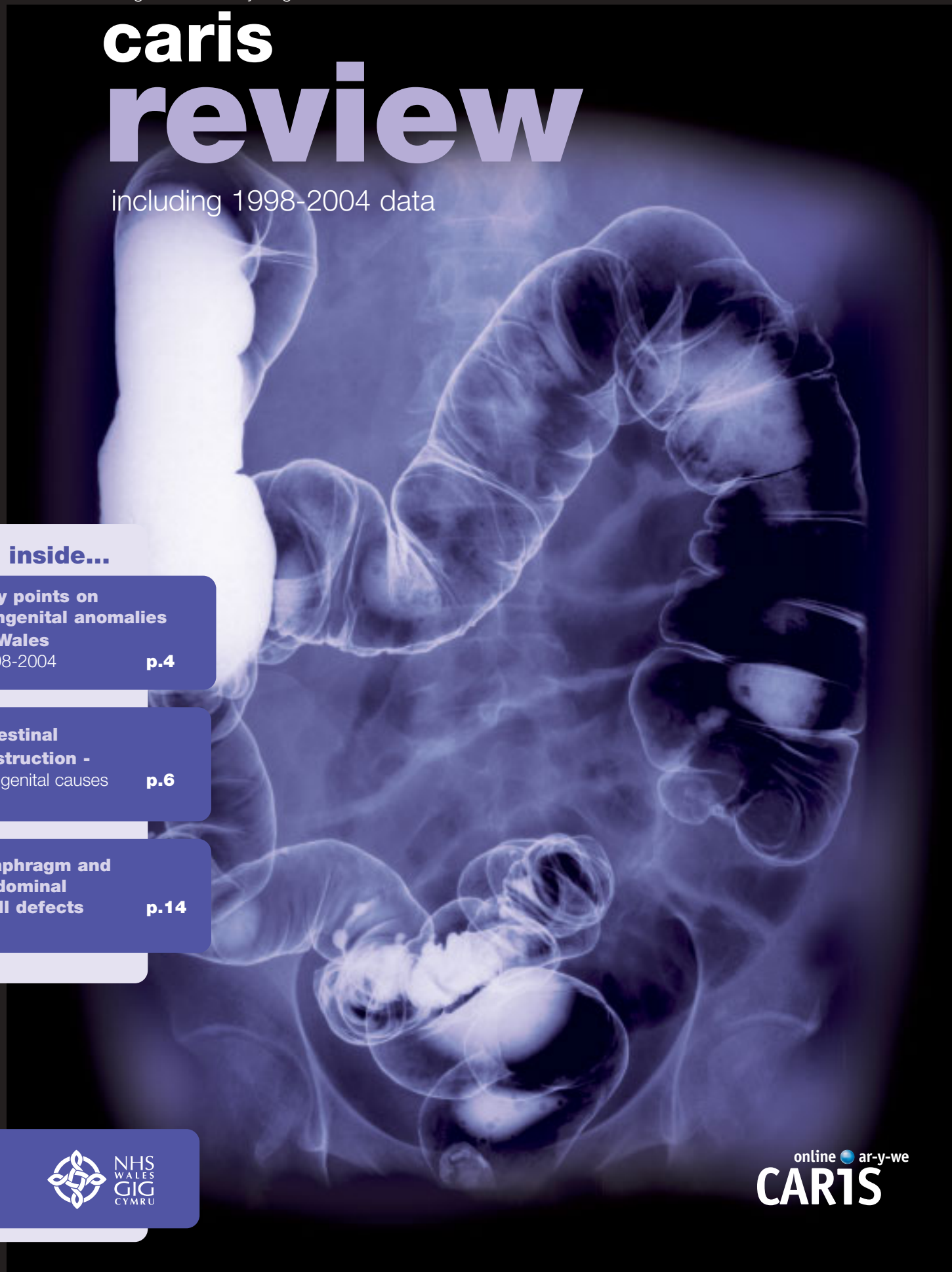
Congenital Anomaly Register & Information Service

caris review

including 1998-2004 data



inside...

NHS WALES GIG CYMRU

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CARIS, the Congenital Anomaly Register and Information Service for Wales, was established in 1998. Based at Singleton Hospital, Swansea, it is funded by the Welsh Assembly Government as part of NHS Wales.

Foreword

Welcome to the 2004 CARIS annual review. This year our special articles focus on some of the major anomalies of the intestines and abdomen. As in the last couple of years, detailed data tables are available from the CARIS website* on www.wales.nhs.uk/caris

Once again, we would like to express our sincere thanks to all contributing health professionals for their continuing support.

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The CARIS team at the 2003 South Wales Annual Meeting and website launch.

We are (left to right) David Tucker, Val Vye, Margery Morgan, Judith Greenacre, Debbie Rogers

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* *also accessible through the HOWIS (NHS Wales) website at www.howis.wales.nhs.uk/caris*

What is CARIS?

The fundamental aim of CARIS is to provide reliable data on congenital anomalies in Wales. This data can be used to study:

- **antenatal screening / interventions**
- **health service provision for affected babies and children**
- **possible clusters of birth defects and their causes**

We collect data on any baby or fetus, for whom pregnancy ended after 1st January 1998, where the mother was normally resident in Wales at the end of pregnancy.

CARIS uses a multiple source reporting system and over 100 individuals or agencies regularly send us information. Data from clinical and laboratory sources are reported via warning cards, reporting forms and data exchanges. CARIS co-ordinators in each trust are responsible for much of the clinical reporting. In the CARIS office, data are collated, information is coded and the data quality carefully checked. The data are then available for feedback to clinicians – paediatricians, ultrasonographers, midwives, etc. As well, we supply information to the National Assembly for Wales, EUROCAT and the Office for National Statistics (NCAS) for surveillance.

We cannot over emphasise the importance we give to data confidentiality. We operate a strict security and confidentiality policy. We have gained support under Section 60 of the Health and Social Care Act 2001, meaning that the register can continue collecting and analysing this valuable information.

Over 37,000 recorded pregnancies occur in Wales each year. Of these, about three quarters are registered as live or still births, the rest ending in termination or spontaneous loss of the fetus before the 24th week of pregnancy. About 3% of births take place at home. Wales has 16 consultant obstetrics units and 10 midwifery / general practitioner units. The majority of births take place in these units. However, a significant number of births to Welsh mothers occur in hospitals across the English border. Good links with congenital anomaly registers that border Wales (Mersey, West Midlands and the South West of England) remain very important.

Clinical reporting is the most important source of information for CARIS, especially for those babies who:

- **die but do not have a post mortem**
- **survive and have anomalies not requiring immediate specialist help.**

Diagnostic services, particularly ultra sound scanning and pathology, can alert us to a case or give valuable further information.

Regional services including cytogenetics and specialist clinical services can help by providing more details of the anomalies involved.

Babies with congenital anomalies may be recorded on other databases, such as PROTOS (Cardiff), the all Wales Perinatal Survey or the Standard Child Health Computer System.

Key points on congenital anomalies in Wales 1998-2004

- 10,026 cases of confirmed congenital anomaly have been reported to CARIS with pregnancy ending between 1st January 1998 and the 31st December 2004. These include live births, still births, terminations of pregnancy for congenital anomalies and miscarriages (although reporting of miscarriages will inevitably be incomplete). This means that the "gross"* rate of known pregnancies affected by congenital anomaly is 4.5%.
- 84% of cases were live born, so that the percentage of live born babies affected by congenital anomalies is 3.8%. CARIS makes every effort to ensure that babies who die during the first year of life are identified. According to our records, over 95% of live born babies with a congenital anomaly survived to the end of their first year of life. This percentage is higher than we have reported in previous years, probably as a result of increased availability of data from inpatient hospital records and community child health computer systems.
- In over half of cases only one birth defect is recorded. In about 11% of cases an underlying chromosomal disorder was identified that could account for many of the physical anomalies. The remainder of cases had multiple anomalies of varying levels of complexity.
- As in previous years defects of the heart and circulation are the largest single group of anomalies, followed by defects of the limbs, urinary system and musculoskeletal system.
- Even allowing for the fact that more male babies are born each year than females, there is a slight excess of congenital anomalies in male babies.

**the gross rate includes fetal losses, terminations of pregnancy, live and still born babies*

- As before, marked variations in congenital anomaly rates are seen around Wales, with apparently much higher rates for Swansea and Neath Port Talbot compared to other areas. Lower rates are seen in some areas of the South Wales valleys, Mid Wales and parts of North Wales. Some of this variation remains due to persistent differences in reporting practices across Wales (See Reporting of anomalies in Wales: CARIS Review 2003). The areas with highest rates tend to have better survival rates for live born babies. This may, again, reflect better reporting of cases in infancy, allowing more survivors to be added to the numbers from better reporting areas.
- Rates for many anomalies in Wales appear relatively high when compared to other areas of Britain and Europe. This was discussed in detail in the 2003 CARIS Review. We continue to suspect that good reporting in Wales accounts for a large part of these differences.
- Data tables and a more detailed commentary are available on the CARIS website **www.wales.nhs/caris**

Summary

- Gross rates of (all) congenital anomalies reported is 4.5%.
- 84% of cases are live born.
- 95% of live born cases survive to the end of their first year.
- Heart and circulatory defects are the largest single group.
- Variations in rates exist around Wales.
- Congenital anomaly rates in Wales are often apparently higher than for other areas of Europe or Britain.

CARIS activity 2004

The team has been involved with projects in Wales, United Kingdom and Europe.

Wales

- Cluster investigation: CARIS contributed to the group investigating a cluster of gastroschisis cases in South Wales. No obvious cause or association was found.
- Surveillance in Wales: CARIS funded a statistician to work with Health Solutions Wales for 1 year to assess the feasibility of improved surveillance of congenital anomalies in Wales. Proposals are now being developed.
- Antenatal Screening Wales: CARIS is collaborating with the development of a new ultrasound module of RADIS (radiology information system) and has also provided data to assess the effectiveness of Down screening. Preliminary work has begun on a population based ultrasound soft marker study.
- Annual meetings were held in Bridgend and Llandudno with a focus on urinary tract anomalies.

United Kingdom

- BINOCAR conference: CARIS hosted the annual conference of the British Isles Network of Congenital Anomaly Registers in the Angel Hotel, Cardiff Oct 2004. Two presentations from CARIS were given
  - Welsh data on gastroschisis
  - the value of inpatient (PEDW) data to identify cases of congenital anomaly
- Gastroschisis: CARIS contributed Welsh data to the English Chief Medical Officer's annual report 2004.

Europe

- Attended the EUROCAT (European Collaboration of Congenital Anomaly Registers) conference in Bergen – June 2004 contributing to the coding and classification committee.

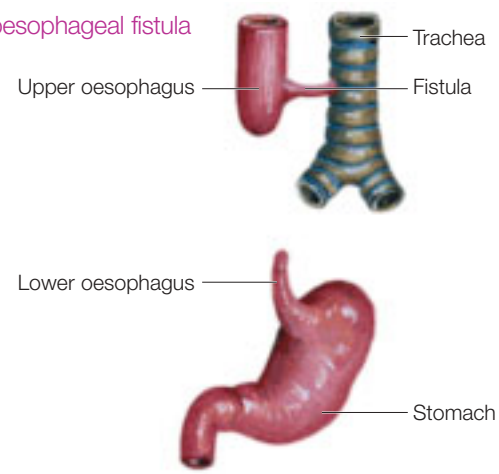
Congenital causes of intestinal obstruction

Tracheo-oesophageal fistula/atresia (TOF)

What is tracheo-oesophageal fistula/atresia?

Oesophageal atresia occurs when the upper part of the oesophagus is closed off, meaning that nothing can pass from the mouth to the stomach. The condition is usually (85% of cases) associated with the lower part of the oesophagus being joined to the trachea – tracheo-oesophageal fistula *(figure 1)*.

figure 1: Tracheo-oesophageal fistula



From 1998 to 2004, CARIS has registered 75 cases of tracheo-oesophageal fistula / atresia, of which 51 were live born (1 in 4350 live births). This is similar to rates published in the literature (1 in 3,500 to 5,000 births[1]). In 19 cases, pregnancy was terminated. Three cases were miscarriages and the remaining 2 were stillborn. Oesophageal atresia was associated with tracheal fistula in 90% of CARIS cases.

Development of TOF

During the 4th week the foregut divides into respiratory and oesophageal parts. When this fails, a defect in the tracheo-oesophageal septum occurs and this enables a communication between trachea and oesophagus.

The cause of TOF is unclear. Most cases occur sporadically with a recurrence risk being quoted as less than 1% in subsequent pregnancies.

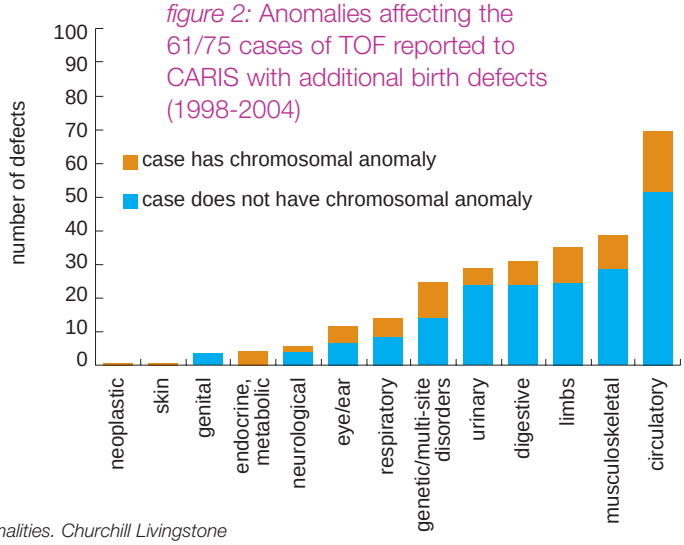
Additional anomalies were reported in 62 / 75 (83%) cases of TOF reported to CARIS – higher than might be expected from the literature. The pattern of anomalies reported was as expected *(figure 2)*. Of the 75 cases, 32 had chromosomal disorders or other recognisable syndromes, notably including:

13 VATER association
8 Trisomy 18 (Edward's syndrome)
3 Trisomy 21 (Down syndrome)
2 sirenomelia
1 cri du chat

VATER association

- **V** Vertebral anomalies
- **A** Anorectal anomalies
- **T** }Tracheo-oEsophageal anomalies
- **E** }
- **R** {Renal anomalies
  {Radial anomalies

figure 2: Anomalies affecting the 61/75 cases of TOF reported to CARIS with additional birth defects (1998-2004)



[1] *Twining P, McHugo,J, Pilling D 2000 Textbook of Fetal Abnormalities. Churchill Livingstone*

Congenital causes of intestinal obstruction

Diagnosis

Diagnosis is unlikely at the 20 week ultrasound scan but the stomach may appear small or absent. The most common finding is polyhydramnios in the 3rd trimester, caused by the inability of the fetus to swallow amniotic fluid. For CARIS cases, timing of diagnosis has been reported for 51 / 75 cases and suggests that 12 (24%) of these cases were diagnosed antenatally. The fact that 16 cases (31%) were diagnosed at post mortem (often following termination of pregnancy) suggests that decisions on management of these cases were based on identification of associated anomalies rather than the TOF.

Immediately after birth the baby produces large amounts of frothy saliva dribbling from the mouth with choking, dyspnoea and episodes of cyanosis. Inability to pass a catheter down the oesophagus will confirm the diagnosis. On chest X ray the presence of gas in the bowel will indicate a TOF. CARIS data suggests that at least 39 / 51 live born cases (77%) were diagnosed at or just after birth.

Management and outlook

If there is significant polyhydramnios the increased uterine size can precipitate premature labour and delivery which can cause its own problems. Otherwise the prognosis is good if there are no other anomalies.

Key features of management are shown in *figure 3*. Feeding is a postoperative challenge and there can be long term problems related to this.

figure 3: Management of TOF

- **nurse upright**
- **withhold feeding**
- **suction to oesophageal pouch**
- **definitive surgery once stable**
- **look for associated anomalies**

Of the 51 live born CARIS cases, 47 (92%) are thought to have survived to the end of their first year of life. Survival was lower (77%) for babies with other recognised syndromes or chromosomal defects. Conversely, 97% of babies without these problems survived 1 year.

Pyloric stenosis

Pyloric stenosis involves thickening of the pyloric sphincter of muscle between the stomach and duodenum. This means that the stomach can no longer empty, giving rise classically to projectile vomiting as the stomach contents are expelled back up through the oesophagus.

The condition is relatively common occurring in about 1 in 400 live births. Boys are far more often affected than girls, in a ratio of around 4:1[2]. Historically, reporting of this condition to CARIS was known to be incomplete. Recent links to inpatient data has led to better ascertainment in many areas. CARIS now has records of 365 (live born) cases between 1998 and 2004, giving a rate of 16.5 per 10,000 or 1 in 600 live births. The male: female ratio is 5:1 in Wales.

Pyloric stenosis classically develops after birth but is considered as a congenital

[2] *Davenport M. ABC of General Surgery in Children: Surgically correctable causes of vomiting in infancy. BMJ 1996;312:236-239 (27 January)*

Congenital causes of intestinal obstruction

anomaly as its origins are thought to lie in prenatal influences. There is a genetic component, particularly through the maternal line[1]. Post natal factors also play a part as a seasonal prevalence has been described and maternal smoking has been reported as a risk factor[3]. Breast feeding has been suggested as protective. CARIS does not have sufficient data to allow analysis of seasonal variation in the presentation of this condition and does not collect information on breast feeding. Reported levels of maternal smoking for cases of pyloric stenosis (40%) is higher than for all cases of congenital anomaly reported to CARIS (29%), although this difference is not statistically significant.

CARIS data shows that the condition occurred as an isolated anomaly in about 90% of cases. The fact that the remaining 10% were associated with additional anomalies (over twice that expected for births as a whole) supports the theory of a congenital origin for this condition.

Clinical picture

Infants have normally established successful feeding but then start vomiting after feeds (no bile). The infants remain hungry and eager to feed. The condition rapidly progresses to projectile vomits after every feed and, without treatment, the baby loses weight and becomes dehydrated. A pyloric mass may be felt on feeding and visible peristalsis is sometimes seen. If the diagnosis is still in doubt, abdominal ultrasound may be helpful.

The peak time for onset of symptoms is around the 3rd to 6th week of life, although some cases start from birth whilst others develop later in infancy. This picture is confirmed by CARIS data *(figure 4)*.

[3] *Toft Sorensen H, Norgard B, Pedersen L et al. Maternal smoking and risk of hypertrophic infantile pyloric stenosis: 10 year population based cohort study. BMJ 2002; 325:1011-1012 (2 November)*

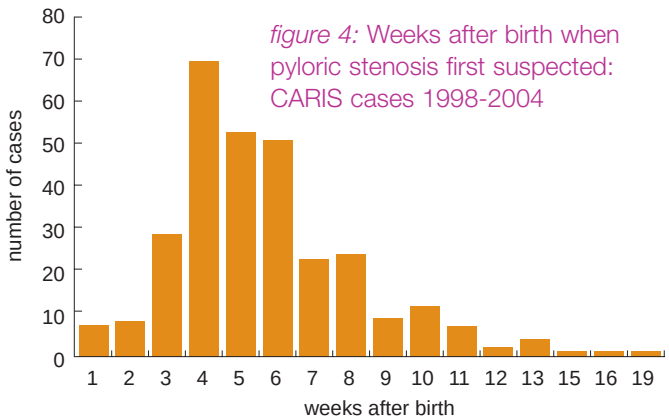


figure 4: Weeks after birth when pyloric stenosis first suspected: CARIS cases 1998-2004

Management and outlook

Management involves correction of dehydration and electrolyte imbalance followed by surgery to cut the pyloric sphincter (Ramstedt's pyloromyotomy). The outcome of surgery and longer term prognosis is usually excellent although the condition has been linked to sudden unexplained death in infancy. CARIS data suggests survival rates to one year to be in excess of 99%.

Duodenal atresia

This is a complete blocking of the duodenum and is the most common type of small bowel obstruction. CARIS has 23 cases recorded with pregnancy ending in 1998-2004. Of these, 20 were live born, agreeing with the accepted occurrence rate of 1 in 10,000 live births.

Development of duodenal atresia

Between the 5th and the 11th week of development, the canal through the duodenum becomes blocked as the tube around it grows rapidly. Re-canalisation occurs as the extra epithelial cells die. In duodenal atresia this reformation of the tube fails in a short segment. Most atresias are located beyond the opening of the bile duct.

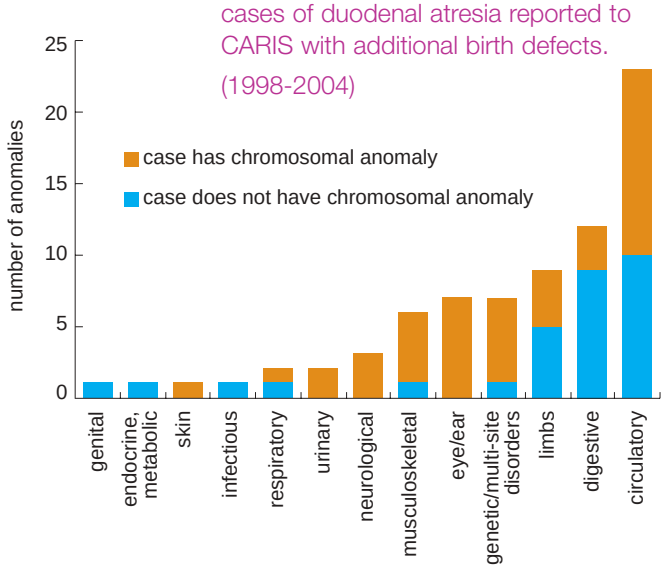
Congenital causes of intestinal obstruction

Thalidomide taken by mothers between the 30th and 40th day of gestation has resulted in duodenal atresia, supporting the view that it could be caused by an early embryonic insult.

Duodenal atresia is commonly associated with other defects, particularly chromosomal anomalies and the VATER association. Down syndrome is said to be associated with up to 30% of cases of duodenal atresia [2].

Of the 23 cases reported to CARIS, about one third (8 cases) occurred as an isolated defect. Six cases (26%) were associated with underlying chromosomal anomalies, including 4 cases of Down syndrome (less than might be expected from other published sources, although numbers are small) and 1 case had the VATER association. The types of anomalies found in association with duodenal atresia are summarised in *figure 5*. This shows how a large number of the reported associated defects are also linked to underlying chromosomal anomalies.

figure 5: Anomalies affecting the 15/23 cases of duodenal atresia reported to CARIS with additional birth defects. (1998-2004)



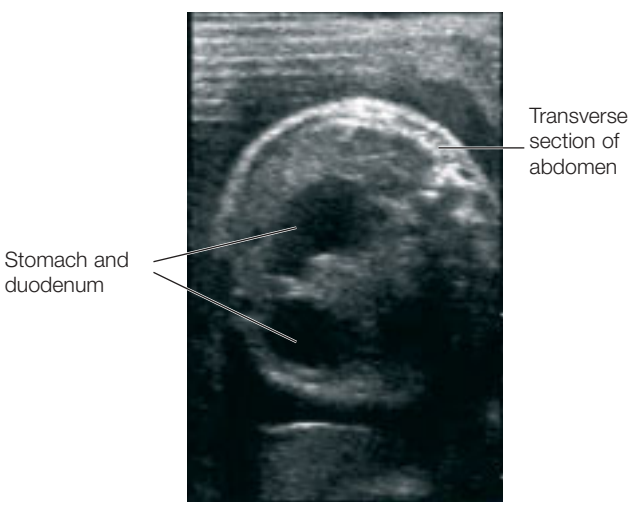
Diagnosis

Diagnosis is not always possible antenatally. Possible indications from antenatal ultrasound are summarised in *figure 6* and *figure 7*. If these are present, it is important to search for other anomalies and to consider karyotyping.

figure 6: Antenatal ultrasound findings in duodenal atresia

- **rarely seen before late 2nd trimester**
- **dilated duodenum – sometimes duodenal peristalsis is seen**
- **double bubble – stomach and duodenum appearing as similar sized fluid filled structures**
- **polyhydramnios**

figure 7: Ultrasound of fetus with duodenal atresia, showing a double bubble.



Normal intestinal absorption of amniotic fluid is prevented, often causing polyhydramnios, which may suggest the condition during the third trimester of pregnancy. This may also trigger premature labour and delivery.

Congenital causes of intestinal obstruction

Clinical suspicion of the condition is raised by vomiting which begins within a few hours of birth and almost always contains bile.

CARIS data includes information relating to time of diagnosis on 20/23 reported cases. Of these, 13 were detected antenatally (65%) although in some cases this was closely associated with detection of underlying chromosomal defects.

Management and outlook

With intravenous support early surgery is needed to join the two ends of the duodenum together. In the absence of other anomalies the outlook is generally good.

Of the live born cases known to CARIS, 18/20 (90%) are thought to have survived to the end of the first year of life.

Other small bowel atresia/ stenosis

Atresias of the jejunum or ileum are rarer than those of the duodenum.

CARIS has reports on 33 cases of jejunal or ileal atresia, of which 28 (85%) were live born, giving a rate of about 1 in 7,700 live births. Together with duodenal atresia, small bowel atresias occur in approximately 1 in 4000 live births in Wales. The 33 cases comprised:

- 15 cases jejunal atresia (13 live born, or 1 in 16,500 live births)
- 16 cases ileal atresia (13 liveborn, or in 1 in 16,500 live births)
- 2 cases multiple atresias

Small bowel atresia distal to the duodenum is thought mainly to be due to 'vascular accidents' during critical periods of development. Such accidents may be secondary to malrotation, volvulus, gastroschisis, exomphalos and other factors. Additional anomalies, particularly those relating to these conditions may again be present. CARIS data shows that 5 / 16 (31%) of ileal cases reported to CARIS were associated with gastroschisis. The link to chromosomal disorders (6%) is less marked than for duodenal atresia.

The clinical picture for jejunal or ileal atresia is similar to that of duodenal atresia with:

- some cases identified on antenatal ultrasound
- polyhydramnios in the third trimester and associated premature labour
- vomiting within the first day or so of life (the vomit is bile stained as the defect is beyond the bile duct).

Data suggest that, of 25 cases with potential for antenatal detection, small bowel atresia was identified in 6 cases (24%).

Treatment and outlook (in the absence of other anomalies) are broadly similar to duodenal atresia. Among the CARIS live born cases, 28 / 30 (93%) are thought to have survived to the end of their first year of life.

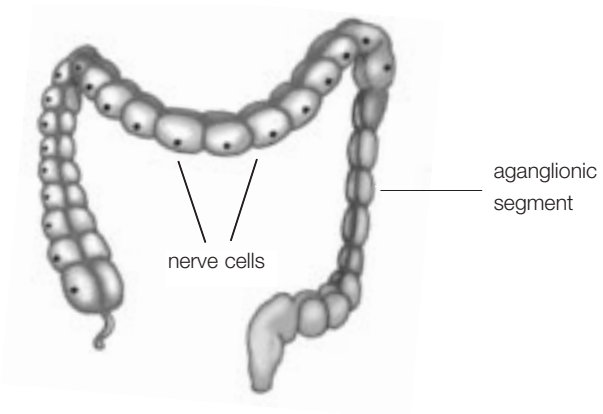
Hirschsprung's disease

Congenital megacolon may arise secondary to atresia or agenesis of the distal colon or anorectal areas. More commonly, it is caused by a functional blockage of the bowel due to an absence of autonomic ganglion cells in the bowel wall (aganglionic megacolon or Hirschsprung's disease - *figure 8*). The affected bowel lies distal to the dilated segment of colon.

Congenital causes of intestinal obstruction

For the years 1998 – 2004, 46 cases of Hirschsprung's disease have been reported to CARIS (all live born), giving a rate of 1 in 4800 live births, similar to generally published figures of 1 in 5000[5].

figure 8: Hirschsprung's disease



Development of Hirschsprung's disease

The condition arises during the fifth to seventh weeks of development when neural crest cells fail to migrate into the wall of the colon. Most cases are sporadic and it occurs more frequently in males (CARIS male to female ratio is 2.8 to 1). The condition is now known to have a genetic basis. Associated anomalies are uncommon and in almost three quarters of CARIS cases (34), no additional defects were reported. One baby reported to CARIS also had trisomy 21, in keeping with a known association with Down syndrome in 2-5% of cases.

Clinical picture

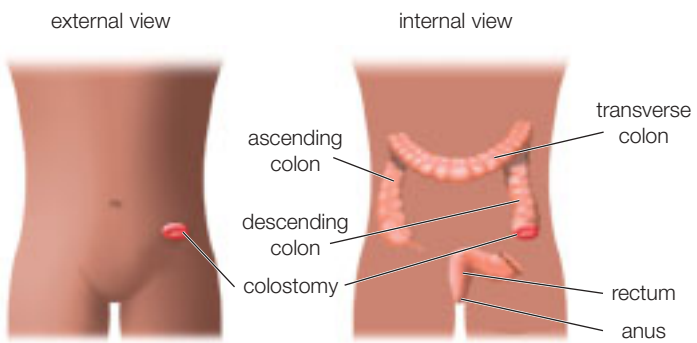
The condition is only occasionally diagnosed by antenatal ultrasound (through detection of dilated large and small bowel). At birth there is delay in the passage of meconium, Approximately 85% of cases will develop problems such as abdominal distension and constipation within the first month of life [6].

CARIS data available on 43/46 cases suggests that none were detected antenatally but 32 (74%) were detected by 4 weeks of age.

Investigations include an abdominal X ray which shows distended small and large bowel, and a barium enema. A rectal biopsy gives the definitive diagnosis.

A defunctioning colostomy or ileostomy is the initial treatment *(figure 9)*. This is followed by a definitive procedure in the baby's first year of life to resect the aganglionic segment and restore the colonic anatomy.

figure 9: Bowel resection and colostomy



Early diagnosis and surgery give good results although faecal soiling (incontinence) has been reported in

[5] *Losty P. Recent advances: Paediatric surgery. BMJ 1999;318:1668-1672 (19 June)*

[6] *Hull D, Johnston D. Essential Paediatrics. 1981 Churchill Livingstone*

Congenital causes of intestinal obstruction

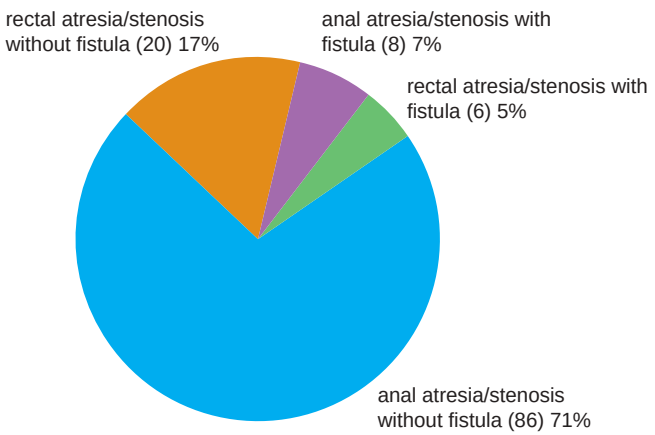
up to 80% of cases several years post operatively.[7] Among CARIS cases, 45/46 (98%) were thought to have survived infancy.

Rectoanal atresias

Rectoanal atresias are said to occur in 1 in 4000 to 5000 live births and occur with or without a fistula. The commonest forms involve the anus (imperforate anus).

For the years 1998-2004, 120 cases were reported to CARIS, giving a 'gross' rate of 5.4 per 10,000 live & stillbirths. Of these, 26 had atresias of the rectum and 94 (78%) had anal defects (*figure 10*). Fifty nine cases (49%) were live born, giving a rate of 1 in 3,800 livebirths. Of the remainder, pregnancy was terminated in 43 cases (36%) and the rest were fetal losses or stillborn.

figure 10: Types of rectoanal atresia reported to CARIS 1998-2004



[7]*Kamm A. Fortnightly review: Faecal incontinence. BMJ 1998;316:528-532 (14 February)*

Development of rectoanal atresias

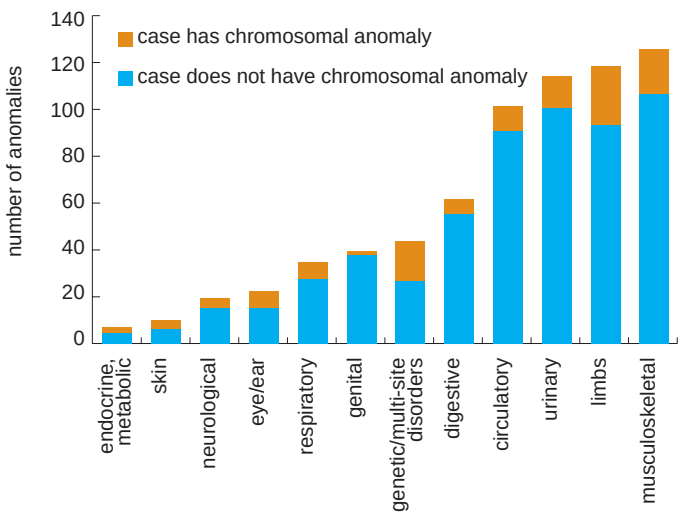
These atresias arise as a result of incomplete formation of the hindgut with deviation of the urorectal septum by the 7th week of gestation. They are commonly associated with other significant anomalies.

Among CARIS cases, 102 / 120 (85%) were associated with additional anomalies and 57 of these had underlying syndromes:

- VATER association (18 cases)
- Sirenomelia (6 cases)
- Trisomy 18 (4 cases)
- Trisomy 21 (2 cases)
- Other chromosomal disorders (8 cases)
- Other syndromes (19 cases)

Figure 11 shows the types of anomaly found among cases of rectoanal atresia and those associated with underlying chromosomal defects.

figure 11: Anomalies affecting the 102/120 cases of rectoanal atresias reported to CARIS as having had additional birth defects (1998-2004)



Congenital causes of intestinal obstruction

Diagnosis and management

CARIS data show a potential for antenatal detection in 68 cases. Of these, 10 (14.7%) rectoanal defects were detected antenatally with a further 53 (78%) identified perinatally. The relatively high rate of termination of pregnancy associated with this defect is probably related to antenatal detection of associated conditions and underlying syndromes.

At birth, the absence of an anal orifice is easily identified at routine examination. Higher atresias may be more difficult to detect.

In the past, several operations were needed to treat the defect. More recently, development of the PSARP (posterior sagittal anorectoplasty) has improved surgical treatment and outcome. It involves an initial colostomy followed by major reconstructive surgery later in infancy.

Despite the presence of other anomalies and the need for major surgery, CARIS data suggests that 51 / 59 (86%) live born cases survived the first year of life.

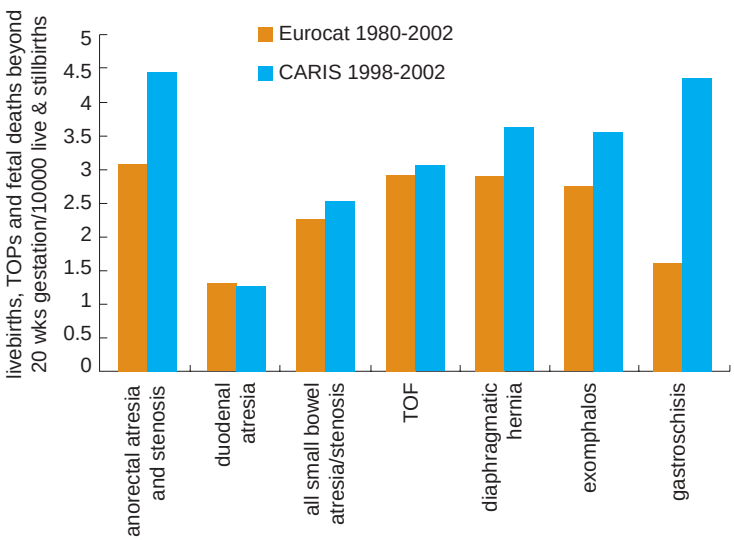
Longer term outlook presents a mixed picture, due to the presence of other anomalies. Post surgical complications include faecal incontinence, occurring in 50-80% of adolescents and adults treated for anal atresia [7].

How does CARIS data compare with elsewhere?

Rates of congenital intestinal atresia published by CARIS are at least as high as those in published literature and EUROCAT. This suggests that case ascertainment is satisfactory (*figure 12*). This figure also includes comparisons for abdominal wall conditions discussed in the next chapter.

Previous problems with reporting conditions such as pyloric stenosis are resolving although some cases may still be missing. Data relating to outcome and additional anomalies also agrees with the published literature.

figure 12: Total prevalence rates for selected abdominal conditions: comparison of EUROCAT and CARIS rates. (Source: EUROCAT 2005)



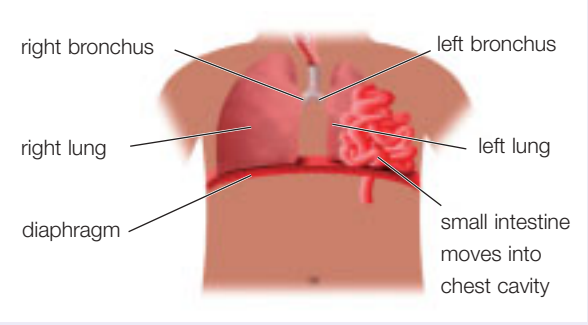
Congenital defects of the diaphragm and abdominal wall

Congenital diaphragmatic hernia

This is an abnormal opening in the diaphragm that allows part of the abdominal contents to move into the chest cavity before birth (*figure 13*).

The defect is quoted as occurring in 1 in 2200 – 5000 live births every year[8]. CARIS has reports of 87 cases with pregnancy ending 1998-2004 giving a gross rate (all cases) of 3.9 per 10,000 live and stillbirths. Of these cases, 59 were live born (1 in 3700 live births in Wales). In 24 cases, pregnancy was terminated and the remaining 4 were miscarriages.

figure 13: Congenital diaphragmatic hernia



Development of CDH

The basic components of the diaphragm normally fuse by the end of the 6th week of embryonic life. In the10th week the intestines return to the abdominal cavity from the umbilical cord. If the diaphragm has not completely closed some abdominal organs may pass into the chest. These commonly include stomach, spleen and most of the intestines. The heart and lungs are pushed forwards by these organs. As a result of the compression, lung development is compromised causing pulmonary hypoplasia. This can cause life threatening breathing difficulties at birth which require immediate attention[9].

The exact cause of the condition is unknown. There is a 2% recurrence rate in subsequent pregnancies. In most babies CDH is an isolated defect but associated anomalies are common and include cardiovascular, genitourinary, musculoskeletal and CNS defects. Underlying chromosomal disorders include trisomy 21, trisomy 18 and deletion of the short arm of chromosome 12.

Among CARIS cases, 56 / 87 (64%) were reported as having additional defects. The general pattern of anomalies are shown in *figure 14*. Underlying syndromes include:

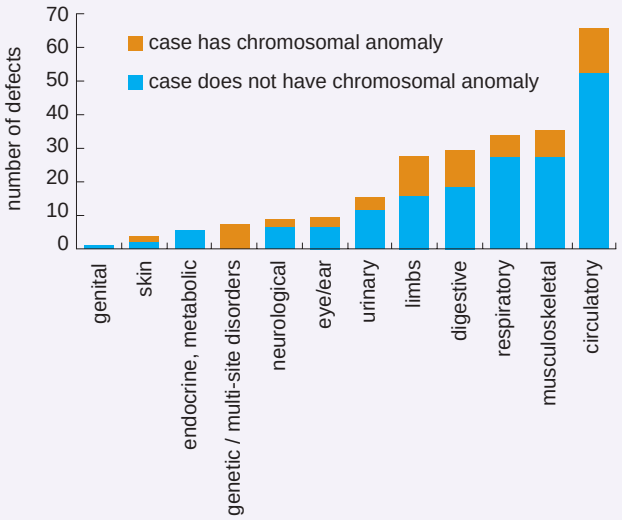
- Trisomy 18 (4 cases)
- Trisomy 21 (1 case)
- Chromosomal rearrangements involving short arm chromosome 12 (2 cases)
- Limb body wall complex (2 cases)
- Fryn syndrome (1 case)

[8] *High Risk Pregnancy Management Options. James, Steer, Weiner et al. 1995 (London) Saunders.*

[9] *Before We are Born. Essentials of Embryology and Birth Defects (6th Edn). Moore & Persaud. 2003 (Philadelphia) Saunders*

Congenital defects of the diaphragm and abdominal wall

figure 14: Anomalies affecting the 56/87 cases of CDH reported to CARIS with additional birth defects (1998-2004).



Antenatal diagnosis

From 18 weeks gestation the defect is often visible on antenatal ultrasound. Key features are shown in *figure 15*. Of cases in Wales where data on antenatal detection is available, 63% were detected antenatally (in keeping with other published rates.)[10]

figure 15: Antenatal Ultrasound Findings

- **possible from 18 weeks gestation**
- **hernia is most common on the left**
- **cardiac displacement from left to right**
- **stomach may be visible next to the heart**
- **right lung may look compressed**

Management and outlook

Compression occurring between 17 and 24 weeks gestation and severity of mediastinal shift usually predict the extent of pulmonary hypoplasia. The baby will need respiratory support from birth and therefore the ideal situation is for the mother to be delivered in a specialist unit. Most centres delay surgical repair until a period of stabilisation has occured which gives members of the team (including cardiologists) time to plan the appropriate surgery. Either a primary repair of the diaphragm is done after retrieving the intestines or a prosthetic implant may be needed to close the defect. Respiratory support is necessary from birth until the infant recovers from surgery. Some babies are placed on ECMO (extracorporeal membrane oxygenation) which gives the lungs a chance to recover and expand after surgery by acting as a heart/lung bypass machine.

The outlook for live born infants with CDH has greatly improved with advances in neonatal intensive care and ventilation. Some centres quote survival rates of over 80% for live born babies. Of the 59 Welsh cases, 44 (75%) are thought to have survived to the end of their first year of life.

Survival depends largely on how much the hernia has affected lung development and the consequences of other defects present (*figure 16*). Survivors of surgery have a high incidence of respiratory and gastrointestinal problems. Some babies require oxygen long term, many have trouble with gastric reflux and some have difficulties with development.

[10] *Smith NC, Hau C. A six year study of the antenatal detection of fetal abnormality in six Scottish Health Boards, BJOG 1999 106:206-212*

Congenital defects of the diaphragm and abdominal wall

figure 16: Poor prognostic signs in CDH

- **other anomalies (e.g. chromosomal, cardiac)**
- **diagnosis before 24 weeks**
- **stomach and / or liver in the chest**
- **polyhydramnios**
- **fetal hydrops**
- **intrauterine growth restriction**

Anterior abdominal wall defects

A variety of defects can develop in the anterior abdominal wall, which may require extensive neonatal surgery. Gastroschisis is one such defect that has received considerable attention in Wales in recent years. Other major abdominal wall defects include exomphalos and prune belly syndrome.

Exomphalos

Exomphalos (or omphalocele) occurs when there is a herniation of abdominal contents into the umbilical cord.

The defect is said to occur in 1 in 3,500 to 6000 births. CARIS has received reports on 98 cases in Wales with pregnancy ending 1998-2004, giving a gross rate of 4.4/10,000 live & stillbirths. Of these, 34 were liveborn (1 in 6,700 births). The potential for antenatal detection of both the defect and any associated chromosomal disorders has increased in recent years (see below). This may account for the relatively high numbers of terminations of pregnancy for this condition (47 / 98 or 48% of Welsh cases). Again because of other anomalies, the condition has a high spontaneous loss rate with 17 / 98 Welsh cases (18%) ending in miscarriage or stillbirth.

Cause of exomphalos

At the beginning of the sixth week of gestation the midgut develops in the proximal part of the umbilical cord. At about 10 weeks the intestines return to the abdomen. Exomphalos occurs when these abdominal contents fail to return to the abdominal cavity. Normally this involves only the intestines but other abdominal organs may also be involved.

The exact cause of the condition is unclear. Underlying chromosomal defects and associated anomalies are said to occur in up to 50% of cases[11]. Additional anomalies or underlying conditions have been reported in 85% of CARIS cases. Associated anomalies are shown in *figure 17* and include the following major syndromes.

• Trisomy 18 (Edwards syndrome)	22 cases
• Trisomy 13 (Patau syndrome)	6 cases
• Triploidy / polyploidy	4 cases
• Trisomy 21 (Down syndrome)	1 case
• Other chromosomal defects	9 cases
• Beckwith Wiedemann syndrome	9 cases
• Limb body wall complex	5 cases
• Constriction bands	2 cases
• Other specific syndromes	6 cases

[11] *Loadsman J. Abdominal wall defects (exomphalos and gastroschisis) RAHC 12/10/94. Accessed at www.usyd.edu.au/su/anaes/lectures/abdo_Wall_Defects.html (Sep 2005)*

Congenital defects of the diaphragm and abdominal wall

figure 17: Anomalies associated with exomphalos reported to CARIS (1998-2004)

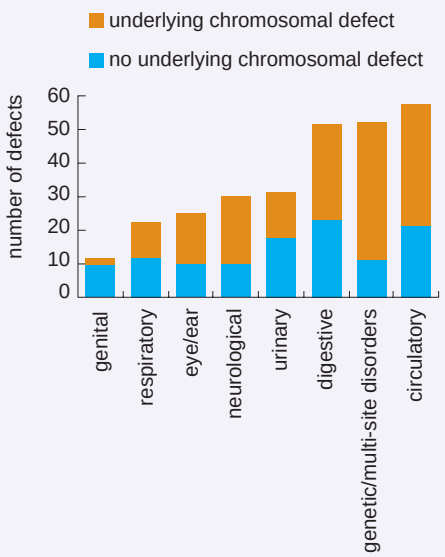
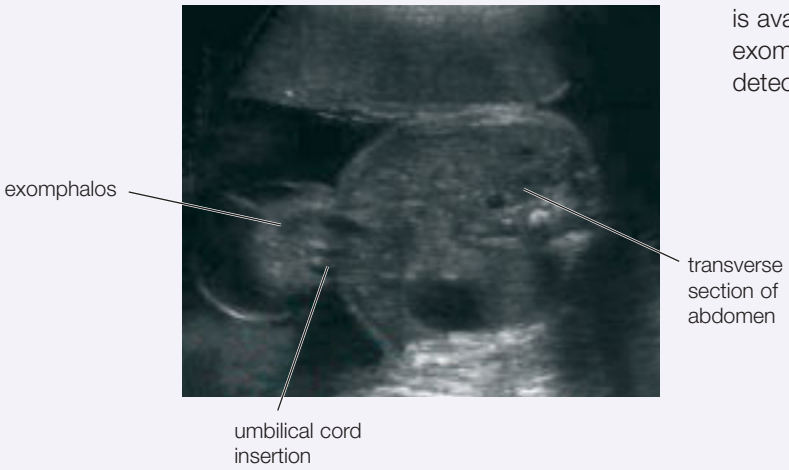


figure 18 Antenatal ultrasound scan showing exomphalos



In exomphalos, the bowel is enclosed within the hernial sac which has a relatively wide neck. Exomphalos therefore has a lower rate of associated bowel anomalies such as thickening or atresia, when compared with gastroschisis (see below).

Diagnosis

Mild forms are difficult to diagnose antenatally on ultrasound. Any transonic area at the base of the umbilical cord which is not a blood vessel is usually a loop of bowel in a minor exomphalos. The main differential diagnosis is that of gastroschisis. In exomphalos, the umbilical vein can be seen coursing through the sac of the hernia *(figure 18)* unlike the free loops of bowel visible in gastroschisis in the amniotic cavity. Initially it can be difficult to distinguish these two conditions at birth, especially if the membrane surrounding the exomphalos has ruptured. Differences between exomphalos and gastroschisis are summarised in *figure 19*.

Among CARIS cases the time of diagnosis is available for 79 / 98 cases of exomphalos. Of these, 74 (93%) were detected antenatally.

Congenital defects of the diaphragm and abdominal wall

figure 19: Key features of gastroschisis and exomphalos

	Gastroschisis	Exomphalos
Defect	Defect in the anterior abdominal wall.	Hernia of umbilical cord containing abdominal contents.
Prevalence in Wales	All cases: 5.5/10,000 live and still births. Liveborn: 1 in 1,800 live births.	All cases: 4.4/10,000 live and still births. Liveborn: 1 in 6,700 live births.
Ultrasound findings	Loops of bowel floating freely in amniotic cavity.	Widened sac seen at the cord insertion site containing bowel and other abdominal contents. The umbilical vein can be seen in the sac.
Maternal alphafetoprotein	Markedly elevated.	Elevated.
Detection rate in Wales	98% detected antenatally.	93% detected antenatally.
Associated anomalies	Not common, usually involve bowel thickening and atresia.	Common, karyotyping advisable. Chromosomal (30%) cardiac (30%) limb anomalies (30%).
Delivery	Can deliver vaginally Best delivered with access to neonatal surgery.	Can deliver vaginally Best delivered with access to neonatal surgery.
Management	Attention to heat and fluid loss from exposed abdominal contents; risk of infection and gastric distension.	
	Careful bowel handling Early closure necessary.	Early surgery necessary. Management of associated anomalies.
Outlook	Good prognosis but some babies have prolonged feeding difficulties.	Depends upon presence of associated anomalies. Possible good prognosis if isolated defect.

Outcome of exomphalos

Outcome is affected by the presence of other defects. Of the 34 liveborn cases in Wales, 22 (65%) are thought to have survived to the end of the first year of life. Of the 12 babies that died, over half (7) died within the first week of life.

Congenital defects of the diaphragm and abdominal wall

Prune belly syndrome

This very rare condition involves congenital deficiency of the abdominal muscles, urinary tract abnormalities and cryptorchidism. Three grades have been described

I severe renal and pulmonary disease, incompatible with life

II severe uropathy (requiring extensive reconstruction)

III healthy neonates requiring little or no surgery

Prune belly syndrome is said to occur in 1 in 50,000 to 1 in 100,000 births. CARIS has reports on 2 cases occurring in Wales between 1998 and 2004, both of which were live born and giving a rate of 1 in 110,000 live births.

The mechanism by which prune belly syndrome develops is not clear. Associated anomalies are common (over 90% of cases). The small number of cases known to CARIS means that further description of this condition in Wales is not yet possible.

Update on gastroschisis

Gastroschisis was considered in depth in the CARIS Review 1998-2003[12]. Key points on this anomaly are summarised in *figure 20.*

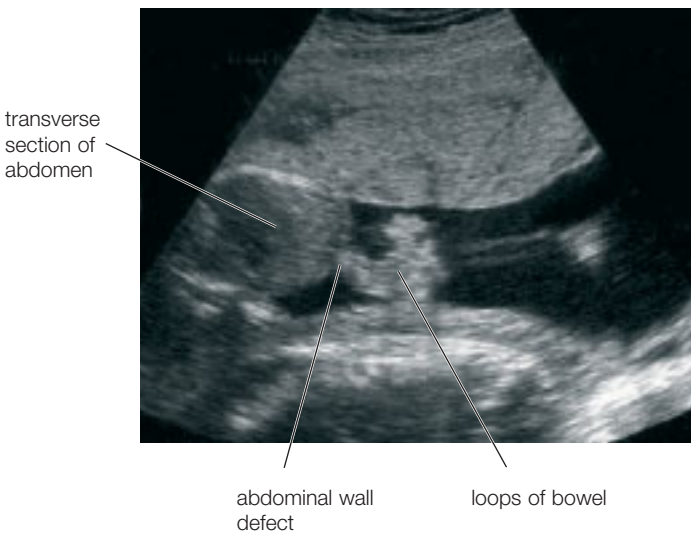
figure 20: Key points on gastroschisis

Defect	Herniation of abdominal contents through a defect in the anterior abdominal wall (usually to the right of the insertion of the umbilical cord, but the cord is not involved)
Associated defects	May be associated with small bowel atresia. No common associations with other anomalies.
Antenatal diagnosis	Abdominal contents (most often loops of bowel) float freely in the amniotic cavity and are normally visible on antenatal ultrasound (figure 21).
Prevalence	Generalised rise in prevalence at birth, especially in the Western World over the past 20 years. Clusters do occur, most notably in Wales in Bridgend in 2004
Cause / risk factors	Cause not clearly understood - may be a consequence of vasoconstrictor episodes in early pregnancy. Known risk factors include: • younger mothers • socially disadvantaged groups • mothers who smoke • maternal use of aspirin and anti cold remedies • maternal substance misuse (in minority of cases only) Links to various environmental pollutants have been suggested, including proximity to landfill sites.
Outcome	Feeding difficulties may follow surgery leading to a prolonged stay in hospital. Once recovered, babies generally do well.

[12] *Update on gastroschisis. CARIS annual review 1998-2003. (CARIS, 2004)*

Congenital defects of the diaphragm and abdominal wall

figure 21: Antenatal ultrasound scan showing gastroschisis



Gastroschisis in Wales 1998-2004

CARIS now has reports on 122 cases of gastroschisis in Wales with pregnancy ending 1998-2004 (gross rate is 5.5 / 10,000 live & stillbirths). Of these, 108 were live born (1 in 1800 births). During 2003 and 2004 there has been a sharp increase in cases across Wales (*figure 22*). There is evidence of a similar increase in some other parts of the UK. In general, rates for gastroschisis in Wales are higher than many other areas of Britain and Europe *(figure 12).* Against this background a cluster of cases was identified in Bridgend County during 2004. CARIS contributed to the investigation of this cluster, which was undertaken by a multi agency group. Unfortunately, no cause for the cluster was identified, as is often the case in this type of investigation. Further national actions undertaken as a result of the investigation include:

- developing proposals for ongoing research into gastroschisis at all-Wales / UK level
- a detailed literature review of the causes of gastroschisis
- development of enhanced surveillance proposals for congenital anomalies in Wales
- development of protocols to manage future investigations of this type

CARIS will report progress on these actions at a future date.

figure 22: Gross rates of gastroschisis in Wales, 1998-2004